Work.

Thriving in a Turbulent, Technological and Transformed Global Economy

Compete.

Council on Competitiveness

Work: Thriving in a Turbulent, Technological and Transformed Global Economy

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Letter from the President & CEO

Since its founding, the Council on Competitiveness has emphasized the key linkage between workforce skills and U.S. competitiveness, and analyzed emerging trends affecting the American workforce. Armed with this insight, the Council has engaged with stakeholders across the nation to promote new approaches to ensuring a competitive workforce that can unleash American innovation and sharpen the U.S. competitive edge, leading to increased productivity, greater prosperity and higher standards of living.

The Council's landmark National Innovation Initiative (NII) and action agenda—*Innovate America: Thriving in a World of Challenge and Change*—identified "talent" as one of three fundamental drivers of innovation and competitiveness. *Innovate America* set forth an agenda to build the U.S. base of scientists and engineers, catalyze the next generation of American innovators and empower U.S. workers to succeed in the global economy.

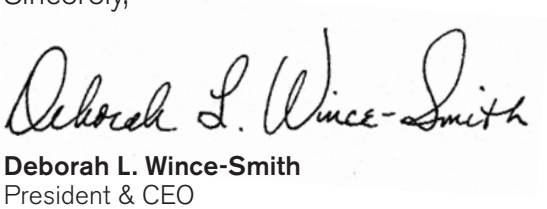
Building on the NII, the Council has remained focused on America's workforce through a series of dedicated initiatives and reports on topics such as 21st century manufacturing, energy and cutting-edge technology. In each of these efforts, the Council has emphasized the critical importance of education and workforce development. *Work: Thriving in a Turbulent, Technological and Transformed Global Economy* looks across these initiatives and reports, highlighting some of the many recommendations to strengthen America's workforce that emerged from this body of research, analysis and dialogue between U.S. business, education, technology and labor leaders.

Work also reviews important long-term trends affecting the U.S. labor market, and the challenges and opportunities they present for America's workers. Shifting drivers of the U.S. economy, globalization

and technological change are significantly affecting jobs and the skills in demand. American workers are creative, industrious risk-takers and among the world's most productive. But many lack the education and skills needed to secure high-paying jobs in the fast-paced, knowledge-based, technology-intensive economy that has evolved in the United States.

The recommendations in *Work* offer a roadmap to align U.S. education and training to 21st century skill needs, leverage our intellectual capital more effectively, supply our businesses with the talent needed to compete globally and enable America's most valuable competitive asset—our people—to apply their creativity and effort toward productive, prosperous lives.

Sincerely,



Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

Table of Contents

Council on Competitiveness Workforce Leadership Initiatives and Reports

America's Workforce as Critical Competitive Driver

2012 ***Accelerating and Innovating Workforce Development***
From the "Out of the Blue" dialogue held at Lehigh University and Air Products, discusses how to educate and motivate workers for jobs in 21st century manufacturing.

2012 ***Leveraging Talent Development to Drive Innovation***
From the "Out of the Blue" dialogue held at Snap-on Tools, discusses workforce challenges in and developing skills for 21st century manufacturing.

2011 ***Developing the Workforce as It Matures***
Profiles efforts across the country to help mature workers access training and job opportunities to return to work or continue working in a different capacity.

2010 ***Bridging the Skills Gap: Why Mature Workers Matter***
Examines the critical role of mature workers in the American economy, and discusses ways to extend the working lives of the baby boom generation.

2010 ***Regional Economic and Workforce Strategies: A Focus on the Mature Workforce***
Reviews strategies and programs that regional leaders might consider to help mature workers transition to jobs that meet the needs of workers and employers.

2009 ***Mobilizing a World Class Energy Workforce***
Recommendations on building an energy workforce of sufficient size and capabilities to meet the needs of a sustainable, secure energy system.

2008 ***Thrive. The Skills Imperative***
Analyzes key trends underpinning future workforce skills challenges and opportunities in the United States, demonstrating the urgent need for a national skills agenda.

2008 ***The Talent Imperative for Older Industrial Areas***
Explains the role of talent in regional economic development, and suggests approaches for regions to develop, retain and attract skilled workers, with a focus on policies and programs for older industrial areas.

2008 ***Cooperate***
A practitioner's guide for effectively aligning regional development and education through partnerships among K-12 schools, community colleges, adult education centers, universities, regional employers, and economic and workforce development organizations.

2013 and 2010 ***Global Manufacturing Competitiveness Index***
Identifies "talent-driven innovation" as top driver of manufacturing competitiveness; benchmarks U.S. talent-driven innovation against other countries.

2009–2011 ***Technology Leadership and Strategy Initiative***
Working group on talent addresses key role of workforce in U.S. technology leadership, and includes recommendations on better leveraging and enhancing that role.

2011 ***MAKE: An American Manufacturing Movement***
Highlights how a new era of manufacturing excellence offers hope for good jobs and how to harness the power of talent to revitalize American manufacturing.

2011 ***Ignite 3.0: Voices of American Labor Leaders on Manufacturing Competitiveness*** Discusses developing America's workforce for the 21st century and the role of American workers in U.S. manufacturing competitiveness.

2011 ***Ignite 2.0: Voices of American University Presidents and National Lab Directors on Manufacturing Competitiveness***
Discusses the critical importance of attracting, developing and retaining top science and engineering talent to drive world-class innovation and R&D, and the need to build strong STEM skills in American students.

2009 ***Drive. Private Sector Demand for Sustainable Energy Solutions***
Explores the potential for creating millions of new jobs through development of sustainable energy products and services, and outlines steps the United States can take to develop a workforce for a transformed energy system.

2007 ***Five for the Future***
Discusses the role of diversity, talent and creativity in innovation and competitiveness.

2007 ***Where America Stands: Entrepreneurship***
Benchmark analysis that looks at America's entrepreneurs.

2007 ***Competitiveness Index: Where America Stands***
Benchmark analysis on the global supply of professional labor, earnings and returns to education, work participation rates, workforce diversity, job churn, employment growth, unemployment, worker productivity, the science and engineering workforce, educational attainment and job training.

2005 ***Innovate America: Thriving in a World of Challenge and Change***
Groundbreaking action agenda to improve U.S. innovation capacity, including strengthening the U.S. talent base for research, innovation and commercialization.

Executive Summary

Radical Changes in the Landscape for America's Workforce

American workers have struggled with a historically slow recovery from the great recession. However, long-term trends also are affecting the American labor force in fundamental ways. U.S. workers are caught up in a turbulent economy being transformed by globalization, shifts in economic drivers and the rapid advance of digital technologies. Up and down the career ladder, and across the workforce landscape, mega trends are affecting U.S. labor markets, the occupational mix in the country, what people do on the job, and the skills they need to compete and succeed in a fiercely competitive global marketplace.

With the continued rapid evolution of technology and global commerce, the cycle of job creation, growth and destruction will continue into the future. The task ahead for Americans is to:

- Understand the economic and technological forces driving productivity and shaping the demand for high-value skills; and
- Develop a diversely skilled and adaptable workforce that can match or exceed the academic, entrepreneurial, creative and technical capabilities of workers in other countries.

Drivers of the Economy Have Changed, Creating Demand for Higher Skills

The primary drivers of the U.S. economy have radically changed. In the 19th century, agriculture and mineral extraction drove prosperity based on natural resources. In 1862, U.S. farms employed almost 60 percent of the U.S. labor force, and agriculture accounted for about 40 percent of U.S. gross domestic product (GDP). By the 1990s, farms employed only 3 percent of the labor force.[1]

Mass production drove 20th century America with machinery and capital. Manufacturing enterprises operated production facilities designed to deliver standard products at low cost. They were staffed with workers with relatively fixed job responsibilities and narrowly defined tasks completed using readily acquired skills.

In 1960, the manufacturing sector's share of U.S. GDP was about 27 percent; today its contribution to GDP is about 12 percent.[2] In 1979, at its peak headcount, the U.S. manufacturing sector employed 19.4 million people. In 2014, manufacturing employed about 12 million people and accounted for 9 percent of U.S. non-farm employment.[3]

In the 21st century, knowledge, technology and innovation drive the economy. For example, 35 years ago, about 80 percent of the market value of the S&P 500 was represented by tangible assets—brick, mortar, equipment and inventory. Today, about 80 percent of the value is represented by intangible assets—patents, trademarks, brands, research and software.[4] Increasingly, competitive and market success depends on people working with these intangible idea-based assets, and the technologies and management systems used to create value from them.

1. Colleges of Agriculture at the Land Grant Universities, National Academies Press, 1996.
2. U.S. Department of Commerce, Bureau of Economic Analysis.
3. Employment, Hours, and Earnings, Current Employment Statistics Survey (National), Bureau of Labor Statistics.
4. http://www.oceantomo.com/about/intellectualcapitalequity

Another way to look at the current U.S. economy is the major role played by knowledge and technology-intensive (KTI) industries. These include commercial knowledge-intensive business, financial and telecommunication services (including computer software and R&D); the knowledge-intensive public education and health services industries; and five high technology manufacturing industries—aircraft and spacecraft, communications equipment and semiconductors, computers and office machinery, pharmaceuticals, as well as testing, measuring and control instruments. These industries incorporate high technology either in their services or in the delivery of their services, or spend a large proportion of their revenues on R&D and make products that contain or embody technologies developed from R&D.[5]

The United States has the highest concentration of KTI industries among major economies, accounting for 40 percent of U.S. GDP. In 2014, these industries accounted for 29 percent of U.S. non-farm employment.[6]

Not surprisingly, the U.S. KTI industries have a higher-than-average share of skilled workers. In these industries, both the share of jobs that typically require an associate's degree or higher, and the share of jobs in knowledge-related occupational groups are higher, or are significantly higher than in manufacturing and the economy generally.

These long-term shifts in drivers of the economy have driven radical changes in occupational staffing patterns. Of 11 major occupational groups listed in the 1950 census, professional, technical and kindred workers had the largest percentage and numeric increase, rising from ninth largest to the largest occupational group. The five major occupational groups that increased include mostly occupations that work with information, ideas or people and, at least for professional and managerial occupations, have higher-than-average education requirements. In aggregate, the five groups that increased grew from 24 percent to 75 percent of total employment.[7]

Hyper Labor Competition to Perform the World's Work

Riding the tidal wave of transformation brought about by the fall of the Iron Curtain, globalization, trade liberalization and the digital revolution, billions of people in emerging economies have entered global commerce and swelled the global labor pool. The effective global labor supply quadrupled between 1980-2005, with most of this increase occurring after 1990.[8] For example, the four BRIC nations—Brazil, Russia, India and China—now represent 45 percent of the world labor supply, compared with less than 20 percent living in OECD countries.[9]

Today, many educated and skilled people in emerging economies compete to perform the world's work, often for wages lower than or comparable to their counterparts in advanced nations such as the United

5. Defined and classified by the Organisation for Economic Co-operation and Development.
6. Table B-1a., Employees on Nonfarm Payrolls by Industry Sector, Current Employment Statistics, Bureau of Labor Statistics.
7. Occupational Changes During the 20th Century, Monthly Labor Review, March 2006.
8. World Economic Outlook, Spillovers and Cycles in the Global Economy, April 2007, International Monetary Fund.
9. Globalisation, Jobs and Wages, Policy Brief, OECD, June 2007.

States. Just as they have new tools to reach markets around the world, employers—of all sizes, domestic and foreign—access the global labor pool through many channels. Employers tap global talent by:

- Offshoring or establishing new foreign operations;
- Moving routine rule-based work that can be digitized over telecommunications networks;
- Assembling global project teams; and
- Hiring talent through temporary worker visa programs.

Offshoring work once done in the United States—part of a larger trend in the growth of enterprises operating globally—has been driven by advances in telecommunications, widespread computerization, digitization of some work and services, and the availability of relatively well educated, English-speaking workers in other nations who perform work at lower cost. Some of the cost differentials reflect differences in not only wages, but also in skills and productivity, and the relatively lower complexity of work being performed.[10] The labor forces in many of these emerging economies have relatively lower productivity than in the United States, as measured by GDP per hour worked.[11] Beyond the cost of labor, the total cost of operation can include land, energy, taxes, regulation, transportation, currency rates, intellectual property theft and other factors. The impact of such factors varies by industry and firm, and affects where operations are located.

The nature of tasks workers perform plays a key role in the level of risk that the job will be offshored. A Bureau of Labor Statistics analysis identified 160 service-providing occupations that are susceptible to offshoring.[12] Those most susceptible include office and administrative support occupations with relatively low education or training requirements—such as telephone operators, computer operators, data entry keyers, typists, payroll clerks and medical transcriptionists—but also professional and related occupations which have higher educational requirements—such as credit analysts, insurance underwriters, pharmacists, financial analysts, biochemists and physicists.

The group of occupations found least susceptible consists largely of highly skilled occupations, most of which are professional and related occupations or management, business and financial operations occupations, including a range of managers (from public relations and marketing managers, to financial and operations managers); and a variety of engineers. While jobs most susceptible to offshoring have a range of education and training requirements—from short-term on-the-job training to doctoral degree, but mostly some level of on-the-job training—almost all of the jobs least susceptible to offshoring require a bachelor's degree or higher. Another characteristic of jobs least susceptible to offshoring involves work that is performed on site, such as the work of health and safety engineers, mining and geological engineers, urban and regional planners, and landscape architects.

10. Embracing the Challenge of Free Trade: Competing and Prospering in a Global Economy, Chairman Ben S. Bernanke, at the Montana Economic Development Summit, 2007, Board of Governors of the Federal Reserve System, May 1, 2007.
11. OECD (2015), GDP Per Hour Worked (indicator).
12. Service-providing Occupations, Offshoring, and the Labor Market, Monthly Labor Review, December 2008.

Work that can be routinized or handled by following a script is more susceptible to offshoring because work outputs and work processes are easier to define and monitor. By contrast, work that is more creative is more difficult to monitor, making companies less likely to have it performed from remote locations.[13] Generally, if a problem can be solved by a rule or a task performed with a straightforward process, a computer (or someone using a computer in a developing economy) will be able to do it.[14] However, data security and protection of intellectual property are concerns.

Labor Market Polarization

The labor market in the United States and other advanced economies is becoming polarized—demand has grown for high-end workers for jobs involving non-routine cognitive tasks and for low-skill/high-touch workers, but is weak for many middle-skill workers.[15] While low skilled and high skilled occupations have increased their share of employment over the past two decades, the employment share of middle skill jobs has declined.[16]

Non-routine manual jobs require little formal education, but require skills—some times substantial skills developed through significant on-the-job training, technical school or apprenticeship—for in-person interactions and hands-on tasks. Examples include home health care or janitorial jobs, or jobs in skilled trades such as plumbers, pipefitters, and HVAC mechanics and installers who work in factories, homes and businesses where there are pipes, septic systems and HVAC systems. These are hard to automate or offshore. As a result, the demand for these workers is generally high.

At the opposite end of the occupational skill distribution, demand for high-skill labor to perform non-routine cognitive tasks has grown rapidly. Non-routine cognitive tasks involve abstract thinking, analytical and problem solving work where there is no rule-based solution-complex work that varies case-by-case and complex communications.[17]

Jobs that include these types of complex tasks are growing two and a half times faster than jobs involving routine tasks, three times faster than jobs in the overall economy, and now employ about 40 percent of the U.S. workforce.[18] This kind of work often requires higher levels of education. Employment share in both manufacturing and non-manufacturing industries is rising for those with some college education or a college degree, and has declined for those with a high school diploma or less.[19]

In the middle are workers with intermediate skills employed in routine jobs—from manufacturing assembly line workers to office clerks—who perform

13. Service-providing Occupations, Offshoring, and the Labor Market, Monthly Labor Review, December 2008.
14. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT and Richard Murnane, Harvard University, May 31, 2006.
15. Labor-Market Polarization Over the Business Cycle, Christopher L. Foote and Richard W. Ryan, Federal Reserve Bank of Boston, December 6, 2012.
16. The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, David Autor, MIT Department of Economics and National Bureau of Economic Research, April 2010, http://economics.mit.edu/ files/5554.
17. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT, and Richard Murnane, Harvard University, May 31, 2006.
18. The Next Revolution in Interactions, by Bradford C. Johnson, James M. Manyika, and Lareina A. Yee, McKinsey Quarterly, November 2005.
19. Economics and Statistics Administration, U.S. Department of Commerce Calculations using Current Population Survey data, National Bureau of Economic Research.

procedural rule-based tasks that are easier to ship offshore to countries with lower wages, or easier and more attractive to automate as the cost of automation falls.[20]

The shift from routine jobs to manual and cognitive non-routine jobs is spreading across the economy, intensifying the polarization of employment opportunities in the United States. This polarization goes beyond a shift in the sector composition of employment in the economy (i.e., just job losses in manufacturing); it is a shift in the occupational mix within all industries.[21]

These trends can also be seen in higher rates of employment growth for those with higher education, and job losses for those with a high school diploma or less. This gap has been widening.

The wage gap between those with higher education and less education has also been widening. Since the 1980s, the average wage for college graduates increased from about one and a half times the wage for workers with only a high school degree to about two times their wage.[22] For example, data from the Bureau of Labor Statistics show that among full-time workers age 25 and over, those holding a bachelor's degree but no advanced degree had $1,101 median weekly earnings in 2014, compared to $668 for those with a high school diploma and no college.[23]

Wage premiums for higher educational attainment are not unique to the United States. The relative earnings premium for those with a college education increased in most OECD countries over the past ten years. Among OECD countries, the United States has one of the largest earnings premiums for university-level educated workers.[24]

The Digital Revolution and Rise of Machines

Over the past 25 years, investment in digital equipment and software has grown an average of more than 5.0 percent annually, and growth was particularly strong from 1992-2000 when investment grew an average of almost 12 percent annually. Today, private investment in information processing equipment and software exceeds $600 billion annually.

Widespread computerization and telecommunications networking across global business and industry has transformed work—the ways in which, and the speed with which, people connect, collaborate, design and build, locate and manage resources, manipulate tools, conduct research, analyze and forecast, reach markets, move and track products, make transactions and perform a myriad of other daily work tasks.[25]

20. The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, David Autor, MIT Department of Economics and National Bureau of Economic Research, April 2010; Labor-Market Polarization Over the Business Cycle, Christopher L. Foote and Richard W. Ryan, Federal Reserve Bank of Boston, December 6, 2012; and Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.
21. Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.
22. Governor Daniel K. Tarullo, Unemployment, the Labor Market, and the Economy, Remarks at the World Leaders Forum, Columbia University, Board of Governors of the Federal Reserve, October 20, 2011.
23. Earnings and Unemployment Rates by Educational Attainment, 2014, Current Population Survey, U.S. Bureau of Labor Statistics, U.S. Department of Labor.
24. Country Note, United States, Education at a Glance 2013 and 2015. OECD Indicators.
25. Futurework: Trends and Challenges for Work in the 21st Century, U.S. Department of Labor, 1999.

The IT revolution not only has allowed workers to "crank" the machine faster, but also created opportunities to fundamentally change the way production and service delivery are organized, and the way work organizations operate. Mobile handheld devices take computing power where workers go, decoupling work from desktop and place. Social networks and peer-to-peer knowledge sharing software are becoming drivers of workplace productivity—not simply social ones. High-performance computing, coupled with "big data" and the "Internet of Things"—vast clouds of interconnected devices and sensors—are allowing real-time and deep analysis across fields ranging from scientific research and the electricity grid, to consumer marketing and manufacturing.

Machines, autonomous systems, sensors and software are increasingly capable of doing routine tasks that have made up jobs for millions of Americans. For example, Internet systems provide customers with account information and payment processing. Tax preparation software carries out work once performed by accountants. Financial institutions use software to assess credit risk. Sensors and imaging technologies perform security functions. More powerful computers, "big data," advances in natural language processing and user interfaces are likely to augment performance in some high skilled jobs, but allow for the automation of others.[26]

Digital technologies have also enabled the practice of breaking down jobs into tasks, sorting repetitive, rule-based tasks from more complex tasks. The routine tasks may then be automated or performed in low cost locations around the world.[27]

The price of automation has fallen significantly in the past few decades, both in absolute terms and relative to the cost of labor.[28] As the cost of labor rises, and the cost of automation declines, it becomes more attractive to automate work and eliminate some jobs.

While many lower skilled workers perform tasks easier to automate, or tend to use technology that reduces the skills needed on the job, technology tends to favor those with higher skills.[29] High-skill workers use technology to enhance their capabilities, using computers to write, perform research, design products and deliberate with others.[30]

Rapid Technological Change and Disruption

Disruptive technologies and innovations can drive a reordering at every level of the economy—from the workplace to the labor market to the mix of industries in a community or country—creating new opportunities for some workers, but also hardships for others. The process of reorganization may create new jobs while eliminating others, create new occupations, or change the occupational mix, tasks to be performed and the skills in demand. For example, digital technologies drove the creation of new industries, created new occupations and many new jobs, but also undermined jobs in other industries and occupations.

26. The Future of Employment: How Susceptible Are Jobs to Computerisation, by Carl Benedikt Frey and Michael A. Osborne, University of Oxford, September 17, 2013.

27. An Economy that Works: Job Creation and America's Future, McKinsey Global Institute, June 2011.

28. Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.

29. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT, and Richard Murnane, Harvard University, May 31, 2006.

30. The Missing Middle: Aligning Education and the Knowledge Economy, by Anthony Carnevale and Donna Desrochers, Educational Testing Service, April 2002.

Disruption is ongoing. Today, Uber drivers are disrupting the work of traditional taxi drivers. Digital equipment has disrupted the film industry, and mobile phones and YouTube are impacting broadcasting. Netflix is challenging cable and broadcast entertainment models, while iTunes is reordering the music industry.

For the United States to leverage rapid advances in technology—especially revolutionary technologies—for their highest economic benefit and productivity gains, businesses must be able to reorganize themselves in ways that take advantage of new technologies, and drive transformation in industry and the economy. Labor markets must be flexible to allow for the rapid reallocation of human capital in response to changes in demand.[31]

Higher-skilled workers are not only at a premium when new technologies are introduced, because they are better able to use them, they are also better prepared to move to new industries, new jobs, new occupations or new skills when displaced by technological, labor market or market disruptions.

Bottom Line for U.S. Workers

The shift in drivers of the economy, advances in technology and the nature of tasks people do on the job have placed a premium on high-skill workers who posses the knowledge that drives service and product innovation, who can engage with customers and colleagues to accomplish organizational goals, and who can perform complex, non-routine tasks.

As we move from a "brute force" to a "brain force" economy, the markets for intellectual capital are growing, and employers look regionally, nationally and globally for top talent, top project teams and locations rich with talent for their business investment. In today's technology- and information-driven economy, skills are the name of the game, and those who invest in education and skills development are more competitive in the workforce, earn more, have lower risk of unemployment and propel the next generation of prosperity.

Answering the Challenges of New Workforce Realities

The trends discussed in *Work* highlight the employment realities of today's highly productive, dynamic, technology- and information-driven economy. Education and skills are essential for success, and those who invest in developing them will be more competitive in the labor market and more successful transitioning as technological change or market forces disrupt labor markets. The long-term, widening gap in income growth across levels of education attainment places education and skills center stage for securing prosperity for Americans and reducing income inequality.

America has the ability to address some of the challenges brought by new realities of the labor market, the workforce and the workplace. The United States must develop strategies to prepare the workforce for adapting to rapid change, and to reach for high-

31. How Economies Grow, The CED Perspective on Raising the Long-Term Standard of Living, Committee for Economic Development, May 2003; International Capital Flows and the Emerging Market Economies, Speech by Governor Randall Kroszner, (at the Central de la Republica Argentina Seminar), Board of Governors of the Federal Reserve System, May 15, 2007.

wage, non-routine cognitive jobs. Every aspect of the education and training system from K-12 to workforce development must function well to prepare the full spectrum of workers—high school and college graduates, adult workers and mature workers—with the skills they need to compete in the 21st century economy.

As stewards of the future, it is incumbent upon America's leaders in government, industry, institutions of education and labor organizations to cultivate an agile and resilient workforce, able to withstand the storms of change and adapt during the droughts of recession. For America's true competitiveness rests in the efficiency with which the nation reallocates productive resources, including the adaptability of its workforce.

National Skills Agenda

- Establish a National Skills Agenda
- Build foundations for success in a high skill knowledge- and technology-driven economy
  - Get ready for the workplace by encouraging real-world skills and experience
  - Develop science and engineering skills, and a science and engineering workforce for the new economy
  - Nurture the next generation of entrepreneurs
- Skill-up for the energy revolution and sustainability
- Expand access to and transform systems for acquiring work skills
  - Support technical and professional skills development
  - Establish new pathways to transition veterans into the workforce
  - Keep mature workers competitive in the labor market and productive in the workplace
  - Develop better labor market information systems

Radical Changes in the Landscape for America's Workforce

American workers have struggled with a historically slow recovery from the great recession. While there have been 10 previous postwar recessions, ranging in length from six to 16 months, the 2007-2009 recession was the longest in the postwar period at 18 months. The 2007-2009 recession was also the deepest recession in the postwar period.[32]

However, long-term trends also are affecting the American labor force in fundamental ways. U.S. workers are caught up in a turbulent economy being transformed by globalization, shifts in economic drivers and the rapid advance of digital technologies. Up and down the career ladder, and across the workforce landscape, mega trends are affecting U.S. labor markets, the occupational mix in the country, what people do on the job, and the skills they need to compete and succeed in a fiercely competitive global marketplace.

Structural changes have eliminated many jobs for skilled workers, while increased global market integration has led to some low-skilled jobs moving overseas where labor is less expensive. Advances in technology have created many new high-wage jobs, but have also enabled the automation of many jobs, increasing productivity and output for some firms without generating significant employment growth.

Many Americans face these competitive realities lacking the level of education and skill that would allow them to thrive in today's complex, knowledge-intensive economy, threatening greater income inequality and unemployment. In a world of rapid, continuous and unpredictable change, highly educated workers are better able to work productively in many different types of jobs than those with less education.

The relentless march of globalization and technological change has wrought wrenching social, economic and personal upheaval on many families, towns and communities. In every era of American history, economic and technical transition has brokered uneven benefits—for a time—on different regions, professions and classes of workers. But history also has proven that nations and communities that adapt to such change rather than hide from it tend to prosper the most. Experience shows that productivity, in the medium and long run, is the most effective driver of both employment and wealth creation.

With the continued rapid evolution of technology and global commerce, the cycle of job creation, growth and destruction will continue into the future. The task ahead for Americans is to:

- Understand the economic and technological forces driving productivity and shaping the demand for high value skills; and
- Develop a diversely skilled and adaptable American workforce that can match or exceed the academic, entrepreneurial, creative and technical capabilities of workers in other countries.

Drivers of the Economy Have Changed, Creating Demand for Higher Skills

The primary drivers of the U.S. economy have radically changed. In the 19th century, agriculture and mineral extraction drove prosperity based on

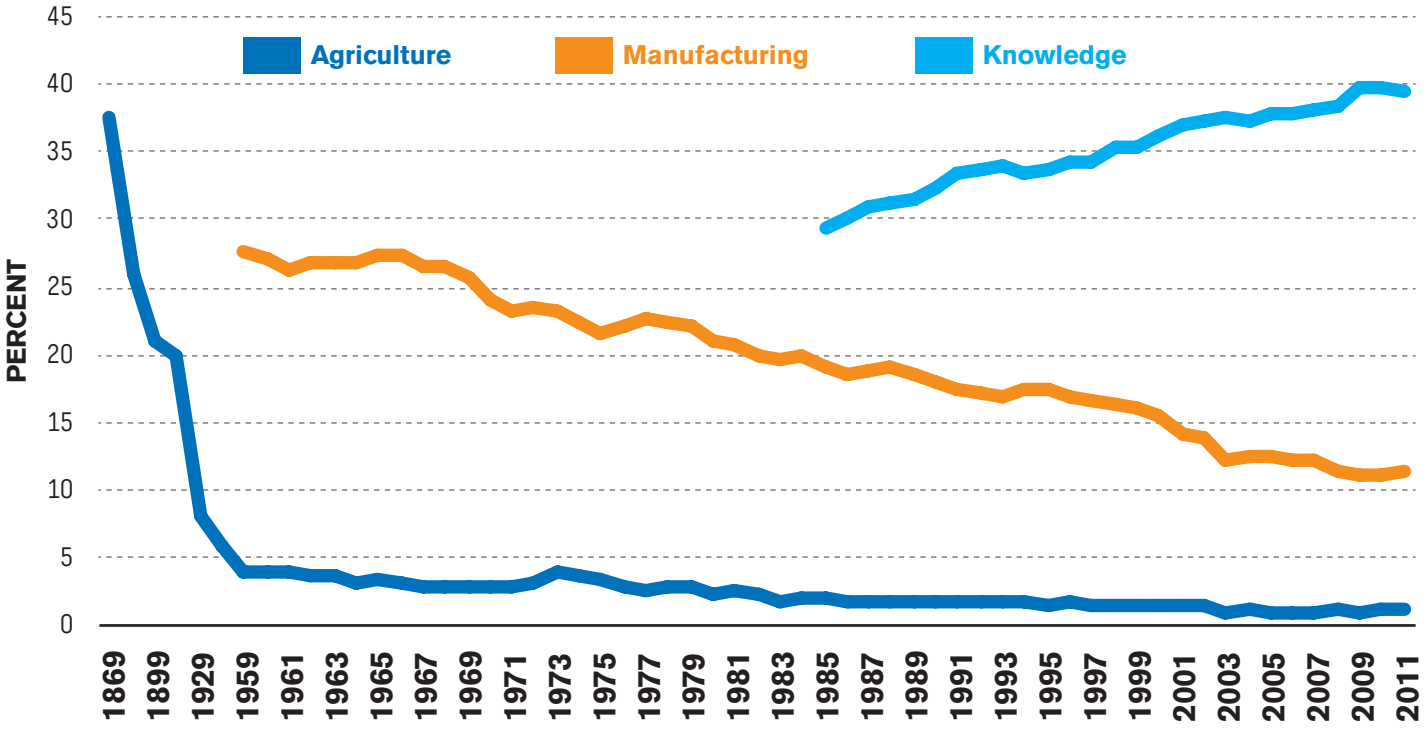
32. The Recession and Recovery in Perspective, Federal Reserve Bank of Minneapolis, https://www.minneapolisfed.org/publications/special-studies/rip/recession-in-perspective.

natural resources. In 1862, U.S. farms employed almost 60 percent of the U.S. labor force, and agriculture accounted for about 40 percent of U.S. gross domestic product (GDP). By the 1990s, farms employed only 3 percent of the labor force.[33]

Mass production drove 20th century America with machinery and capital. Manufacturing enterprises operated production facilities designed to deliver standard products at low cost. They were staffed with workers with relatively fixed job responsibilities, and narrowly defined tasks completed using readily acquired skills. As technological change accelerated and consumers welcomed an expanding range of choices, mass production's inflexibility burdened innovation and new product introduction and, as global infrastructure developed, manufacturing enterprises could more easily move routine work to lower-wage regions.

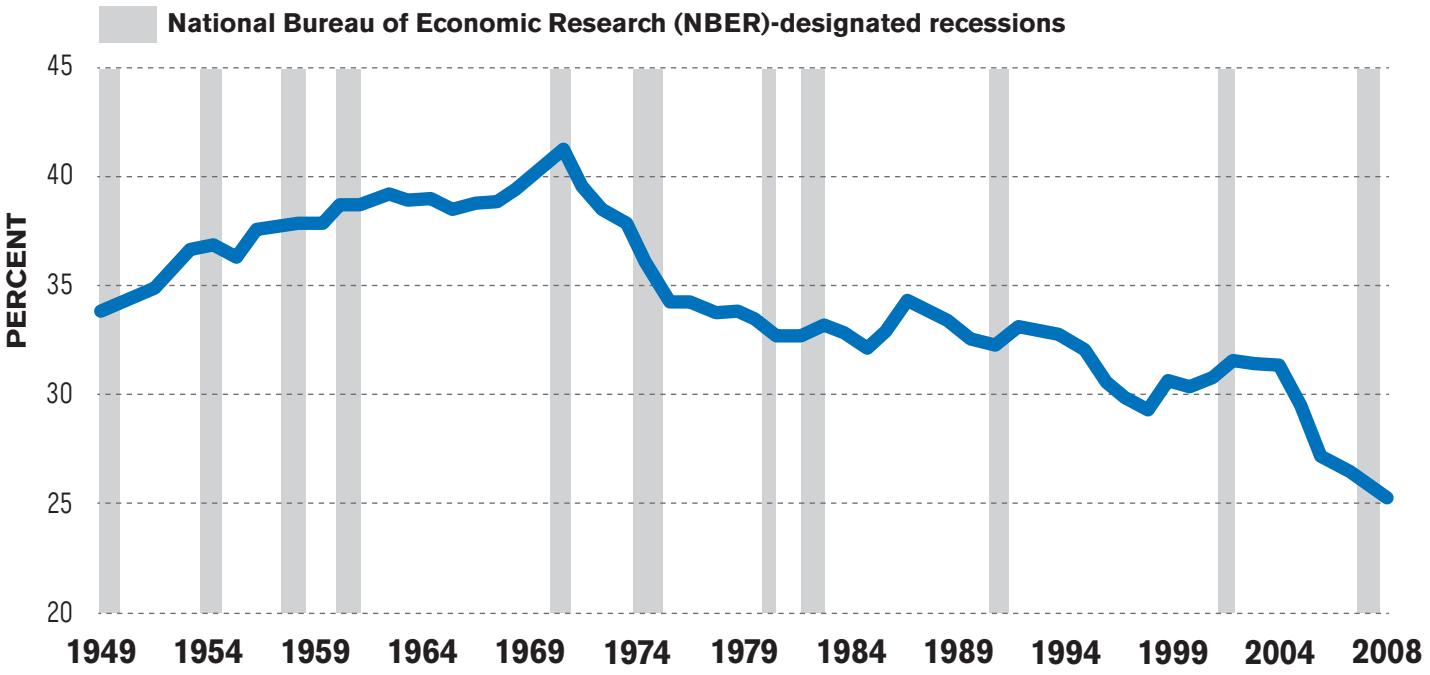
Figure 1. Share of U.S. GDP: Agriculture, Manufacturing, Knowledge/Technology-intensive Industries (estimated)

Publicly Available Data Sources: A Brief History of Agriculture, Persistence Pays, U.S. Agriculture Productivity Growth and the Benefits from Public R&D Spending (Alston, Anderson, James, Pardey), 2010, Springer; Economic Reports of the President; Science and Engineering Indicators, National Science Foundation. Data not readily available for all years.



33. Colleges of Agriculture at the Land Grant Universities, National Academies Press, 1996.

Figure 2. Labor Share of Manufacturing Sector Output, 1949-2008
Source: Bureau of Labor Statistics



From 1960 to 2011, the manufacturing sector's share of U.S. GDP declined from 27 percent to about 12 percent.[34] After growing quickly during the 1950s and the 1960s, labor's share of output in manufacturing declined steadily, as companies became increasingly more capital intensive.[35] Manufacturing's share of U.S. employment dropped from a high spike of 38 percent during World War II (1943-1944), to about 30 percent in the early 1950s.

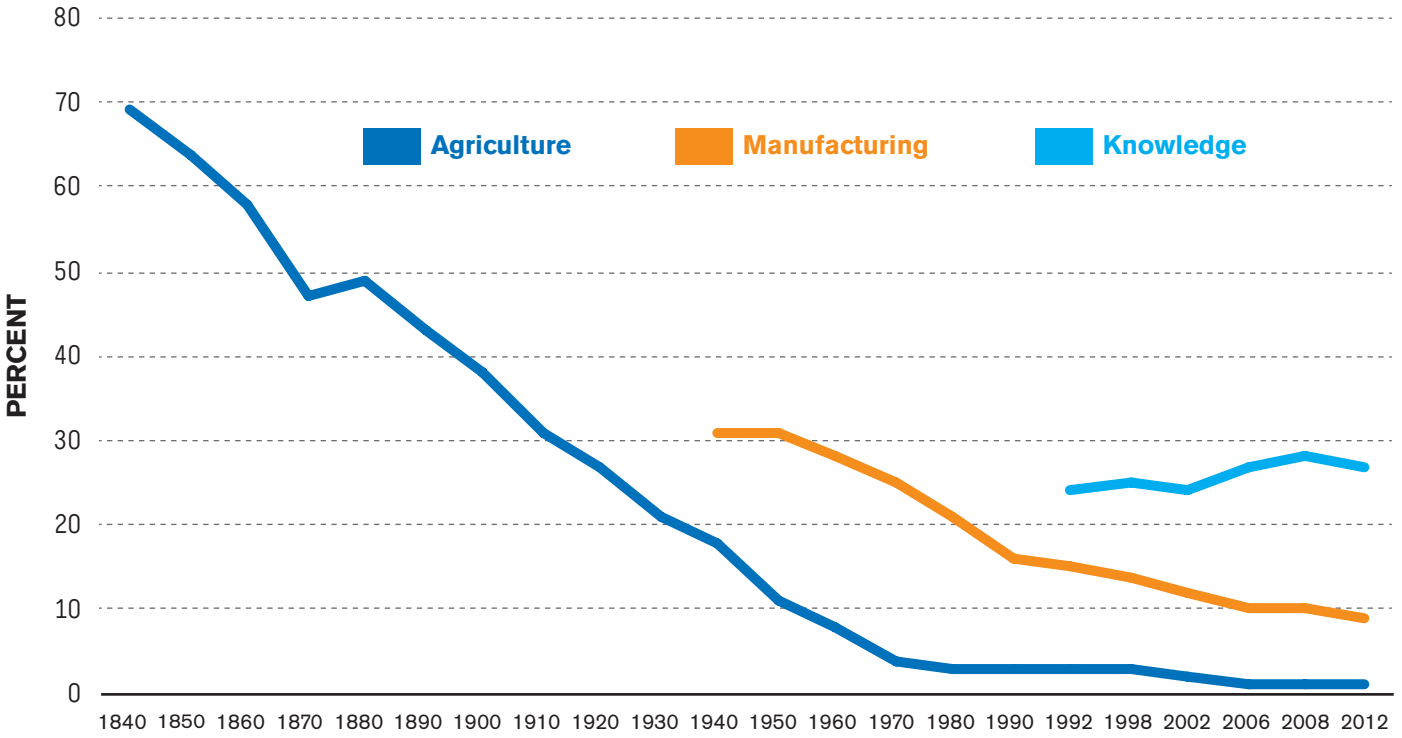
In 1979, at its peak headcount, the U.S. manufacturing sector employed 19.4 million people. In 2014, manufacturing employed about 12 million people and accounted for 9 percent of U.S. non-farm employment.[36]

Today, infused with high technology in all aspects of production and business, the manufacturing sector is up-skilling. The share of manufacturing employment held by people with some college education has increased to more than half, 53 percent in 2011, up from 43 percent in 1994.[37] Some 29 percent possess college degrees.[38] Only two in five manufacturing employees are directly involved in making things.[39] As of 2014, 31 percent of all manufacturing workers held management and professional jobs.[40] And, many new jobs in the sector are in the information technology field and require workers who can operate networked robotic machines, develop software and manipulate electronic databases.[41]

34. U.S. Department of Commerce, Bureau of Economic Analysis.
35. The Compensation-Productivity Gap: A Visual Essay, Monthly Labor Review, January 2011.
36. Employment, Hours, and Earnings, Current Employment Statistics Survey (National), Bureau of Labor Statistics.
37. The Benefits of Manufacturing Jobs, Economics and Statistics Administration, U.S. Department of Commerce, May 2012.
38. U.S. Manufacturing in International Perspective, Congressional Research Service, March 17, 2015.
39. Job Creation in the Manufacturing Revival, Congressional Research Service, July 2, 2015.
40. Job Creation in the Manufacturing Revival, Congressional Research Service, July 2, 2015.
41. Industry Employment Projections, 2012-2022, Bureau of Labor Statistics, December 2013.

Figure 3. Share of U.S. Employment: Agriculture, Manufacturing, Knowledge/Technology-intensive Industries (estimated)

Publicly Available Data Sources: Colleges of Agriculture at the Land Grant Universities, National Academies Press, 1996; Current Employment Statistics Survey, and Industry Employment and Output Projections (multiple years), Bureau of Labor Statistics; Appendix B. Economic Report of the President. Data not readily available for all years.



In the 21st century, knowledge, technology and innovation drive the economy, and intellectual capital is among the most important resources for production. For example, 35 years ago about 80 percent of the market value of the S&P 500 was represented by tangible assets—brick, mortar, equipment and inventory. Today, about 80 percent of the value is represented by intangible assets—patents, trademarks, brands, research and software.[42] Increasingly, competitive and market success depends on people working with these intangible idea-based assets, and the technologies and management systems used to create value from them.

Another way to look at the current U.S. economy is the major role played by knowledge and technology-intensive (KTI) industries. These include commercial knowledge-intensive business, financial and telecommunication services (including computer software and R&D); the knowledge-intensive education and health services industries; and five high technology manufacturing industries—aircraft and spacecraft, communications equipment and semiconductors, computers and office machinery, pharmaceuticals as well as testing, measuring and control instruments. These industries incorporate high technology either in their services or in the delivery of their services, or spend a large proportion of their revenues on R&D and make products that contain or embody technologies developed from R&D.[43]

The United States has the highest concentration of KTI industries among major economies, accounting for 40 percent of U.S. GDP. The KTI concentrations for the European Union and Japan are considerably

42. http://www.oceantomo.com/about/intellectualcapitalequity

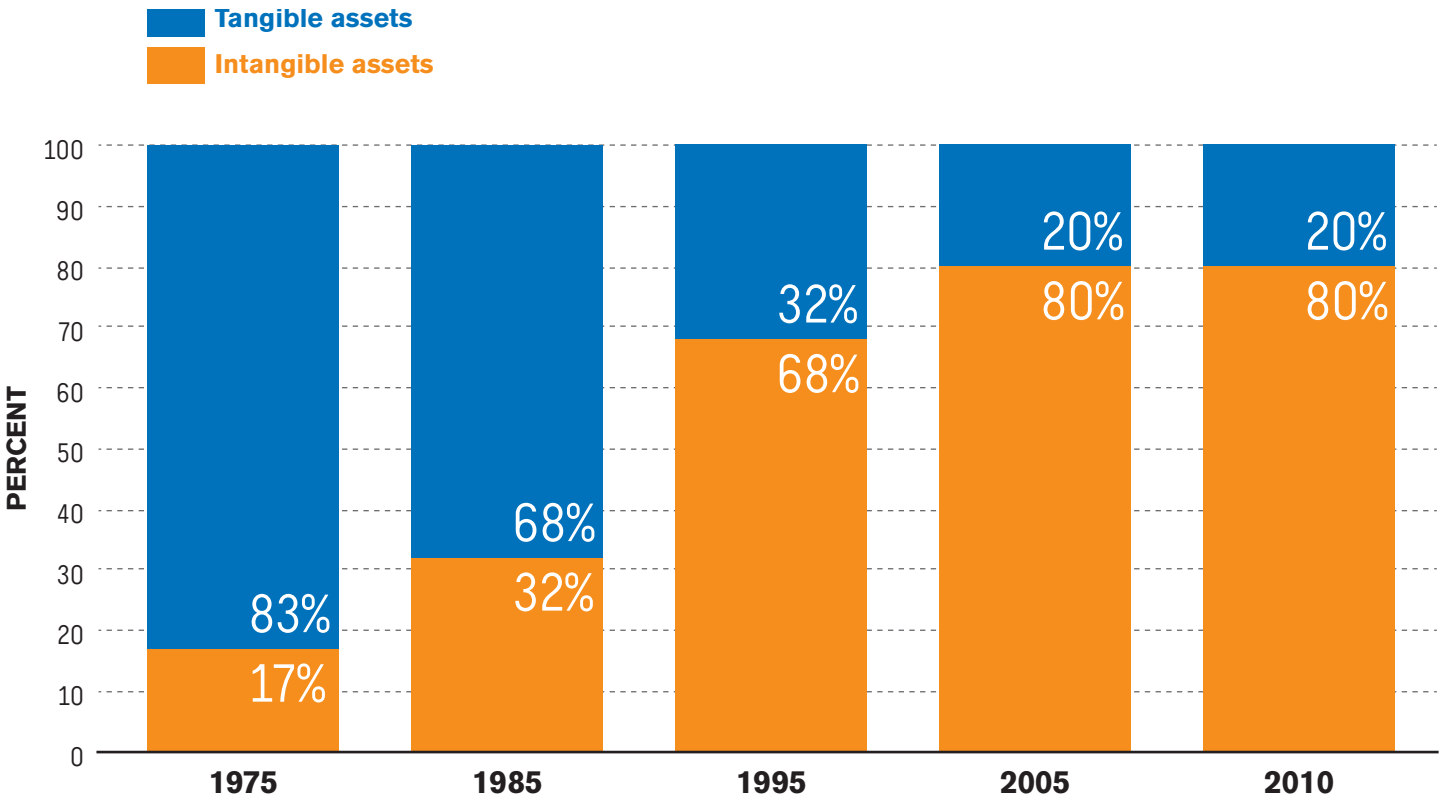
43. Defined and classified by the Organisation for Economic Co-operation and Development.

lower at 29–30 percent.[44] In 2014, these industries accounted for 29 percent of U.S. non-farm employment.[45]

Knowledge and innovation drive these industries more than in other industries. The five high technology manufacturing industries reported rates of product innovation that were at least double the U.S. manufacturing sector average. In the U.S. non-manufacturing sector, software firms were the leading innovators, with 69 percent of companies reporting the introduction of a new product or service compared to the 9 percent average for all non-manufacturing companies. Innovation is two to three times higher than the non-manufacturing average in computer systems design; data processing, hosting and related services; and scientific R&D services.[46]

Not surprisingly, the U.S. KTI industries have a higher-than-average share of skilled workers. Table 1. highlights KTI industries' knowledge occupation intensity. It shows the percentage of employees in each industry represented by knowledge-related occupational groups, including: management; business and financial; computer and mathematical; architecture and engineering; life, physical and social sciences; legal; education and library; healthcare practitioners and technical occupations. The table also shows, in

Figure 4. Components of S&P 500 Market Value: United States
Source: Ocean Tomo



44. Science and Engineering Indicators 2014, National Science Foundation.

45. Table B-1a., Employees on Nonfarm Payrolls by Industry Sector, Current Employment Statistics, Bureau of Labor Statistics.

46. Science and Engineering Indicators 2014, National Science Foundation.

each KTI industry, the share of jobs that typically require an associate's degree or higher. In both cases, the knowledge worker and educational intensity of KTI industries is higher, or significantly higher, than in manufacturing and the economy generally.

Looking to the future, over the years 2014-2024, knowledge intensive industries are expected to be among the industries with both the fastest growing employment and the largest employment growth.[47] Of the top 20 industries projected to have the fastest growing employment, 15 are KTI-related. Of the top 20 industries projected to have the largest employment growth, 12 are KTI-related.

These long-term shifts in drivers of the economy have driven radical changes in occupational staffing patterns. Of 11 major occupational groups listed in the 1950 census, professional, technical and kindred workers had the largest percentage and numeric increase, rising from ninth largest in the previous census to the largest occupational group. Five of the major occupational groups increased as a share of the total, while six declined. The five that increased include mostly occupations that work with information, ideas or people and, at least for professional and managerial occupations, have higher-than-average education requirements. In aggregate, the five groups that increased grew from 24 percent to 75 percent of total employment.[48]

Table 1. Knowledge Occupation Intensity and Education Requirements in KTI (estimated)
Source: Council on Competitiveness analysis of Bureau of Labor Statistics data.

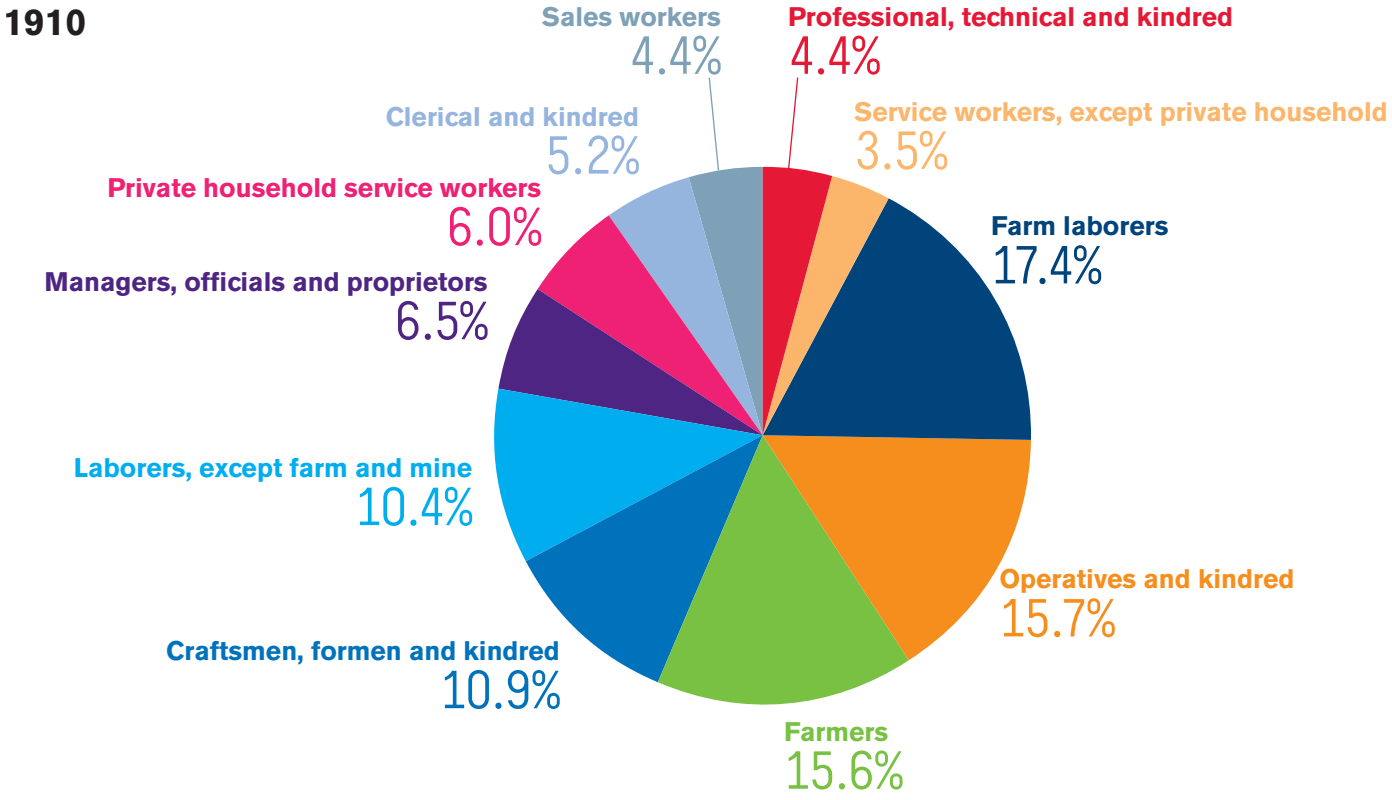
KTI Industry	% Knowledge Worker-Related Occupations	% of Jobs Typically Requiring Associate Degree or Higher
Finance and Insurance	40%	40%
Management of Companies and Enterprises	59%	59%
Professional, Scientific, Technical Services	65%	65%
Software Publishing	78%	80%
Telecommunications	32%	32%
Education Services	71%	70%
Healthcare and Social Assistance	41%	40%
Aircraft and Aerospace	48%	48%
Computers and Electronics Manufacturing	54%	58%
Pharmaceuticals	47%	48%
All Occupations in the Economy	29%	26%
Manufacturing	20%	20%

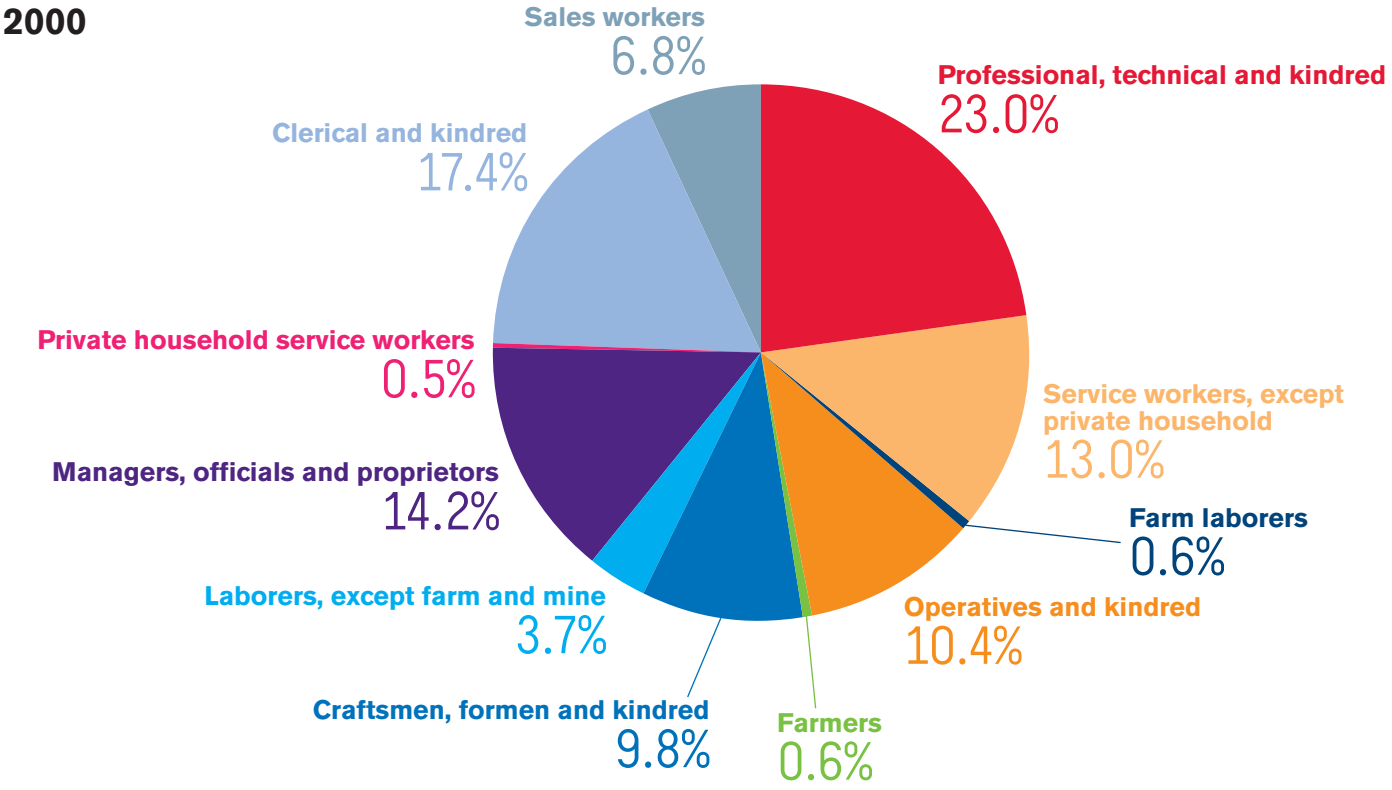
47. Industry Output and Employment Projections for 2014-2024, Bureau of Labor Statistics, U.S. Department of Labor.

48. Occupational Changes During the 20th Century, Monthly Labor Review, March 2006.

Figure 5. Proportional Employment in Occupational Categories

Source: U.S. Bureau of Labor Statistics





Hyper Labor Competition to Perform the World's Work

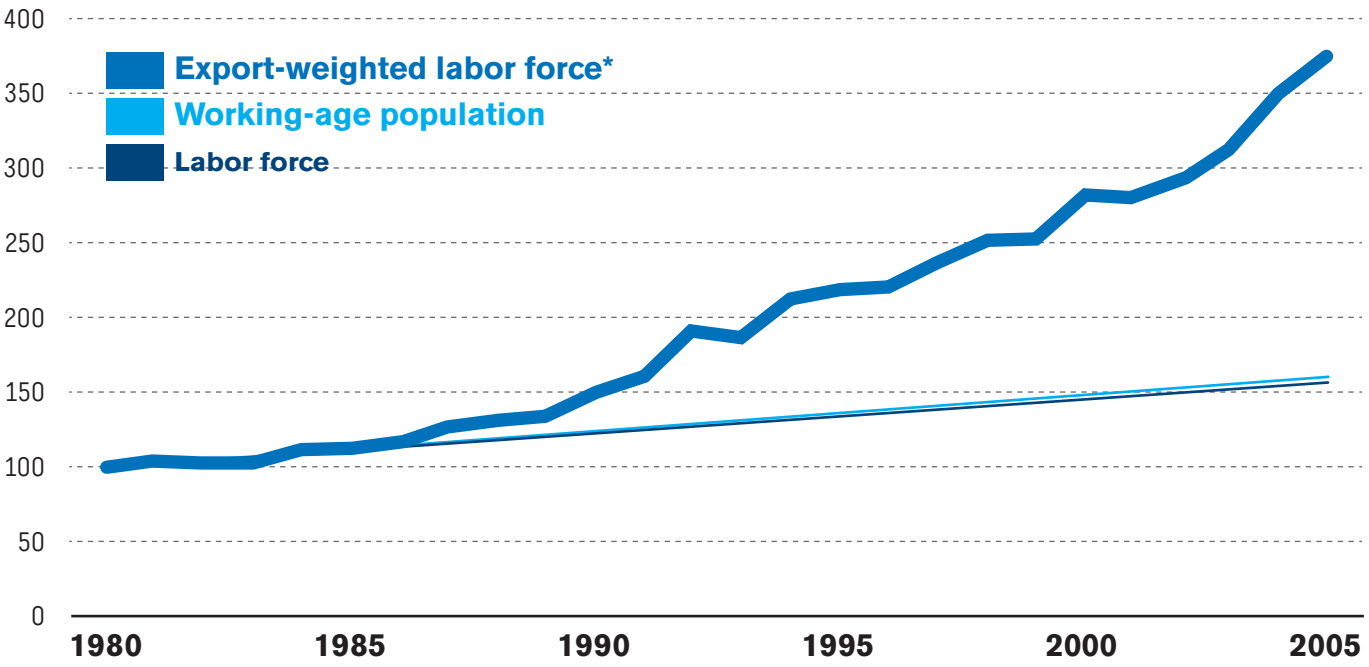
The fall of the Iron Curtain in 1989 began a process of many nations adopting more market-oriented economies, including regimes across the former Soviet Union, Eastern Europe and China. Many less-developed countries in Asia and Latin America followed suit, reducing barriers to trade and investment, and joining the World Trade Organization. As a result, trade and the movement of capital between countries expanded rapidly.

Riding the tidal wave of transformation brought about by globalization, trade liberalization and the digital revolution, billions of people in emerging economies have entered global commerce and swelled the global labor pool. The effective global labor supply quadrupled between 1980-2005, with most of this increase occurring after 1990.[49] For example, the four BRIC nations—Brazil, Russia, India and China—now represent 45 percent of the world labor supply, compared with less than 20 percent living in OECD countries.[50]

Today, many educated and skilled people in emerging economies compete to perform the world's work, often for wages that are lower than or comparable to their counterparts in advanced nations such as the United States. Just as they have new tools to reach markets around the world, employers—of all sizes, domestic and foreign—access the global labor pool through many channels. Employers tap talent globally by:

- Offshoring or establishing new foreign operations;
- Moving routine rule-based work that can be digitized over telecommunications networks;
- Assembling global project teams; and
- Hiring talent through temporary worker visa programs.

Figure 6. Global Labor Supply (index, 1980=100)
Source: International Monetary Fund



*National labor forces scaled by export-to-GDP ratios.

49. World Economic Outlook, Spillovers and Cycles in the Global Economy, April 2007, International Monetary Fund.

50. Globalisation, Jobs and Wages, Policy Brief, OECD, June 2007.

In addition to widespread deployment of digital computing and telecommunications technologies, a large increase in the number of global enterprises, and efforts by governments around the world to attract jobs, have further advanced the globalization of labor. In the early 1990s, there were about 37,000 of these global enterprises, with 170,000 affiliates in foreign countries.[51] By 2010, there were more than 103,000 parent companies, and their foreign affiliates had grown to more than 890,000.[52] These firms are a major source of foreign direct investment. In a 2014 UNCTAD global survey of investment promotion agencies (IPAs) on incentives for foreign investors, job creation ranked as the most important objective of investment incentives. About 85 percent of IPAs indicated that job creation ranks among their top five objectives, with almost 75 percent ranking it their primary or secondary objective.[53]

Offshoring of work once done in the United States—part of a larger trend in the growth of enterprises operating globally—has been driven by advances in telecommunications, widespread computerization, digitization of some work and services, and the availability of relatively well educated, English-speaking workers in other nations who perform work at lower cost. Some of the cost differentials reflect differences in not only wages, but also skills and productivity, and the relatively lower complexity of work being performed.[54] The labor forces in many of these emerging economies have relatively lower productivity than in the United States, as measured by GDP per hour worked.[55]

Although wage rates are undoubtedly a factor in where manufacturing activity is located, wage rates are not the sole determinant (even for routine work). The total cost of production includes land, energy, taxes, regulations, transportation, intellectual property protection, currency rates and other factors. The impact of such factors varies by industry and firm, some of which require special skills, proximity to customers or robust local supply networks to compete. The largest overseas stock of U.S. investment remains in Europe rather than in low wage nations.

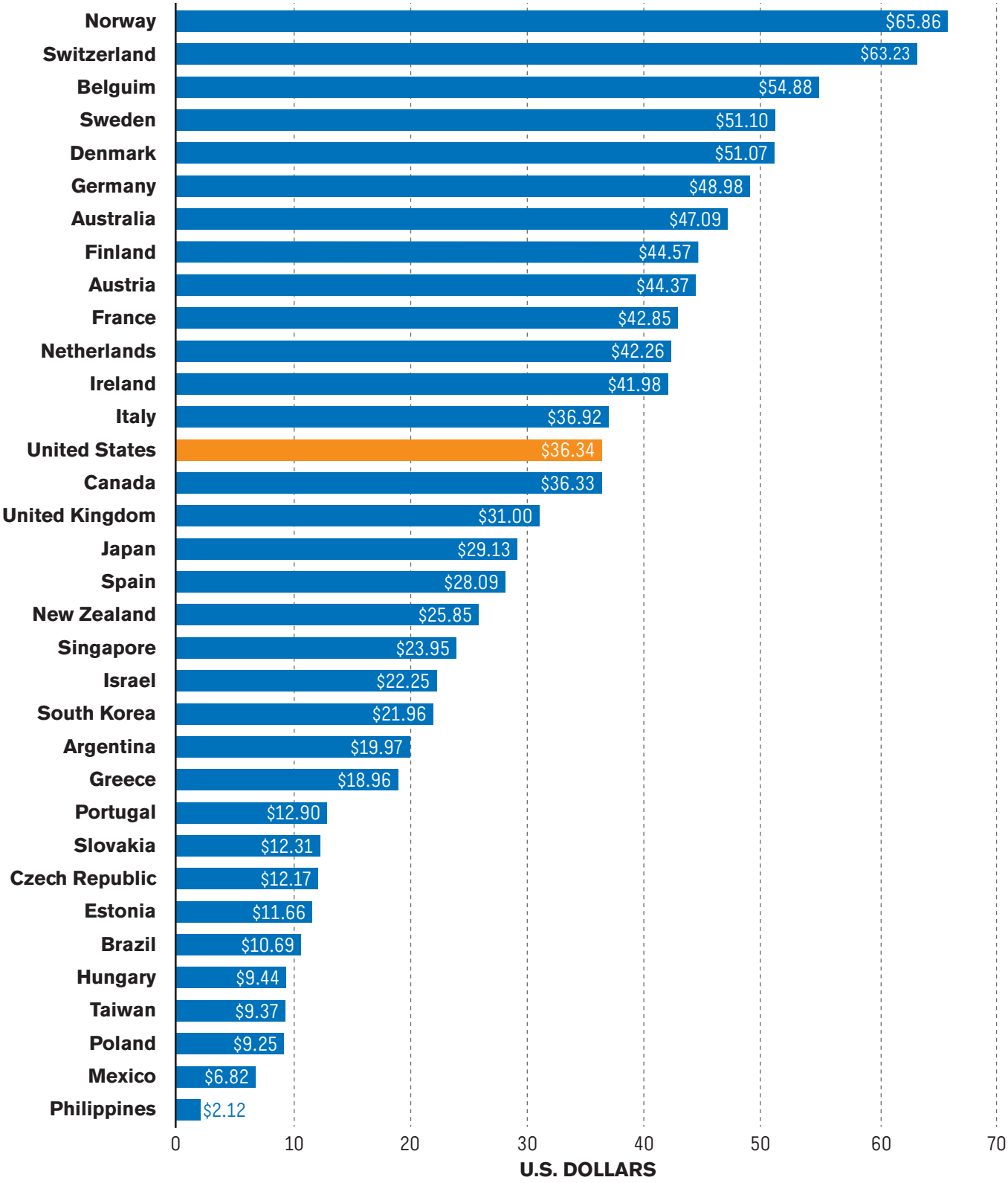
The United States does maintain a significant trade surplus in services, providing high-value financial, legal, engineering and software development services to customers around the globe.[56] A recent study examining U.S. "internationally tradable" technology-related occupations from 1999-2004 found that there were large job losses to offshoring in low-wage IT-related occupations—such as telemarketers, telephone operators, computer operators and data entry keyers. Overall, employment declined 30 percent in these occupations. In contrast, there were significant employment gains in high-wage IT occupations such as computer software engineers, network systems and data communications analysts, and computer hardware engineers. These high-skilled jobs increased 17 percent over the period, much higher than the 3 percent employment growth in the economy overall.[57]

Another study found that digitally deliverable services such as banking and telecommunications are important contributors to U.S. trade and the overall

51. The Universe of the Largest Transnational Corporations, United Nations, 2007.
52. World Investment Report 2011, Annex Table 34, Number of Parent Corporations and Foreign Affiliates, by Region and Economy, 2010, United Nations Conference on Trade and Development.
53. Chapter III, Recent Policy Developments and Key Issues, World Investment Report 2014: Investing in the SDGs: An Action Plan, UN Conference on Trade and Development, 2014.
54. Embracing the Challenge of Free Trade: Competing and Prospering in a Global Economy, Chairman Ben S. Bernanke, at the Montana Economic Development Summit, 2007, Board of Governors of the Federal Reserve System, May 1, 2007.
55. OECD (2015), GDP Per Hour Worked (indicator).
56. Embracing the Challenge of Free Trade: Competing and Prospering in a Global Economy, Chairman Ben S. Bernanke, at the Montana Economic Development Summit, 2007, Board of Governors of the Federal Reserve System, May 1, 2007.
57. Accelerating the Globalization of America: The Role for Information Technology, Catherine L. Mann, June 2006.

Figure 7. Hourly Compensation Costs in Manufacturing 2013 (U.S. Dollars)

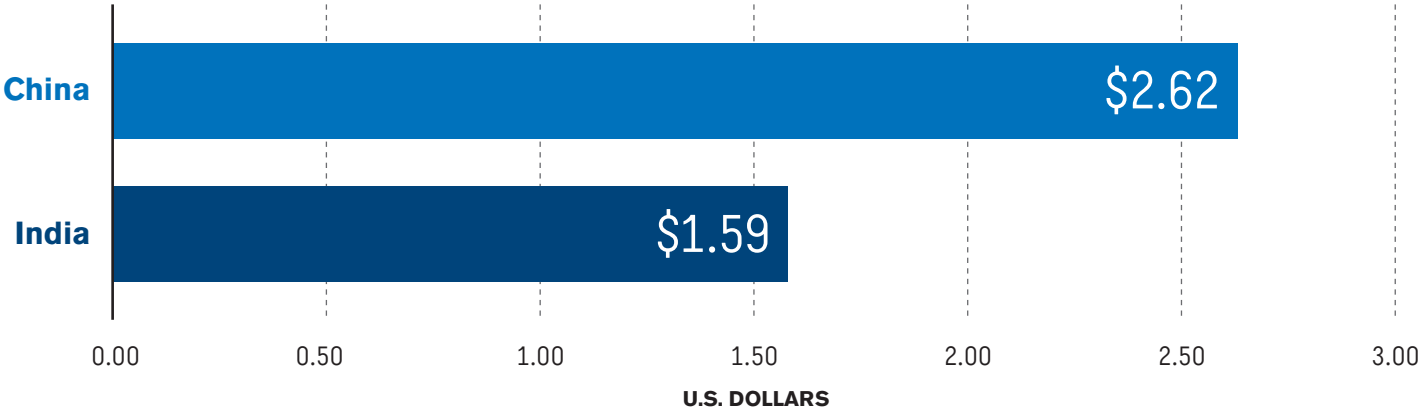
Source: The Conference Board, International Labor Comparisons Program, December 2014. Used with permission. Content reproduced with permission from The Conference Board, Inc. © 2014 The Conference Board, Inc.



Note: For complete definitions and country information, see the Technical Notes and Country Notes at www.conference-board.org/ilcprogram/compensation.

Figure 8. Hourly Compensation Costs in Manufacturing 2011 (U.S. Dollars)

Source: The Conference Board, International Labor Comparisons Program, December 2014. Content reproduced with permission from The Conference Board, Inc. © 2014 The Conference Board, Inc.



Note: Data for China and India are not strictly comparable with each other nor with data for other countries published by The Conference Board International Labor Comparisons Program. For a description of data limitations associated with estimates for China and India, see the Country Notes at www.conference-board.org/ilcprogram/compensation/countrynotes.

trade balance. The study reported that the United States exported $357 billion in digitally deliverable services in 2011, representing more than 60 percent of U.S. services exports, and 17 percent of total U.S. goods and service exports. The United States imported about $222 billion in digitally deliverable services, for a digitally deliverable trade surplus of $135 billion.[58]

The nature of tasks workers perform plays a key role in the level of risk that the job will be offshored. A Bureau of Labor Statistics analysis identified 160 service-providing occupations that are susceptible to offshoring. These occupations are diverse in their job functions, educational requirements and wages.[59]

Those most susceptible to offshoring include office and administrative support occupations with relatively low education or training requirements—such as telephone operators, computer operators, data entry keyers, typists, payroll clerks and medical transcriptionists—but also professional and related occupations which have higher educational requirements—such as credit analysts, insurance underwriters, pharmacists, financial analysts, biochemists and physicists.

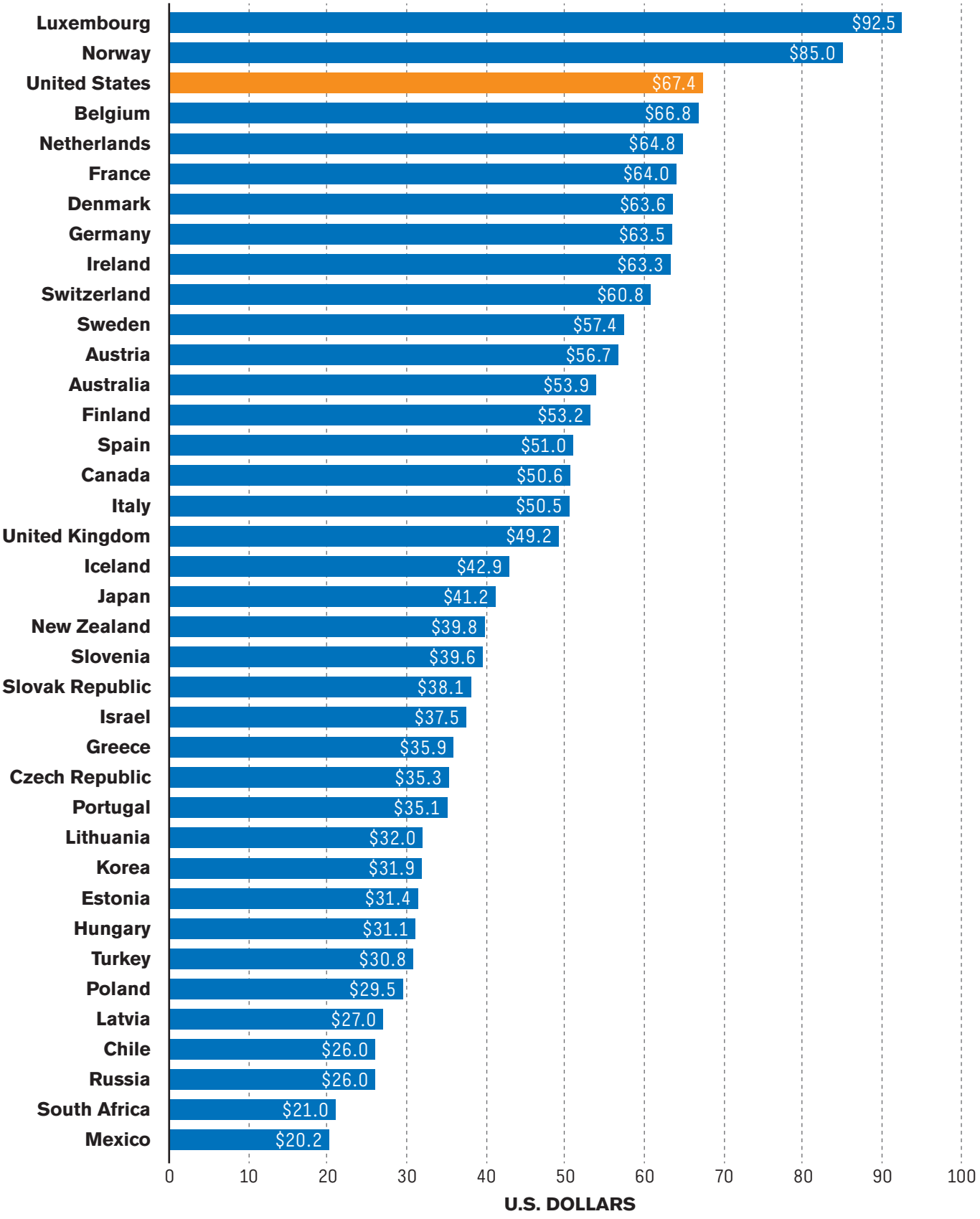
The group of occupations found least susceptible consists largely of highly skilled occupations, most of which are professional and related occupations or management, business and financial operations occupations, including a range of managers (from public relations and marketing managers, to financial and operations managers); and a variety of engineers. While jobs most susceptible to offshoring have a range of education and training requirements—from short-term on-the-job training to doctoral degree, but mostly some level of on-the-job training—almost all of the jobs least susceptible to offshoring require a bachelor's degree or higher. Another characteristic of jobs least susceptible to offshoring involves work that is performed on site, such as the work of health and safety engineers, mining and geological engineers, urban and regional planners, and landscape architects.

58. Digital Economy and Cross Border Trade: The Value of Digitally Deliverable Services, Economics and Statistics Administration, U.S. Department of Commerce, January 2014.

59. Service-providing Occupations, Offshoring, and the Labor Market, Monthly Labor Review, December 2008.

Figure 9. GDP Per Hour Worked, 2014 USD, current prices, current PPPs

Source: OECD



Characteristics of Jobs Susceptible to Offshoring

A number of studies have identified the types of characteristics of jobs and tasks that could be susceptible to offshoring. These include:

- Lack of face-to-face contact with customers
- Little interaction with other types of workers
- Digitally transmitted, Internet enabled
- High information content
- High wage differentials between the United States and destination country
- Low set-up costs
- Labor intensive (without need to perform at specific job site, for example, building construction)
- Codifiable (rule-based); clear requirements with few nuances
- Routinized, repetitive tasks (series of repeatable steps)
- Requires little knowledge of social or cultural idiosyncrasies of the target market

Sources: Service-providing Occupations, Offshoring, and the Labor Market, Monthly Labor Review, December 2008; and The Offshore Outsourcing of Information Technology Jobs in New York State, New York State Department of Labor and Empire State Development, September 2010.

According to Bureau of Labor Statistics analysis, general operations managers, for example, must maintain contact with all branches of an organization. Computer programmers, by contrast, can perform their duties with little to no interaction with those in other parts of an organization. If the duties of an occupation require familiarity with the cultural or social idiosyncrasies of the target market—the kind of knowledge that can be obtained only by living in that market—performing those duties from abroad would be difficult. Marketing managers, for example, must understand the tastes of the population to whom they market their products. Tax preparers, however, need only know tax laws and a client's financial information, both of which can be obtained from places across the globe.

Work that can be routinized or handled by following a script is more susceptible to offshoring because the outputs, and the processes by which they are completed, are easier to define. With such occupations, it is easier for companies to gauge whether the work is being completed and less management oversight is needed. By contrast, work that is more creative is more difficult to monitor, making companies less likely to have it performed from remote locations. Engineers, for example, engage in research and development, whereas insurance underwriters generally follow a set of instructions and are not part of an organization's creative functions.[60]

Generally, if a problem can be solved by a rule or a task performed with a straightforward process, a computer (or someone using a computer in a developing economy) will be able to do it.[61] However, data security and protection of intellectual property are concerns.

60. Service-providing Occupations, Offshoring, and the Labor Market, Monthly Labor Review, December 2008.

61. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT and Richard Murnane, Harvard University, May 31, 2006.

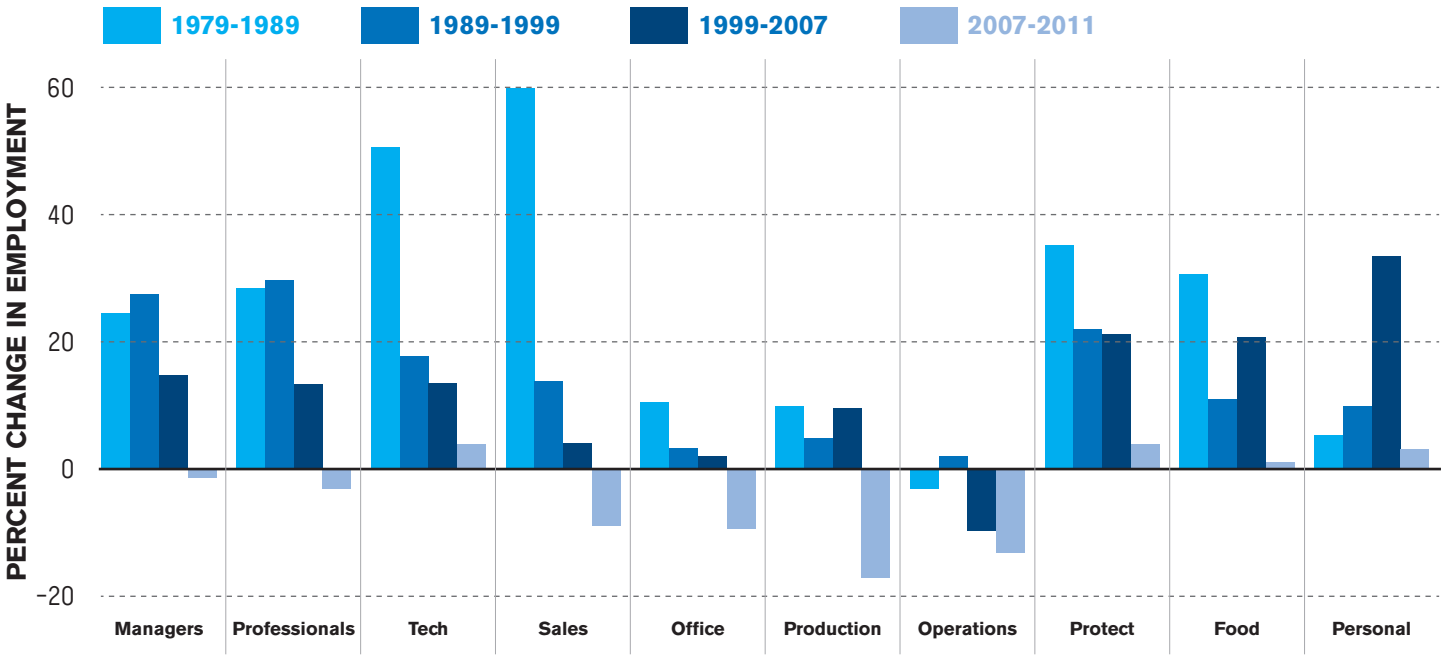
Labor Market Polarization

The labor market in the United States and other advanced economies is becoming polarized—demand has grown for high-end workers for jobs involving non-routine cognitive tasks and for low-skill/high-touch workers, but is weak for many middle-skill workers.[62] While low skilled and high skilled occupations have increased their share of employment over the past two decades, the employment share of middle skill jobs has declined.[63]

Non-routine manual jobs require little formal education, but require skills—some times substantial skills developed through significant on-the-job training, technical school or apprenticeship—for in-person interactions and hands-on tasks. Examples include home health care or janitorial jobs, or jobs in skilled trades such as plumbers, pipefitters, and HVAC mechanics and installers who work in factories, homes and businesses where there are pipes, septic systems and HVAC systems. These are hard to automate or offshore. As a result, the demand for these workers is generally high. The Bureau of Labor Statistics projects that the healthcare and social assistance sector—a sector with significant numbers of jobs like these—will account for about one third of projected job growth from 2014 to 2024. Employment in the construction sector is also expected to see a large increase.[64]

Figure 10. Employment Growth By Occupation: 1979-2011

Source: Labor Market Polarization Over the Business Cycle, Christopher L. Foote and Richard W. Ryan, Public Policy Discussion Papers, Federal Reserve Bank of Boston, December 6, 2012.



Note: The authors note that this figure is an updated version of a chart that appears in Figure 3 in Autor (The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, 2010), and Figure 12 in Acemoglu and Autor (Skills, Tasks, and Technologies: Implications for Employment and Earnings, 2011). The authors' updated the chart using microdata from the Current Population Survey.

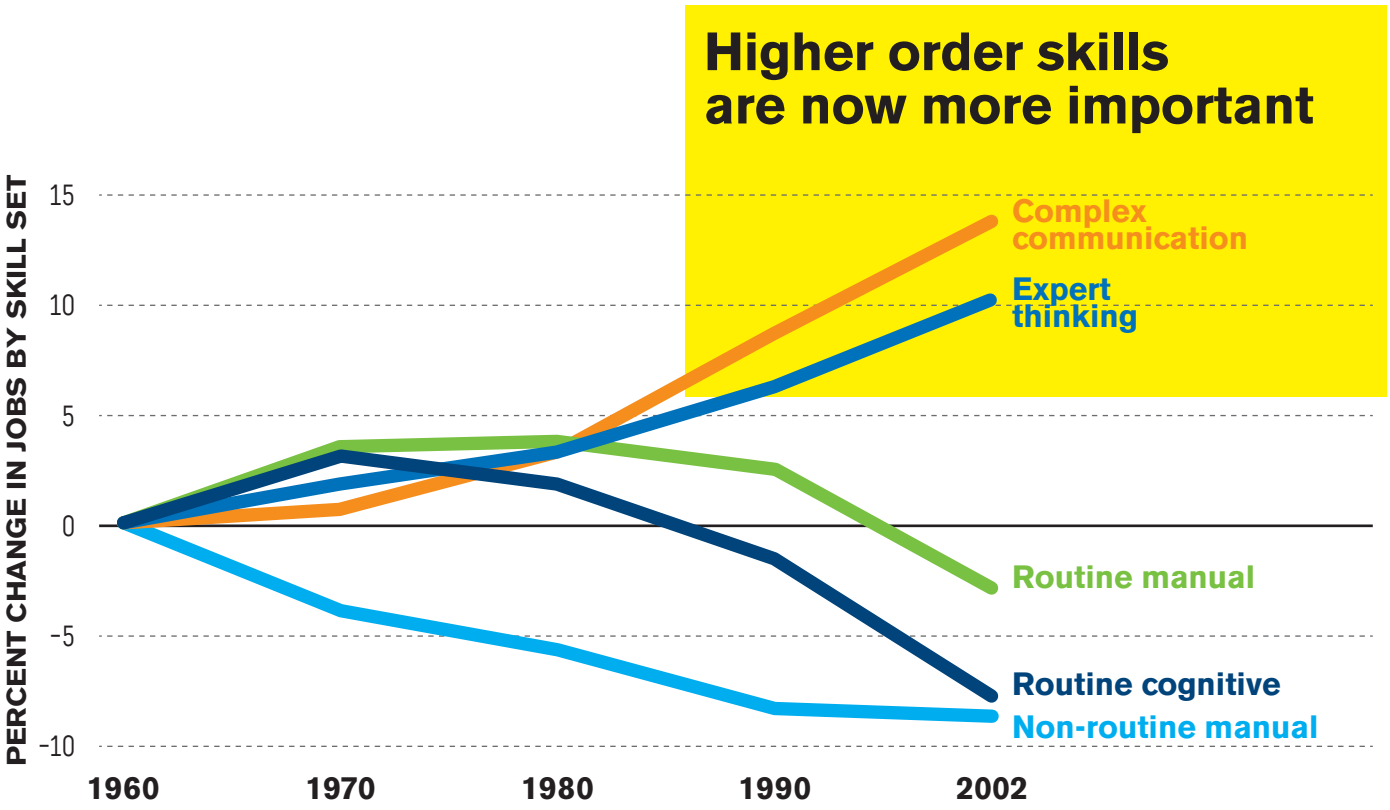
62. Labor-Market Polarization Over the Business Cycle, Christopher L. Foote and Richard W. Ryan, Federal Reserve Bank of Boston, December 6, 2012.

63. The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, David Autor, MIT Department of Economics and National Bureau of Economic Research, April 2010, http://economics.mit.edu/ files/5554.

64. Table 2.1, Employment by Major Industry Sector, Employment Projections Program, U.S. Bureau of Labor Statistics, December 2015.

Figure 11. Higher-Order Skills Have Grown in Importance, Driven by Technological Change and Globalization

Source: Updated version of Figure 1 in David H. Autor, Frank Levy, and Richard J. Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration," *Quarterly Journal of Economics*, 118(4), November 2003. See also Frank Levy and Richard J. Murnane, "How Computerized Work and Globalization Shape Human Skill Demands," May 31, 2006.



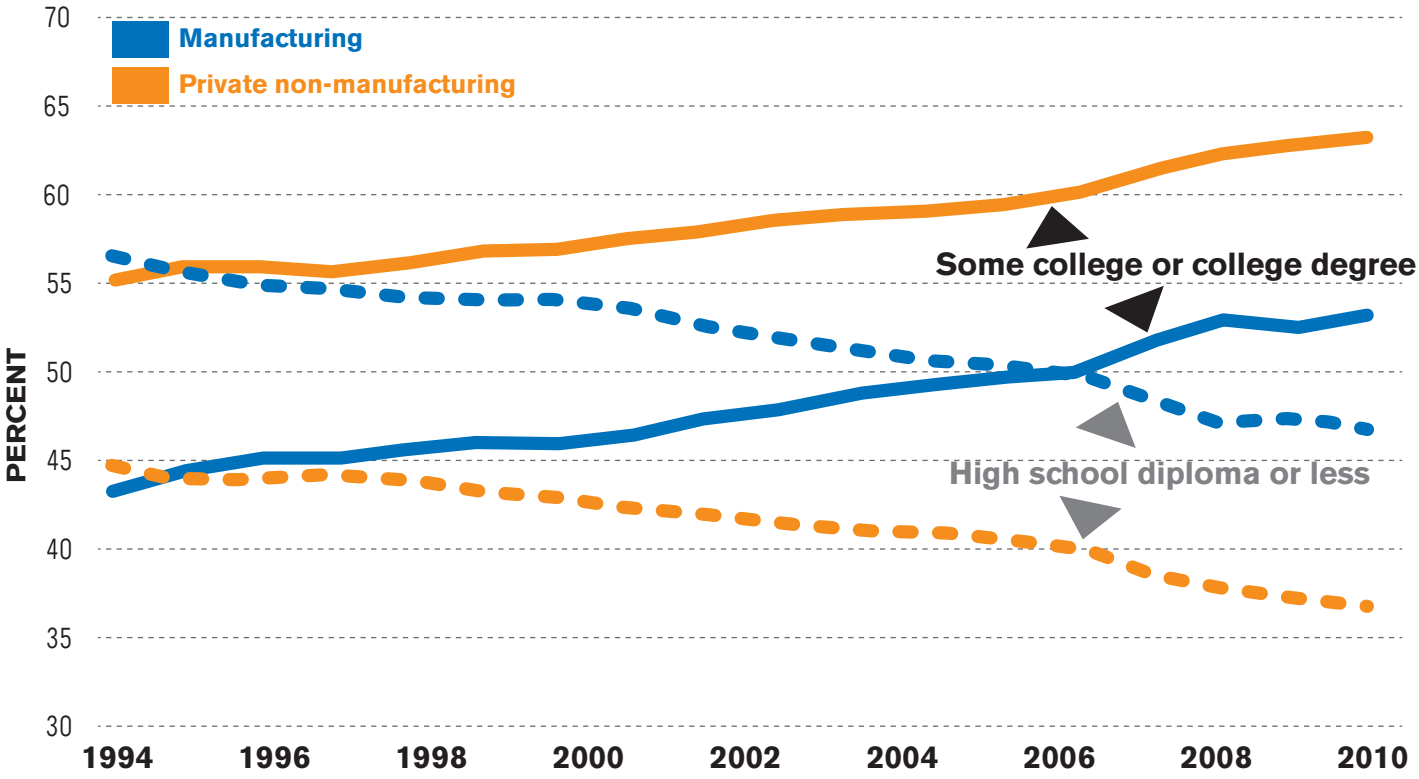
At the opposite end of the occupational skill distribution, demand for high-skill labor to perform non-routine cognitive tasks has grown rapidly. Non-routine cognitive tasks involve abstract thinking, analytical and problem solving work where there is no rule-based solution, complex work that varies case-by-case and complex communications.[65] For example, managers or consumer service personnel use complex interactions with others and knowledge to solve problems, make decisions and take actions.[66] As a management consultant, each client engagement is likely to be different from the last. Some processes and methods could be reapplied, but new methods or applications are often needed. Judgment as to what methods to apply may be required.[67]

Jobs that include this type of non-routine work involving complex tasks are growing two and a half times faster than jobs involving routine tasks, and three times faster than jobs in the overall economy, and now make up about 40 percent of the U.S. workforce.[68] This kind of work often requires higher levels of education. Employment share in both manufacturing and non-manufacturing industries is

65. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT, and Richard Murnane, Harvard University, May 31, 2006.
66. The Next Revolution in Interactions, by Bradford C. Johnson, James M. Manyika, and Lareina A. Yee, McKinsey Quarterly, November 2005.
67. Why Are Jobs Designed the Way they Are? Office of Productivity and Technology, Bureau of Labor Statistics Working Paper 382, June 2005.
68. The Next Revolution in Interactions, by Bradford C. Johnson, James M. Manyika, and Lareina A. Yee, McKinsey Quarterly, November 2005.

Figure 12. Percent of Employment By Industry and Educational Attainment, 1994-2011

Source: ESA calculations using Current Population Survey public-use Merged Outgoing Rotation Group files, National Bureau of Economic Research.



rising for those with some college or a college degree, and has declined for those with a high school diploma or less.[69]

In the middle are those workers with intermediate skills employed in routine jobs—from manufacturing assembly line workers to office clerks—who perform procedural rule-based tasks that are easier to ship offshore to countries with lower wages, or easier and more attractive to automate as the cost of automation falls.[70]

The shift from routine jobs to manual and cognitive non-routine jobs is spreading across the economy, intensifying the polarization of employment opportunities in the United States. This polarization goes beyond a shift in the sector composition of employment in the economy (i.e., just job losses in manufacturing); it is a shift in the occupational mix within all industries.[71]

Looking to the future, labor market polarization can be seen in the Bureau of Labor Statistics' occupational employment projections for growing and declining occupations over 2014-2024. Most of the fastest growing occupations involve non-routine/high touch manual jobs such as physical therapists, personal care and home health aides, and nurses, as well as non-routine cognitive jobs such as inter-

69. The Benefits of Manufacturing Jobs, Executive Summary, ESA Issue Brief #01-12, Economics and Statistics Administration, U.S. Department of Commerce, Ma 2012.

70. The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings, David Autor, MIT Department of Economics and National Bureau of Economic Research, April 2010; Labor-Market Polarization Over the Business Cycle, Christopher L. Foote and Richard W. Ryan, Federal Reserve Bank of Boston, December 6, 2012; and Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.

71. Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.

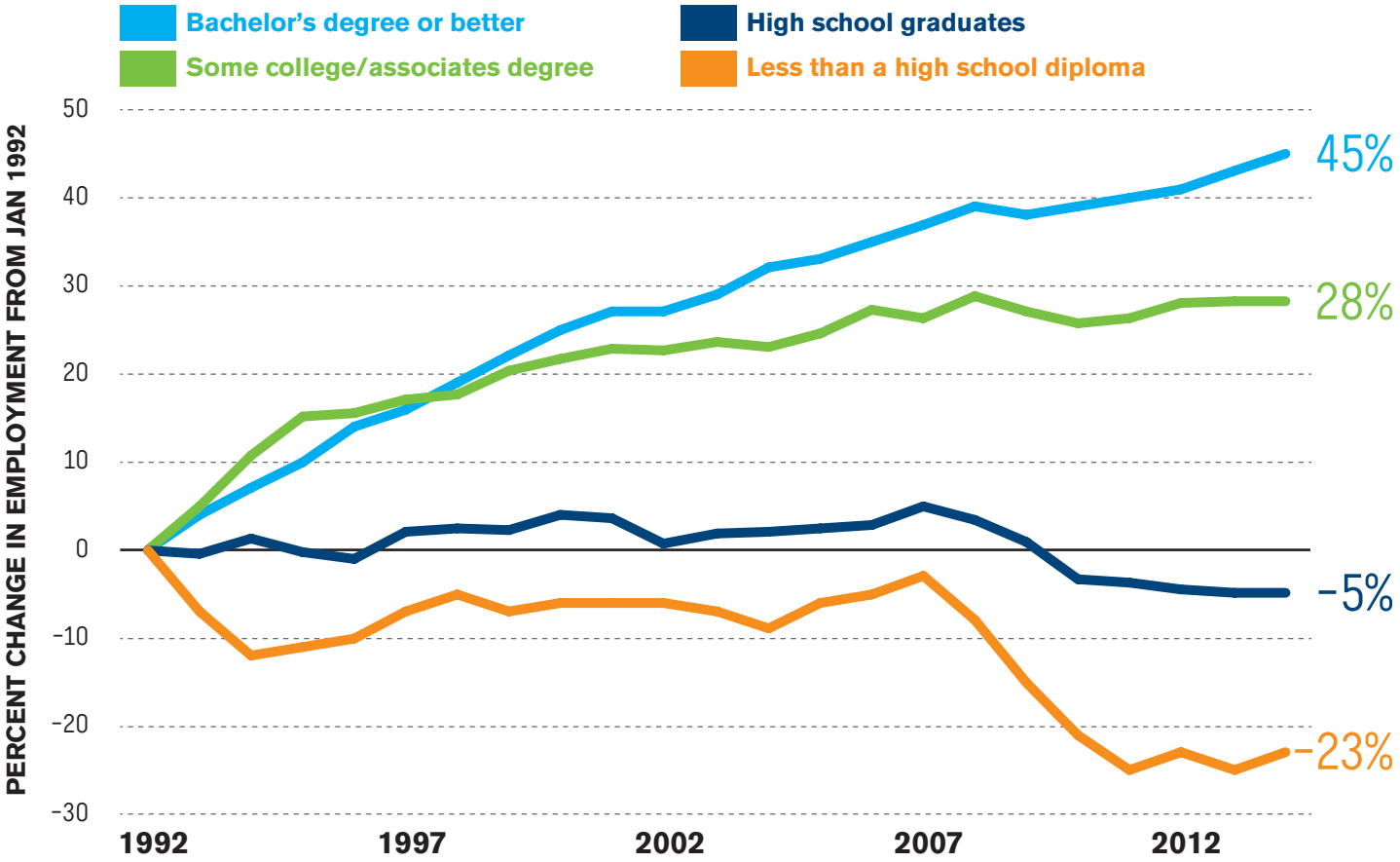
preters and translators, genetic counselors, personal financial advisors and operations research analysts. Many of the occupations projected to have the largest growth in employment are also these types.

Occupations projected to have the fastest and largest numerical declines are dominated by two groups: office and administrative support occupations and production occupations. Many of these jobs are routine jobs involving intermediate skills, and rule-based or repetitive tasks, the types of tasks at risk for offshoring or automation, such as a range of production-related manufacturing occupations; mail sorters, clerks, and processors; executive secretaries and administrative assistants; word processors and typists; and computer operators. For example, the projected loss in postal jobs is due to automation—more reliance on email and online bill pay services, and automated mail sorting.

These trends can also be seen in higher rates of employment growth for those with higher education, and job losses for those with a high school diploma or less. This gap has been widening.

The wage gap between those with higher education and less education is also widening. A 2011 Census Bureau study confirmed a positive correlation linking educational attainment to both real annual income and lifetime earnings, even while controlling for other meaningful income determinants, including race, gender and age—and in some cases—"exceeding and overwhelming" them.[72]

Figure 13. Employment Growth by Educational Attainment
Source: Bureau of Labor Statistics



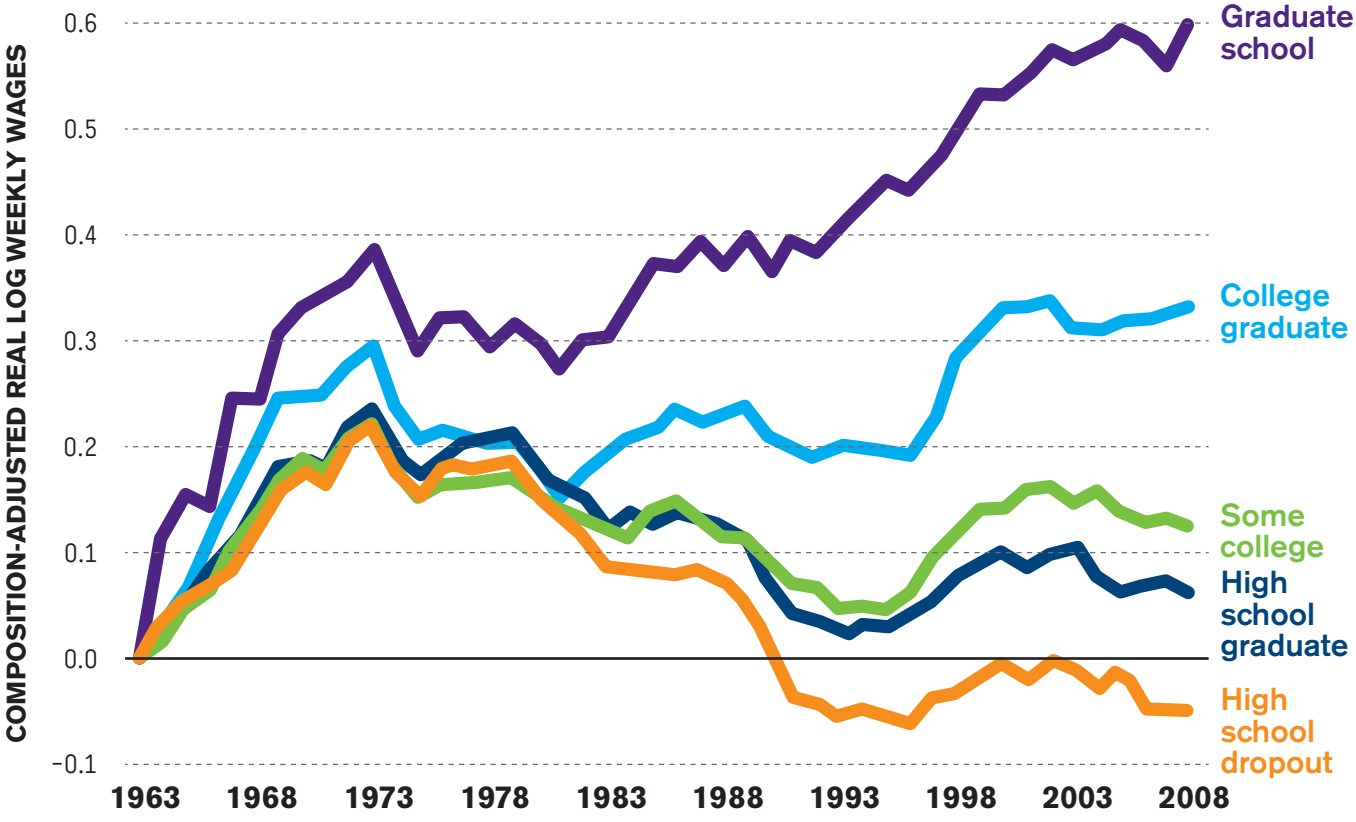
72. Jullian, Tiffany, and Kominski, Robert. Education and Synthetic Work-Life Earnings Estimates. U.S. Census Bureau. September 2011. http://www.census.gov/prod/2011pubs/acs-14.pdf.

Taking inflation into account, earnings for a worker in the middle of the wage distribution have risen about 10 percent since 1980, while earnings for a highly paid worker at the 90th percentile of the wage distribution have risen more than 30 percent over the same period. Earnings for workers near the low end of the distribution—those around the 10th percentile—have risen only about 5 percent.[73] Over the same period, the average wage for college graduates has increased from about one and a half times the wage for workers with only a high school degree to about two times their wage.[74] On average, the skills premium enjoyed by college graduates over high school graduates has been estimated between 65-75 percent, depending on the data source. For example, data from the Bureau of Labor Statistics show that among full-time workers age 25 and over, those holding a bachelor's degree but no advanced degree had $1,101 median weekly earnings in 2014, compared to $668 for those with a high school diploma and no college.[75]

Workers who use knowledge, judgment and complex communications to solve problems, interact with customers and undertake complex tasks—knowledge and skills attained through higher education and experience—have a disproportionate impact on companies' ability to attract and retain customers and innovate, as well as on other critical competitive capabilities and, thus, command higher salaries.[76]

Figure 14. Changes in Wages for Full-Time, Full-Year Male U.S. Workers, 1963-2008

Source: Daron Acemoglu and David Autor. Analysis of the Current Population Survey. Skills, Tasks, and Technologies: Implications for Employment and Earnings, MIT, 2011.



73. Governor Daniel K. Tarullo, Unemployment, the Labor Market, and the Economy, Remarks at the World Leaders Forum, Columbia University, Board of Governors of the Federal Reserve, October 20, 2011.

74. Governor Daniel K. Tarullo, Unemployment, the Labor Market, and the Economy, Remarks at the World Leaders Forum, Columbia University, Board of Governors of the Federal Reserve, October 20, 2011.

75. Earnings and Unemployment Rates by Educational Attainment, 2014, Current Population Survey, U.S. Bureau of Labor Statistics, U.S. Department of Labor.

76. The Next Revolution in Interactions, by Bradford C. Johnson, James M. Manyika, and Lareina A. Yee, McKinsey Quarterly, November 2005.

Wage premiums for higher educational attainment are not unique to the United States. The relative earnings premium for those with a college education increased in most OECD countries over the past ten years. Among OECD countries, the United States has one of the largest earning premiums for university-level educated workers.[77]

College graduates also have significantly lower rates of unemployment, even during the recent recession.[78] While job losses occurred across the economy, at the end of 2010, 78 percent of those unemployed in the United States had no post-secondary education.[79] By 2012, the unemployment rate for those with a high school diploma was 8.3 percent, but only 4.5 percent for those with a bachelor's degree.

As the United States has shifted toward a more knowledge-based economy, jobs and earnings are different across the urban-rural divide. High skill occupations are more concentrated in U.S. urban areas. This includes workers such as scientists, engineers and executives whose work involves high levels of complex problem solving, generating ideas, process skills, and social skills such as coordination and negotiation. These urban areas tend to be more innovative, have more economic activity and faster economic growth, and workers earn higher wages. In contrast, occupations more prevalent in rural areas are those with lower skills, hands-on jobs such as laborers, construction trades, maintenance and repair, machinists, etc.[80]

Table 2. Unemployment Rate by Educational Attainment 2012

Source: Employment Status of the Civilian Noninstitutional Population 25 years and over by Educational Attainment, Current Population Survey, Bureau of Labor Statistics

Education Attained	2012 Unemployment Rate (percent)
Doctoral degree	2.5
Professional degree	2.1
Master's degree	3.5
Bachelor's degree	4.5
Associate's degree	6.2
Some college, no degree	7.7
High school diploma	8.3
Less than a high school diploma	12.4
All workers	6.8

77. Country Note, United States, Education at a Glance 2013 and 2015. OECD Indicators.

78. College Degrees: Why Aren't More People Making the Investment?, Maria Canon and Charles Gascon, The Regional Economist, Federal Reserve Bank of St. Louis, April 2012.

79. An Economy that Works: Job Creation and America's Future, McKinsey Global Institute, June 2011.

80. Workforce Skills Across the Urban-Rural Hierarchy, Jaison R. Abel, et.al., Federal Reserve Bank of New York, February 2012.

The Digital Revolution and Rise of Machines

Over the past 25 years, investment in digital equipment and software grew an average of more than 5 percent annually, and growth was particularly strong from 1992-2000 when investment grew an average of almost 12 percent annually. Today, private investment in information processing equipment and software exceeds $600 billion annually.

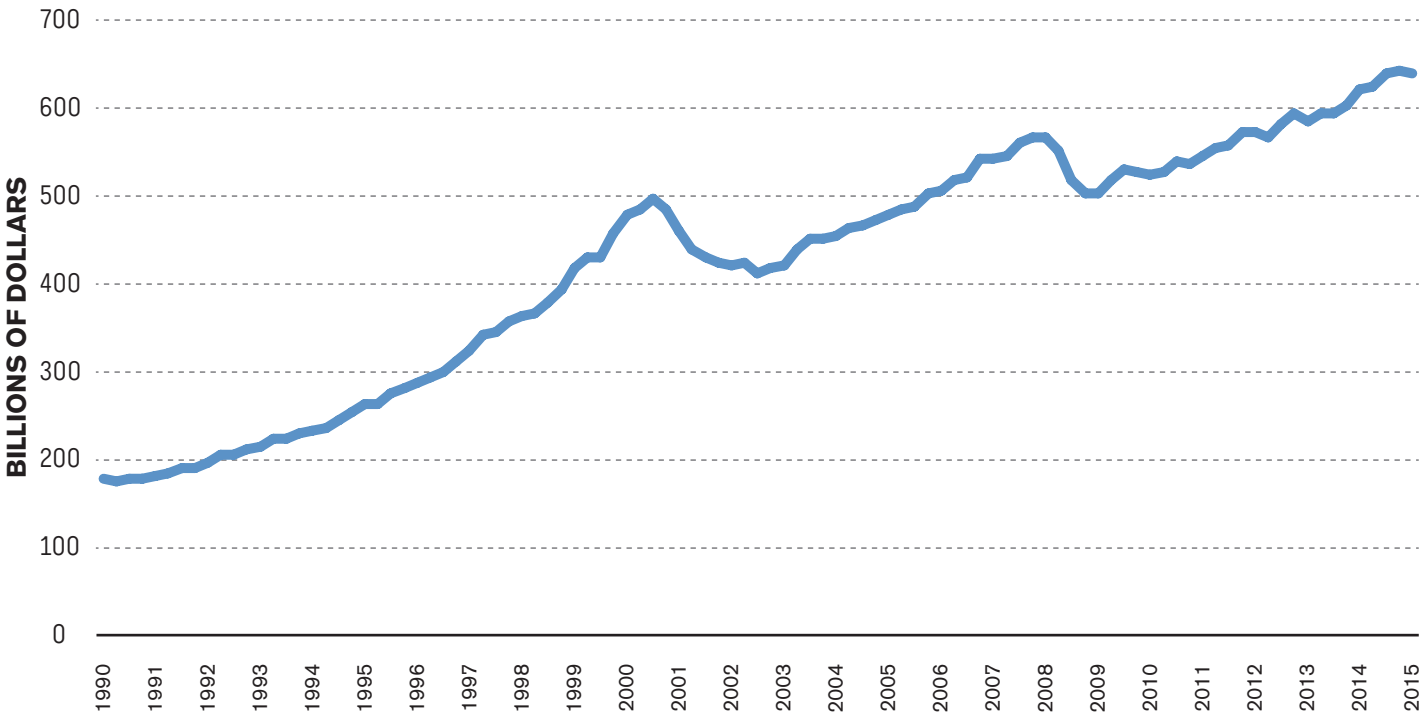
Widespread computerization and telecommunications networking across global business and industry has transformed work—the ways in which, and the speed with which, people connect, collaborate, design and build, locate and manage resources, manipulate tools, conduct research, analyze and forecast, reach markets, move and track products, make transactions and perform a myriad of other daily work tasks.[81]

The cost of powerful computing has fallen significantly. In 1975, the cost of the fastest supercomputer was $5 million. Today, an iPhone 4 with the same computing power costs $400.

Disruptive Technologies, McKinsey Global Institute, May 2013.

The IT revolution not only has allowed workers to "crank" the machine faster, but also created opportunities to fundamentally change the way production and service delivery are organized, and the way work organizations operate. Mobile handheld devices take computing power where workers go, decoupling work from desktop and place. Social networks and peer-to-peer knowledge sharing software are becoming drivers of workplace productivity—not sim-

Figure 15. U.S. Private Fixed Investment in Information Processing Equipment and Software
Source: Bureau of Economic Analysis, U.S. Department of Commerce



81. Futurework: Trends and Challenges for Work in the 21st Century, U.S. Department of Labor, 1999.

Figure 16. Global Growth in Internet Users & Mobile Phone Subscribers

Source: Keeping Track of Our Changing Environment: From Rio to Rio+20 (1992-2012), United Nations Environment Program, 2011.

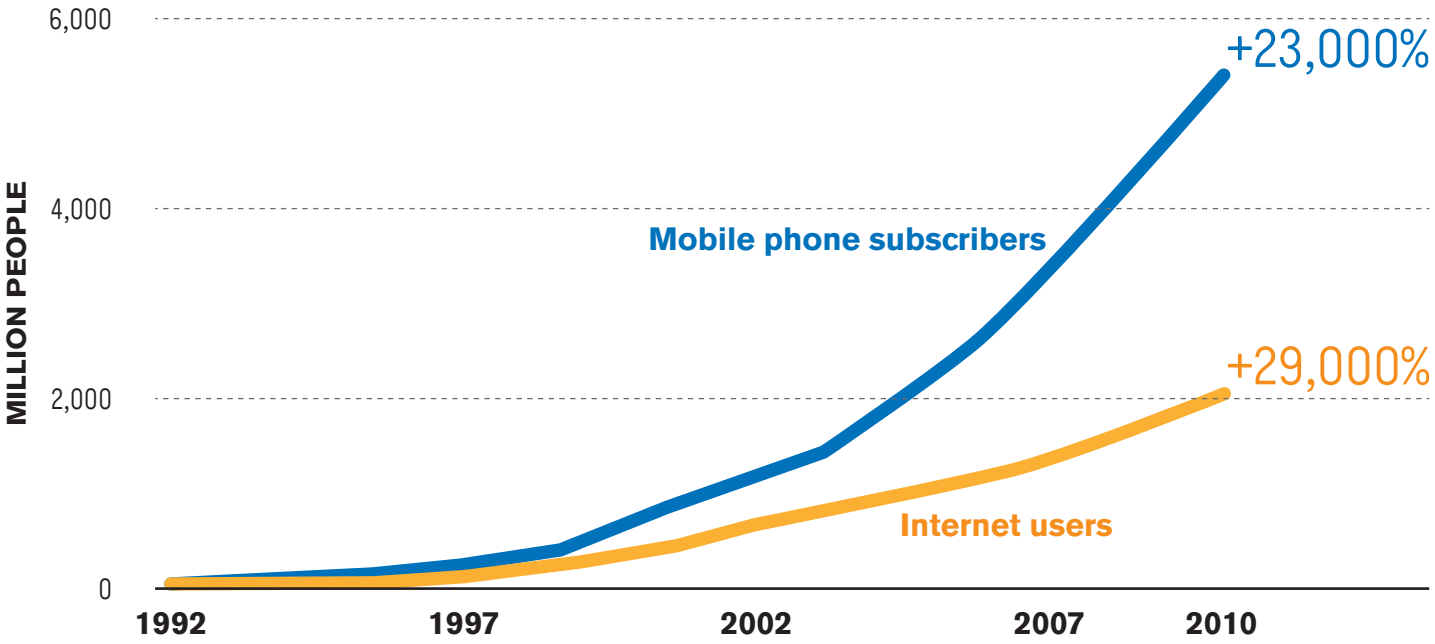
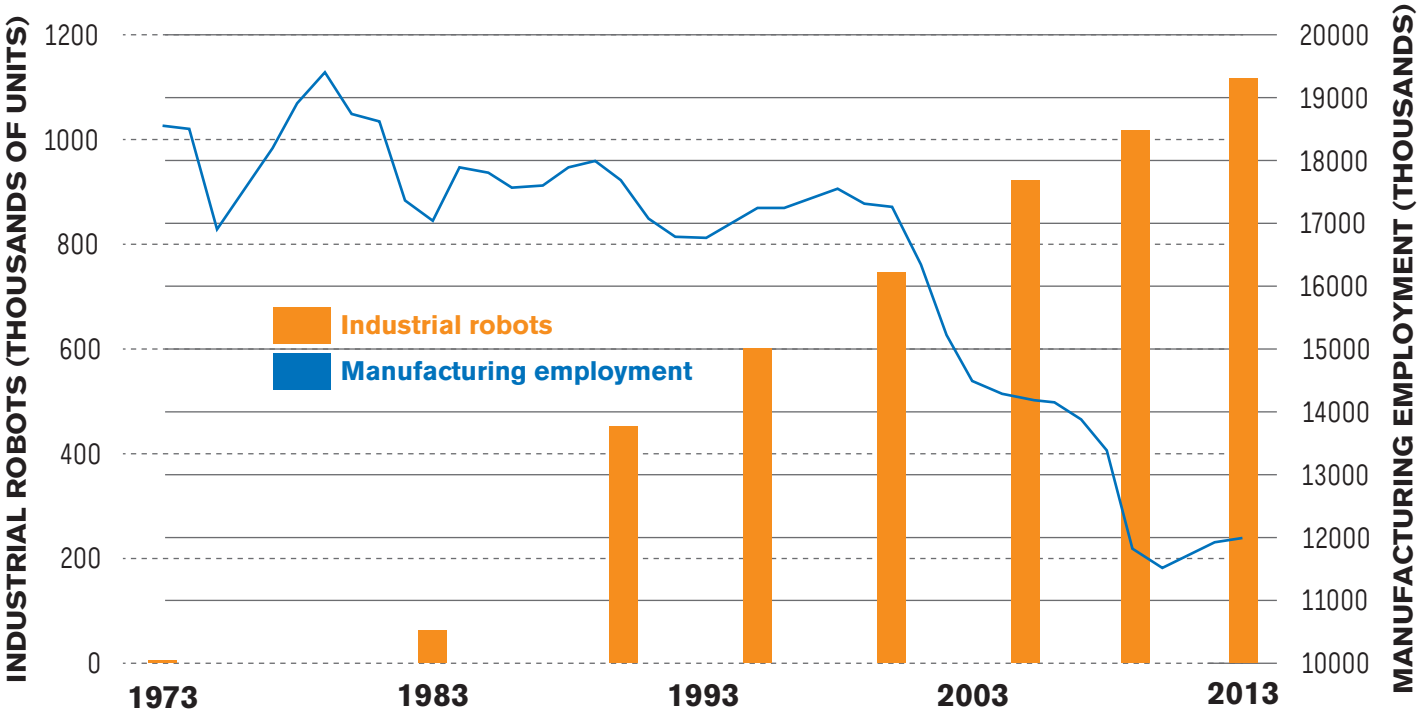


Figure 17. Trends in Industrial Robots and Manufacturing Employment

Source: Bureau of Labor Statistics, International Federation of Robotics



ply social ones. High-performance computing, coupled with "big data" and the "Internet of Things"—vast clouds of interconnected devices and sensors—are allowing real-time and deep analysis across fields ranging from scientific research and the electricity grid, to consumer marketing and manufacturing.

Employers are no longer satisfied with an office worker who is "good with figures" or "detail oriented." Administrative staff must now be able to work with a suite of office software tools, or accounting and billing software. Even traditional blue-collar fields today require that workers be comfortable using new technology, and work with quantitative information and processes. Technicians, skilled trades workers and mechanics all work side-by-side with advanced technologies that allow them to more quickly and effectively do their jobs. "Old school" auto mechanics can forget about getting a job if they lack the skills to use computer-based diagnostic tools now standard in repair shops, allowing these technicians to spend less time identifying vehicle problems and more time resolving them. Machinists who once worked with manually-operated lathes and drilling machines, and needed skills in reading gauges and other measurement devices, now operate computer controlled machine tools that require computer literacy and sometimes programming.

Machines, autonomous systems, sensors and software are increasingly capable of doing routine tasks that have made up jobs for millions of Americans. For example, Internet systems provide customers with account information and payment processing. Tax preparation software carries out work once performed by accountants. Financial institutions use software to assess credit risk. Sensors and imaging technologies perform security functions.

More powerful computers, "big data," advances in natural language processing and user interfaces are likely to augment performance in some high skilled jobs, but allow for the automation of others.[82] For example, Apple's Siri recognizes natural language, and can retrieve information requested by the user with relative accuracy. These types of support systems could raise productivity in complex knowledge-related jobs, but also eliminate jobs in routine customer service applications.

> Another novel feature of the ongoing wave of globalization is that it goes hand-in-hand with the rapid adoption of information and communications technologies. Such technology makes it easier to fragment the production of goods and services, and to outsource certain tasks to other countries. This great "unbundling" has extended the reach of globalization to domestic activities where workers were previously sheltered from direct international competition.
>
> **OECD**

Digital technologies have also enabled the practice of breaking down jobs into tasks, sorting repetitive, rule-based tasks from more complex tasks. The routine tasks may then be automated or performed in low cost locations around the world.[83]

In addition, while today's digital networks and technologies that enable mobility and "virtualization" of work create opportunities for offshoring, they also enable more people to work from home, work remotely and, potentially, to access employers and jobs in a much wider geographic area. For example, after initial training, Jet Blue's reservationists are allowed to work from home.[84]

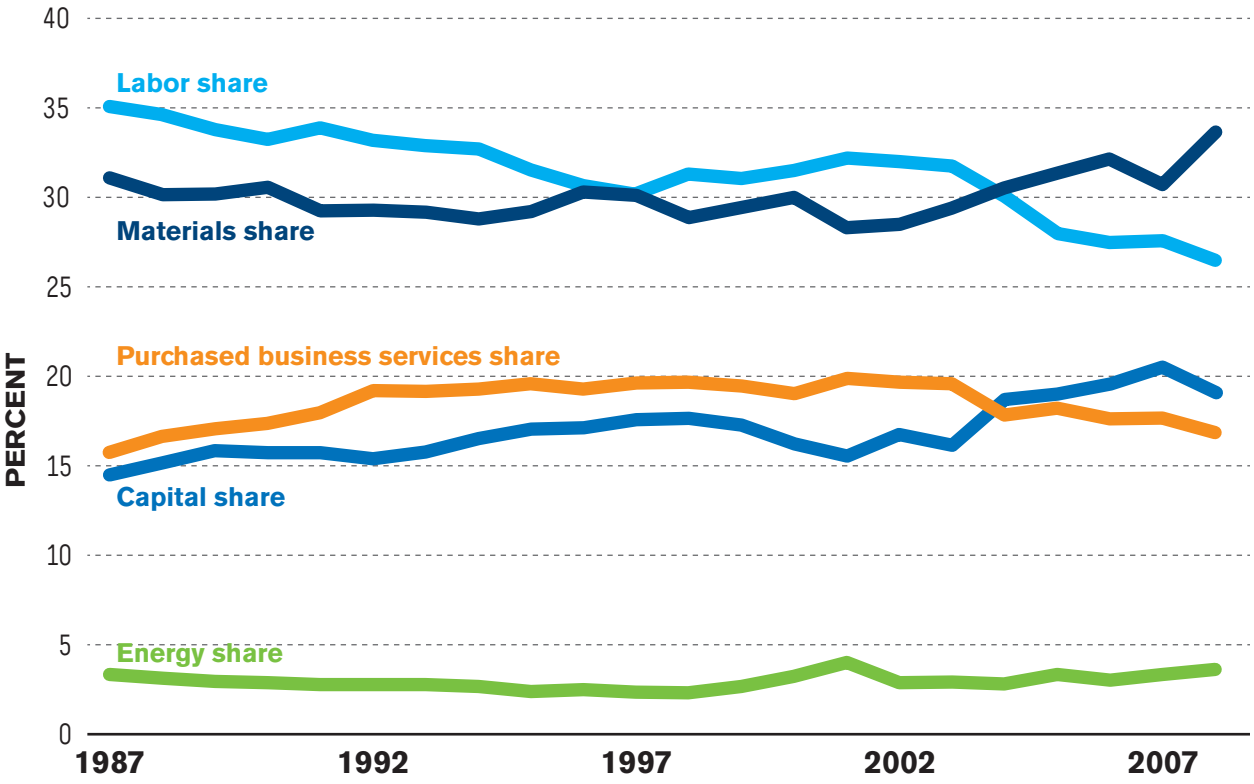
In a survey by McKinsey Global Institute, 2,000 business leaders were asked how their company's workforce would change over the next five years. One quarter said there would be more telecommuting, and about 20 percent said there would be more

82. The Future of Employment: How Susceptible Are Jobs to Computerisation, by Carl Benedikt Frey and Michael A. Osborne, University of Oxford, September 17, 2013.

83. An Economy that Works: Job Creation and America's Future, McKinsey Global Institute, June 2011.

84. http://www.jetblue.com/work-here/job-descriptions.aspx

Figure 18. Input Cost share as a Percent of Manufacturing Sector Output, 1987-2008



offshored or outsourced workers.[85] In the same survey, 65 percent of the business executives reported that they had restructured operations in the past three years to reduce headcount. Of those, 44 percent had automated some tasks, while about a quarter had offshored or outsourced functions.

The price of automation has fallen significantly in the past few decades, both in absolute terms and relative to the cost of labor.[86] As the cost of labor rises, and the cost of automation declines, it becomes more attractive to automate work and eliminate some jobs.

For example, labor inputs to multifactor productivity in manufacturing have been dropping, while purchased business services and capital investments have been on the rise. Manufacturing is reorganizing production—becoming less labor intensive and more capital intensive—shedding jobs along the way.[87] Automation has eliminated many routine assembly jobs; fewer than 39 percent of the workers in U.S. manufacturing establishments are now directly engaged in production.[88]

A recent analysis used U.S. Department of Labor data to identify jobs that either are or are not susceptible to automation. The analysis estimated that 47 percent of U.S. employment is at risk of being automated in the next 10-20 years.[89]

85. An Economy that Works: Job Creation and America's Future, McKinsey Global Institute, June 2011.

86. Job Polarization Leaves Middle-Skilled Workers Out in the Cold, Maria E. Canon and Elise Marifian, The Regional Economist, Federal Reserve Bank of St. Louis, January 2013.

87. The Compensation-Productivity Gap: A Visual Essay, Monthly Labor Review, January 2011.

88. U.S. Manufacturing in International Perspective, Congressional Research Service, March 17, 2015.

89. The Future of Employment: How Susceptible Are Jobs to Computerisation, by Carl Benedikt Frey and Michael A. Osborne, University of Oxford, September 17, 2013.

Figure 19. Jobs at Risk of Automation

Source: The Future of Employment: How Susceptible Are Jobs to Computerisation, by Carl Benedikt Frey and Michael A. Osborne, University of Oxford, September 17, 2013.

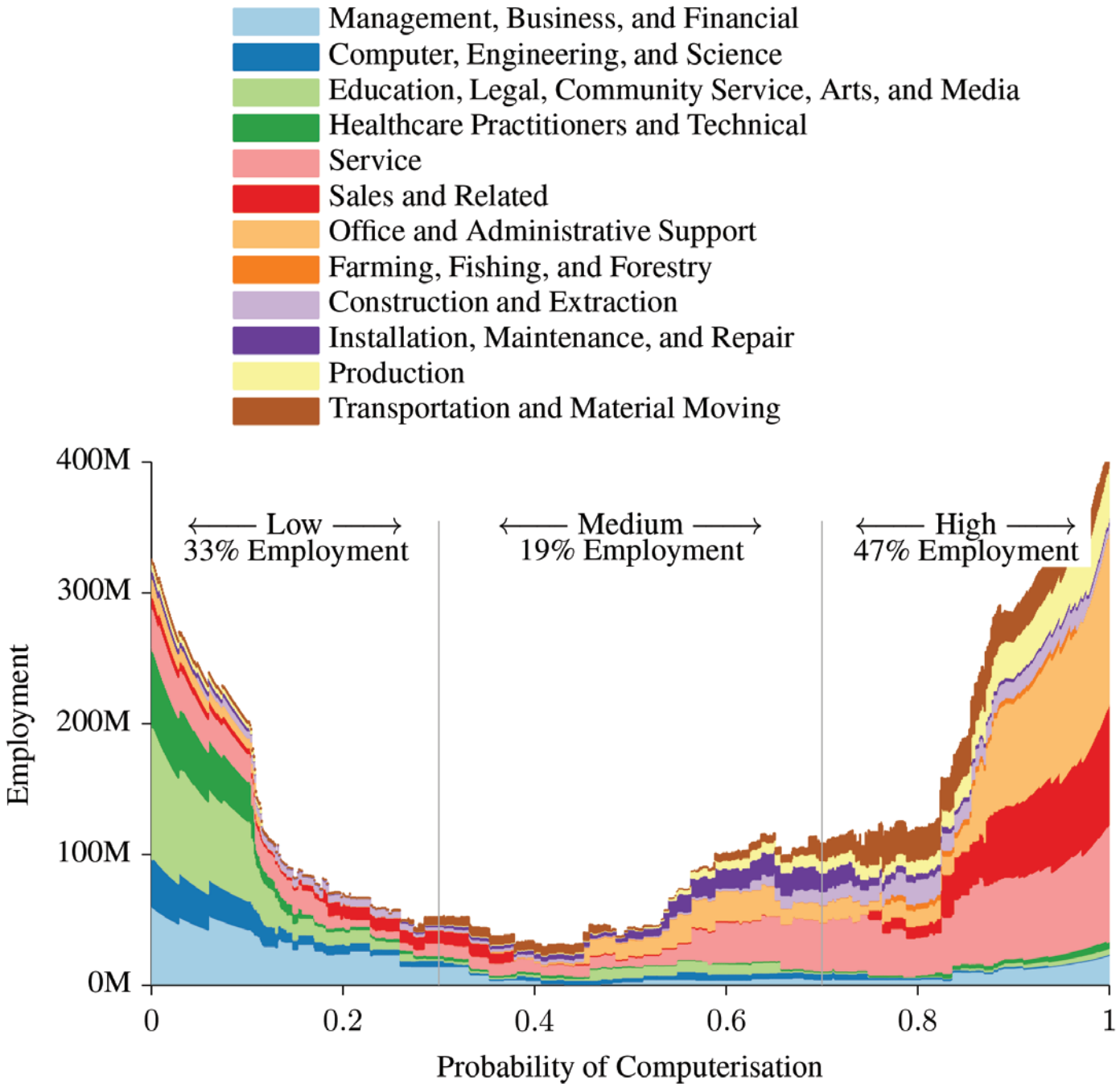


Table 3. How Technology Can Affect Jobs and Workers

Task/Job Level	
Change skills needed on the job	• Machinists who once worked with manual lathes and drills need new skills to operate CNC machine tools. • More electric/hybrid vehicles on the road means automotive service technicians/mechanics must be able to work on high-voltage electrical systems, lithium-ion batteries and electric generators.
Change way work is organized	• 20th century workplace characterized by hierarchy and work "place;" today, workplace characterized by networks; high-speed telecommunications and mobile computing decoupling work from place; some workers have greater autonomy. • Customer on-line travel and ticket booking reducing demand for reservation and ticket agents. • Use of digitized self-service checkout lanes in groceries mean fewer hand packers and packagers needed to bag groceries.
Change tasks performed	• Instead of manual typesetting, printers use digital publishing/desk top printing. • Manual tasks in production have been reduced by automation; workers have become monitors of automated production lines. • Scientists using more computational tools in research, substituting human effort with computational techniques such as data analytics, simulation and modeling.
Organizational Level	
Make workers more productive, so fewer workers are needed or jobs eliminated	• Fallers (who cut down trees) are more productive using complex machines instead of hand tools; logging companies expected to need fewer of these workers. • Demand for insurance underwriters expected to fall; underwriting software helps workers process insurance applications quickly.
Change mix of human capital and skills needed in the organization	• Industrial robots reduce need or eliminate jobs for assembly workers, but increase need for programmers and robot maintainers. • Use of electronic filing/data bases reduces need for file clerks, but increases need for data base administrators.

While many lower skilled workers perform tasks easier to automate, or tend to use technology that reduces the skills needed on the job, technology tends to favor those with higher skills.[90] High-skill workers use technology to enhance their capabilities, for example, using computers to write, perform research, design products and deliberate with others.[91]

Productivity growth has a dual effect on employment. In the medium to long run, productivity growth is essential for American workers. Higher productivity saves jobs and raises wages by making economic activity in the United States competitive as more output is produced per hour worked. In the short run or at the firm level, however, productivity is often driven by automation that reduces the demand for workers with certain skills. This cycle of productivity growth and economic churn has made the U.S. economy more dynamic and prosperous, but lower-skilled workers—especially in fields susceptible to offshoring or automation—often face a challenge to learn new skills to regain employment or sustain wages.

90. How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT, and Richard Murnane, Harvard University, May 31, 2006.

91. The Missing Middle: Aligning Education and the Knowledge Economy, by Anthony Carnevale and Donna Desrochers, Educational Testing Service, April 2002.

Industry Level	
Drive expansion in an existing industry's employment	• Fracking and horizontal drilling technology significantly raising oil and natural gas production, increasing employment in U.S. oil and gas industry by 40% over 2007-2012.
Create new industries with growing employment; drive declines and employment losses in other industries	• Personal computer drove employment growth in computer systems design and software publishing, but reduced/eliminated employment in computer mainframe industry. • Increased use of Internet, e-readers and tablets expected to cause job losses in newspaper, periodical, book publishing industry. • Expanded use of e-mail, on-line bill pay, automatic mail sorting forecast to contribute to declines in Postal Service employment.
Occupational Level	
Create new or eliminate existing occupations	• Personal computing eliminated jobs for computer operators and data-entry keyers; new occupations established such as network administrator and help desk personnel. • Low cost gene sequencing creating genetic counselor occupation.
Labor Market Level	
Change what skills/ occupations in demand	• Personal computing, networking, Internet expansion drove major growth in demand for IT professionals such as software engineers, computer systems analysts and network administrators.
Change supply of skills/ occupations in the labor market	• Rapid employment growth and high demand for IT workers raised wages, motivating students to study computer science in college and others to participate in wide range of IT training increasing skills availability in the market place.
Change labor market value of skills	• IT workers with "hot" or the latest skills are in high demand and command wage premium in the labor market.

Rapid Technological Change and Disruption

Disruptive technologies and innovations can drive a reordering at every level of the economy—from the workplace to the labor market to the mix of industries in a community or country—creating new opportunities for some workers but also hardships for others. The process of reorganization may create new jobs while eliminating others, create new occupations, or change the occupational mix, tasks to be performed and the skills in demand.

For example, digital technologies not only provided workers with better tools, they allowed companies to fundamentally change the way production in both manufacturing and services takes place. In the process, digital technologies drove the creation of new industries, created new occupations and many new jobs, but also undermined jobs in other industries and occupations.

When personal computers first hit the marketplace, computer manufacturing industry jobs in the United States soared. However, as PCs were commoditized and low cost foreign producers entered the market, U.S. computer manufacturing and the industry's jobs

dramatically declined. However, as PCs and other digital technologies became cheaper and spread throughout the economy, the loss of PC manufacturing jobs was more than off-set by jobs such as software engineers, web designers, and data base and network administrators.[92]

We have seen disruptive technologies drive large-scale reordering of production that affected the workforce throughout U.S. history. For example, development of new agricultural technology in the second half of the 19th century produced tremendous productivity gains in farming. Farm acreage in production quadrupled between 1860 and 1920. Cheaper food freed capital for industrialization and consumption of manufactured goods. Coupled with plentiful food supplies, gains in agricultural productivity reduced the need for farm labor, freeing workers to move from agriculture to mills, factories and shops supporting industrialization. This shift from agriculture to industry drove change in the geographic dispersion of the U.S. population. In 1870, the U.S. population was about 75 percent rural and 25 percent urban. Just 30 years later, in 1900, it was about 60 percent rural and 40 percent urban.[93]

Disruption is ongoing. Today, Uber drivers are disrupting the work of traditional taxi drivers. Digital photography has disrupted the film industry, and mobile phones and YouTube are impacting broadcasting. Netflix is challenging cable and broadcast entertainment models, while iTunes is reordering the music industry.

For the United States to leverage rapid advances in technology, especially revolutionary enabling technologies, for their highest economic benefit and productivity gains, businesses must be able to reorganize themselves in ways that take advantage of new technologies, and drive transformation in industry and the economy. Labor markets must be flexible to allow for the rapid reallocation of human capital in response to changes in demand.[94]

The U.S. labor market is dynamic. There is a significant amount of churn that is masked if only looking at net change in employment. In any given month, many workers are being hired and many are leaving their current jobs. For example, between 2001 and 2007, private employers hired nearly 5 million people, on average, each month. Total separations, on average, were only slightly smaller. Taking the difference between gross hires and separations, the net monthly change in payrolls during this period was, on average, less than 100,000 jobs per month—a small figure compared to the gross flows.[95]

Higher-skilled workers are not only at a premium when new technologies are introduced, because they are better able to use them, they are also better prepared to move to new industries, new jobs, new occupations or new skills when displaced by technological, labor market or market disruptions.

In addition, workers whose skills are on the leading edge of technology may command wage premiums. When new technologies or innovations are introduced and initially deployed, often a limited number of workers possess the knowledge, skills and experience associated with the new technology or innovation. Workers who have these valuable and scarce skills may command higher wages. This phenomenon is common in the IT/software sector. For example, in the 2013-2012 Dice Tech Salary Survey, Hadoop, Big Data and NoSQL were the top three skills in demand and commanded the highest average pay. By the 2014-2013 survey, the top three were R, NoSQL and MapReduce. Average salaries for Hadoop had dropped 5.6 percent and salaries for Big Data skills had dropped by 6.3 percent.

92. Futurework: Trends and Challenges for Work in the 21st Century, U.S. Department of Labor, 1999.

93. Population Growth, Migration, and Urbanization, 1860-1920, David Ward, University of Wisconsin-Madison, https://cascourses.uoregon.edu/geog471/wp-content/uploads/2010/01/WardImmigration.pdf.

94. How Economies Grow, The CED Perspective on Raising the Long-Term Standard of Living, Committee for Economic Development, May 2003; International Capital Flows and the Emerging Market Economies, Speech by Governor Randall Kroszner, (at the Central de la Republica Argentina Seminar), Board of Governors of the Federal Reserve System, May 15, 2007.

95. Recent Developments in the Labor Market, Remarks at the National Association for Business Economics Annual Conference, Chairman Ben S. Bernanke, March 26, 2012.

The IT sector is relatively quick in expanding new skills. In many other industries and technologies, it takes time for the new knowledge and skills to be codified, and embedded into education and training programs needed to expand their supply. Moreover, transferring the new technology to initial applications or deployments may require significant people-to-people, face-to-face interactions, which are hard to offshore.

Bottom Line for U.S. Workers

The shift in drivers of the economy, advances in technology and the nature of tasks people do on the job have placed a premium on workers who possess the high skills, knowledge and know-how that drive service and product innovation, who can engage with customers and other workers to accomplish organizational goals and who can perform complex non-routine tasks.

In 2014, about 36 percent of jobs were in occupations that typically require at least some postsecondary education for entry.[96] However, looking to the future, faster growth is expected in occupations that require higher-level education and training. For example, occupations that typically require a master's degree for entry are projected to grow the fastest over the 2014-2024 decade, followed by doctoral or professional degree occupations. All groups with postsecondary degree or award are projected to grow faster than the average of 6.5 percent for all occupations in the economy.

As we move from a "brute force" to a "brain force" economy, the markets for intellectual capital are growing, and employers look regionally, nationally and globally for top talent, top project teams and locations rich with talent for their business investment.

Table 4. Average Unemployment Rates by Educational Attainment 2014 (Persons age 25 and over; earnings for full-time wage and salary workers)

Source: Current Population Survey, U.S. Department of Labor, U.S. Bureau of Labor Statistics

Education Attained	Unemployment Rate (Percent)
Doctoral degree	2.1
Professional degree	1.9
Master's degree	2.8
Bachelor's degree	3.5
Associate's degree	4.5
Some college, no degree	6.0
High school diploma	6.0
Less than a high school diploma	9.0

Data underscore the realities of the modern, highly-productive, technology- and information-driven economy: skills—both soft and hard—are the name of the game, and those who invest in education and skills development are more competitive in the workforce, earn more, have lower risk of unemployment and propel the next generation of prosperity.

96. 2014 Employment, Wages, and Projected 2014-2024 Change in Employment by Typical Entry-Level Education, Employment Projections Program, U.S. Bureau of Labor Statistics.

Figure 20. Percent Growth in Employment, Projected 2014-24

Source: U.S. Bureau of Labor Statistics, Employment Projections Program

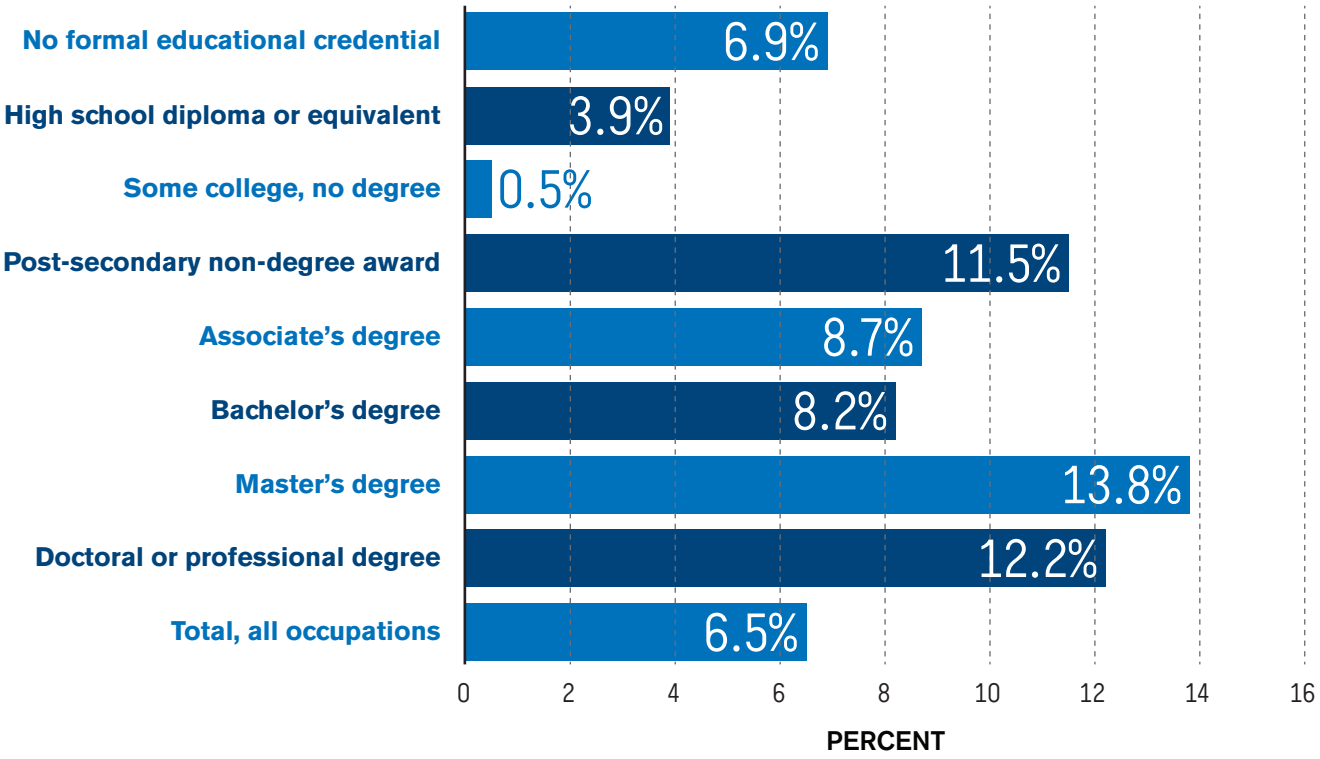
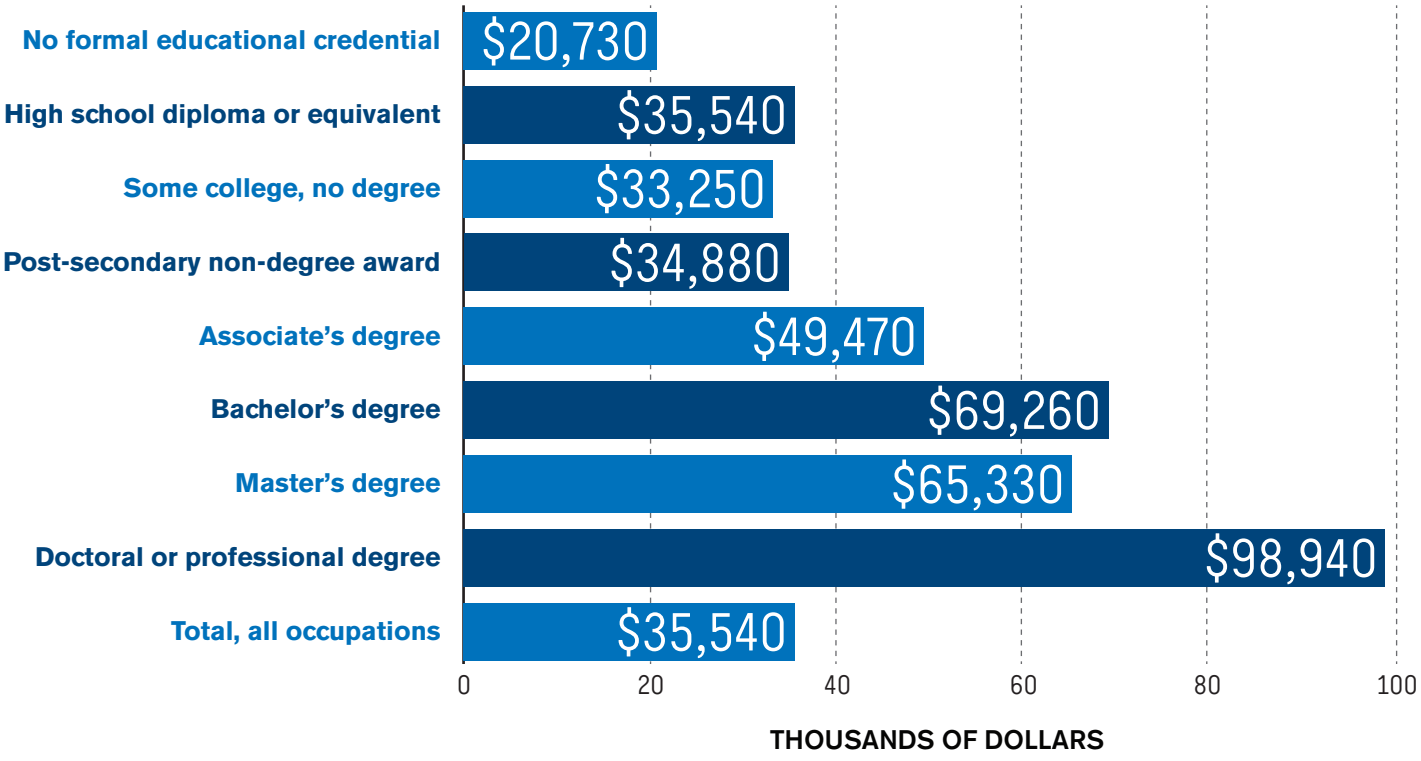


Figure 21. Median Annual Wage by Education Attainment, 2014

Source: Occupational Employment Statistics Program, U.S. Bureau of Labor Statistics



Answering the Challenges of New Workforce Realities–Recommendations

The trends discussed in *Work* highlight the employment realities of today's highly productive, dynamic, technology- and information-driven economy. Education and skills are essential for success, and those who invest in developing them will be more competitive in the labor market and more successful transitioning as technological change or market forces disrupt labor markets. The long-term, widening gap in income growth across levels of education attainment places education and skills center stage for securing prosperity for Americans and reducing income inequality.

America has the ability to address some of the challenges brought by new realities of the labor market, the workforce and the workplace. The United States must develop strategies to prepare the workforce for adapting to rapid change and to reach for high-wage, non-routine cognitive jobs. Every aspect of our education and training system from K-12 to workforce development must function well to prepare the full spectrum of our workers—high school and college graduates, adult workers, and mature workers—with the skills they need to compete in the 21st century economy.

As stewards of the future, it is incumbent upon America's leaders in government, industry, institutions of education and labor organizations to cultivate an agile and resilient workforce, able to withstand the storms of change and adapt during the droughts of recession. For it is in the efficiency with which America reallocates productive resources, including the adaptability of our workforce, rests her true competitiveness.

> In an economy driven by innovation and knowledge...in marketplaces engaged in intense competition and constant renewal ...in a world of tremendous opportunities and risks...in a society facing complex business, political, scientific, technological, health and environmental challenge ...and in diverse workplaces and communities that hinge on collaborative relationships and social networking...the ingenuity, agility and skills of the American people are crucial to U.S. competitiveness.
>
> **Partnership for 21st Century Skills**

Establish a National Skills Agenda and a Strategic National Skills Investment Plan

Recommendation

Establish a U.S. National High Skills Agenda, complementing the Strategy for American Innovation and National Strategic Plan for Advanced Manufacturing, to help ensure employability for Americans in an era of rapid change and increasing demand for high skills.

Build Foundations for Success in a High-Skill, Knowledge- and Technology-Driven Global Economy

It is difficult to predict what the jobs of the future will be. Historical trends and projections can paint a picture of demand for growing career fields three, five and even ten years out. But the pace of technological and market change, and rapid globalization are shortening foresight and make

National Skills Agenda

- Establish a National Skills Agenda
- Build foundations for success in a high skill knowledge- and technology-driven economy
  - Get ready for the workplace by encouraging real-world skills and experience
  - Develop science and engineering skills, and a science and engineering workforce for the new economy
  - Nurture the next generation of entrepreneurs
- Skill-up for the energy revolution and sustainability
- Expand access to and transform systems for acquiring work skills
  - Support technical and professional skills development
  - Establish new pathways to transition veterans into the workforce
  - Keep mature workers competitive in the labor market and productive in the workplace
  - Develop better labor market information systems

forecasting long-term skill needs challenging. In the early 1990s, for example, citing growing wealth in the middle class and a vibrant tourism industry, the National Economic Council highlighted travel agents as a key area for employment growth over the next 10 to 20 years.[97] It did not—and could not—anticipate the ubiquity and democratizing impact of the Internet on everyday business, or the widespread availability of on-line ticket booking and travel reservations. Indeed, in 2012, the Bureau of Labor Statistics projected that reservation and transportation ticket agents, travel clerks and travel agents would be among the occupations with the largest projected numeric declines between 2012-2022.

As both the complexity and ubiquity of technology advance, companies will innovate faster, markets will emerge and become saturated more quickly, new industries will emerge and all sectors will need employees to adapt faster to more frequent change. Well educated, highly skilled workers are more able to navigate the seas of economic change, to adapt, move to different jobs or new occupations than those with lower education and skill attainment.

Also, to succeed at the leading edge of innovation, an economic imperative for the United States, requires not only technical excellence but also pursuing the leading edge of design, marketing, social media and building value for a diversity of customers. This goes beyond the need for technical skills, to include critical thinking, creativity, imagination and understanding people, societies, and what they need and want.[98]

97. Gene Sperling, "Manufacturing U.S. Prosperity: A Policy Discussion," Talk at the Brookings Institute, July 25, 2013.

98. Why America's Obsession with STEM Education is Dangerous, by Fareed Zakaria, Washington Post, March 25, 2015.

In addition, the ability to work on projects, problems, on teams and in environments characterized by multidisciplinarity is becoming more important. Few real-world problems are amenable to solution through the knowledge and methods of a single subject area.

Most modern problems are multi-dimensional. Many of the global challenges that must be addressed—global food, clean water, energy security and sustainability—require interaction among multiple fields such as a range of engineering disciplines, economics, environmental science, and social and behavioral science. Today, development and application of many new enabling technologies, development of many new products and services, and many emerging fields are also multidisciplinary in nature. For example, innovation in new media may require a broad skill base such as IT workers, business process and service delivery designers, marketing personnel, entertainers and artists, and social scientists.

The core curriculum at the United States Naval Academy—coursework required of all midshipmen regardless of academic major—reflects this need for multidisciplinary learning. While the core academic program is focused especially on science, technology, engineering and mathematics, midshipmen are required to take courses in the humanities, social sciences and leadership. These range from courses on rhetoric and literature, history and government to ethics and moral reasoning, law and foreign languages.

Taking inspiration from the Grand Challenges for Engineering,[99] the University of Southern California's Viterbi School of Engineering is focused on the "new canvas on which engineers now paint," the new norm—Engineering + (subject)—for example, engineering + medicine, or engineering + energy. More than gadgets and devices, it is a way of thinking and solving problems. The Grand Challenges for Engineering—such as providing access to clean water, improving urban infrastructure and advancing personalized learning—cannot be solved in silos, or purely with engineering knowledge and skill. The convergence in Engineering + (subject) will generate new approaches to solving problems and new innovations by, for example, providing quantitative training to non-scientists and non-engineers, and exposing scientists and engineers to non-quantitative subjects, from design to artistic creation to human behavior. The "Engineering +" radial graph shows the degree to which non-engineering subjects are present in the research or teaching portfolios of the faculty in the Viterbi School. Examples of some of the strongest intersections are: electrical engineering and chemistry, electrical engineering and interactive arts, computer science and biology, computer science and neuroscience, computer science and education, and biomedical engineering and neurology/psychiatry. The Engineering+ map, in its interactive format, can be accessed at: http://viterbi.usc.edu/about/engineeringplus/map/

Many corporations have already moved to multidisciplinary innovation teams, because the problems faced by their customers and opportunities in the marketplace require it. The United States needs

99. National Academy of Engineering.

> The challenges workers face don't come in a multiple-choice format and typically don't have a single right answer. Nor can they be neatly categorized as "math problems," for example, or passed off to someone at a higher pay grade. Businesses expect employees at all levels to identify problems, think through solutions and alternatives, and explore new options if their approaches don't pan out. Often, this work involves groups of people with different knowledge and skills who, collectively, add value to their organizations.
>
> **Partnership for 21st Century Skills**

workers who can operate and perform productively in a range of business and work endeavors with others who have different knowledge and tools. This requires workers being open to multiple perspectives, intellectual realms and aesthetic traditions; able to communicate effectively with people from other fields; the ability to put their particular knowledge in a context that transcends their particular training; and the ability to recognize, recruit and work with people who have knowledge and perspectives they lack.

The skills needed for success in the 21st century are already evident in the earnings premiums for workers able to respond to complex problems, communicate effectively, manage and analyze information, work in teams and across cultures, produce new knowledge, invent and create. In a recent survey, more than 70 percent of business executives and managers said critical thinking, communications skills and collaboration/team building have been articulated in their organization as a priority for employee development and talent management. The pace of change, global competition and the nature of work were most cited as the reasons for this priority. However, the managers and executives indicated that about half of their employees were average or below in these areas of skills.[100] Also, in a recent survey of hiring decision makers, 84 percent believed that the ability to think creatively is just as important as the ability to think critically.[101]

The foundation for these abilities is laid in school. Mastery of core academic subjects—English, reading, languages, mathematics, science, economics, geography, history, government and civics—is essential. Subjects such as financial, economic and business literacy will help students make good personal economic choices, understand the role of business and the economy in society, and better manage their career options. Global awareness will ease their work in a diverse workplace and global economy, while understanding government processes will help them participate effectively in civic life or understand the interplay between government, business and the economy.

Get Ready for the Workplace by Encouraging Real-World Skills and Experience

Through experiential education, students from primary to post-secondary education can begin to taste today's complex fast-paced knowledge economy and technology-intensive workplace, and learn to apply knowledge and skills creatively to challenges and opportunities. Project-based and service learning, internships and co-ops are all experiences that can promote work skill and professional development. In a recent survey of hiring decision makers, 74 percent believed students with work experience from an internship or paid employment related to their fields are generally more successful in their careers. Nearly 80 percent of the public also believes such practical experience, such as internships, is important.[102]

100. AMA 2012 Critical Skills Survey, American Management Association.

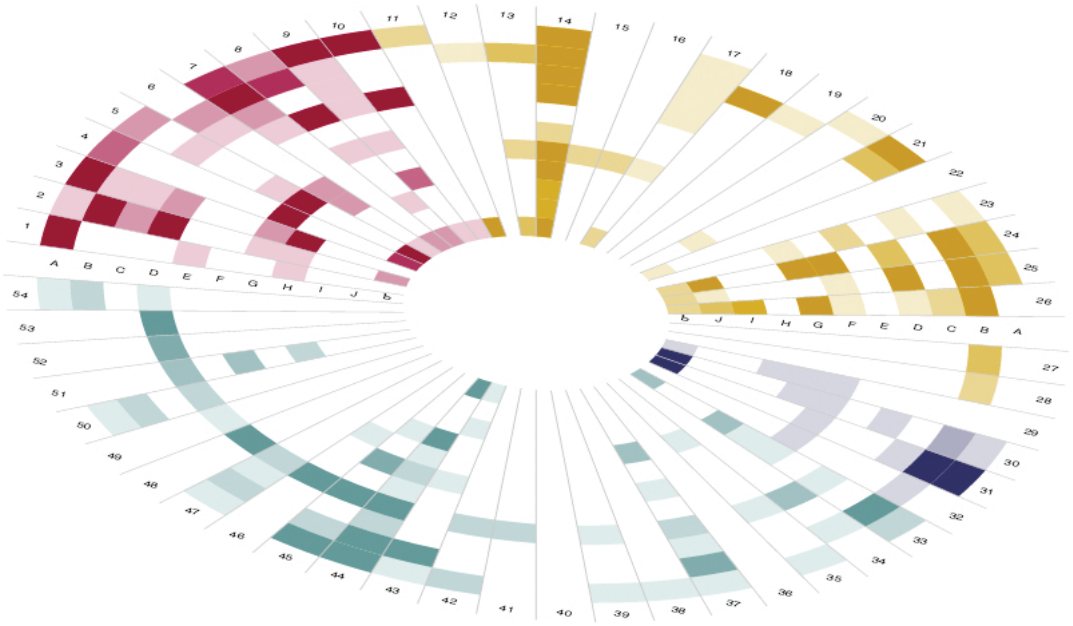
101. Preparing Graduates for Global Success, Northeastern University, 2013.

102. Preparing Graduates for Global Success, Northeastern University, 2013.

Figure 22. Mapping Engineering+ at USCViterbi

Source: http://viterbi.usc.edu/about/engineeringplus/map/

Engineering+ is simply Engineering + (subject). This radial graph charts the frequency of 54 non-engineering subjects (numbers) through the 11 departments (letters) in the USC Viterbi School of Engineering. The concentric ellipses establish rows and in each row is a letter for each department. The cells generated at the intersections of the numbers and the letters represent the presence of the non-engineering subjects in the research or teaching portfolios of tenured and tenure-track faculty in the departments. The more frequent the appearance of a subject, the more saturated the shade of the cell.



• • • ENGINEERING
A Electrical Engineering
B Computer Science
C Aerospace and Mechanical Engineering
D Biomedical Engineering
E Astronautical Engineering
F Industrial and Systems Engineering
G Civil and Environmental Engineering
H Chemical Engineering and Materials Science
I Information Technology Program
J National Center for Risk and Economic Analysis of Terrorism Events
K Engineering

• • • SCIENCES
1 Astronomy
2 Biology
3 Chemistry
4 Energy
5 Environment
6 Earth Sciences
7 Mathematics
8 Neuroscience
9 Physics
10 Radiology

• • • SOCIAL SCIENCES
11 Communications
12 Decision Analysis
13 Economics and Finance
14 Education
15 Emergency Response
16 Geography
17 Government & Politics
18 Internet Studies
19 Journalism
20 Law
21 Linguistics
22 Management
23 Manufacturing Base
24 Policy, Planning & Development
25 Psychology
26 Safety/Security
27 Sociology
28 Urban Studies

• • • ARTS
29 Architecture
30 Cinema
31 Interactive Arts
32 Music

• • • MEDICINE
33 Assistive
34 Biokinesiology
35 Dentistry
36 Dermatology
37 Devices
38 Epidemiology
39 Genetics
40 Hearing
41 Cardiology
42 Imaging
43 Informatics
44 Medicine
45 Internal/Preventive
46 Neurology/Psychiatry
47 Oncology
48 Ophthalmology
49 Orthopedics
50 Pediatrics
51 Pharmacology
52 Prosthetics
53 Surgery
54 Vision

Learning By Doing

The Baker Institute for Entrepreneurship, Creativity and Innovation at Lehigh University is a prime example of experiential, project-based learning. Through courses in product development and mentored experiences in developing their own businesses, students learn to recognize real problems, craft solutions and organize enterprises to make their solutions available. Students can begin and grow their enterprises while still undergraduate or graduate students, or perhaps have their first failures from which to learn in a "safety-netted" environment.

Recommendations

- Initiate K-12 pilots and programs that emphasize team-based, experiential and inter-disciplinary learning geared toward problem solving.
- Renew the commitment to broad education. For example, reinstate classes such as shop, art, music and other skills-based areas of study in middle and high school curricula to encourage creativity, skills acquisition and self-efficacy.
- Begin academic and career planning at a much earlier stage to give students an opportunity to explore and develop their passions, and plan for the future.
- Increase experiential education through internships, using the workplace as a venue for education, and providing students of all ages with practical experience and development of relevant skills.
- Replicate best practices from disciplines such as health care to make work experience mandatory at the secondary and post-secondary education levels.

Helping Students See A Career and How to Get There

Wisconsin's Academic and Career Plan (ACP) is an individual roadmap for students to achieve their academic and career goals. Starting in middle school, students develop a formal ACP. The program includes a focus on career clusters and the pathways to achieving career goals. There are 16 broad clusters of occupations and 79 pathways. A career pathway articulates a sequence of academic and career related courses, starting in the ninth grade and leading to an associate degree, an industry-recognized certificate or licensure, or a baccalaureate and beyond. Pathways highlight both the secondary and post secondary skills and knowledge all students need within the career cluster (such as algebra, statistics or communications); the career and technical courses central to the pathway; other career and technical learning, organizations or experiences that relate to the pathway such as service learning, career development events and school clubs; and the range of occupations related to a particular pathway. Through the ACP, students have a realistic vision of their future, they know the skills and knowledge needed to achieve that vision, and they see they have access to instruction to develop the needed skills and knowledge.

- Develop more students and workers with global perspectives. Academia, industry and government should launch the "American Explorers Initiative" to send more Americans abroad to study, perform research and work in global businesses. Expand the Fulbright Program to include undergraduate students.

Examples of Skills Needed for the Future, Skills Employers Want

Critical Thinking/Sound Reasoning
- Analyze/synthesize information to answer questions
- Identify/ask questions that clarify views
- Understand interconnections among systems
- Analyze/make comparisons
- Detect inference/make interpretations
- Understand trade-offs, advantages/disadvantages

Problem Solving
- Identify/diagnose problems, identify customer needs
- Identify elements of problem, interaction/importance of elements
- Assess similarities/differences in problems
- Investigate problems using knowledge/facts/data/experiments
- Understand problems in context of systems
- Identify what rules may apply to new situation/problem
- Transfer knowledge to application/new applications
- Develop/implement solutions
- Evaluate success/failure of solutions

Planning and Executing
- Analyze/synthesize information to answer questions
- Identify/ask questions that clarify views
- Understand interconnections among systems
- Analyze/make comparisons
- Detect inference/make interpretations
- Understand trade-offs, advantages/disadvantages

Working with Information
- Analyze/synthesize information to answer questions
- Identify/ask questions that clarify views
- Understand interconnections among systems
- Analyze/make comparisons
- Detect inference/make interpretations
- Understand trade-offs, advantages/disadvantages

Cultural Awareness
- Analyze/synthesize information to answer questions
- Identify/ask questions that clarify views
- Understand interconnections among systems
- Analyze/make comparisons
- Detect inference/make interpretations
- Understand trade-offs, advantages/disadvantages

Complex Communications
- Make persuasive oral/written arguments
- Elicit information from others/probe for critical information
- Effective listening
- Ascertain that parties have a common understanding
- Clear/concise writing, communicate logically
- Interpret/use/create visual media to enhance communications

Creativity
- Bring something into existence that is original
- Develop/implement new ideas/communicate new ideas to others
- Be open/responsive to new/diverse perspectives
- Analyze problems from multiple perspectives
- Brainstorm to generate multiple ideas
- Understand problems can be solved using different strategies
- Integrate knowledge from different disciplines
- Combine ideas/information in new ways
- Reinterpret ideas/solutions for different audiences
- Make connections between seemingly unrelated ideas
- "Walk" in the customer's shoes

Adaptability
- Ability to learn
- Handle multiple environments/goals/tasks
- Work within constraints of time/resources/systems
- Adapt to varied roles/responsibilities
- Identify/react to changing conditions
- Ability to handle unplanned events and complexity

Interpersonal Skills and Teamwork
- Influence others
- Help others learn
- Negotiate, work toward agreement
- Devise win-win solutions
- Cooperate with others to solve problems
- Read emotions/motivations/behavior during interactions with others
- Take on different roles/tasks within group
- Lead/follow
- Participate in iterative design/redesign
- Collaborating with others virtually
- Working in large groups/collaborating with many people simultaneously

Drawn from: How Computerized Work and Globalization Shape Human Skill Demands, by Frank Levy, MIT and Richard Murnane, Harvard University, May 31, 2006; Do You Have Skills Employers Want?, American Education Services, 2003; Skills Employers Want, Harper College; enGauge, 21st Century Skills for 21st Century Learners, National Central Regional Educational Laboratory and the Metiri Group; Are They Ready to Work? Employers' Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce, Conference Board, et.al., 2006; Skills and Tasks for Jobs-A SCANS Report for America 2000, U.S. Department of Labor; Future of Work Skills 2020, Institute for the Future, 2011; The Future of Work: Perspectives, Technology Horizons Program, Institute for the Future, October 2007.

Develop Science and Engineering Skills, and a Science and Engineering Workforce for the New Economy

Recommendations

- Ensure primary and secondary level students have access to teachers who are STEM subject matter experts to better educate and inspire students to pursue advanced STEM education, career opportunities and the application of STEM in a wide range of occupations.
- Develop flexible paths to help achieve STEM literacy and STEM skills, such as through community colleges, vocational trade schools and work training programs.
- Link STEM higher education to projected job opportunities of the future.
- Develop scientists and engineers who are multidisciplinary. Expose or train scientists and engineers beyond a traditional single discipline to produce more inter- and multi-disciplinary STEM professionals, including providing opportunities for cross-disciplinary collaborations with fields outside of science and technology such as business and society.
- Establish reward structures at educational institutions to encourage cross-disciplinary interaction among students and in the development of STEM professionals. Organize more university R&D, and science and engineering training around grand challenges.
- Rethink traditional paths for students who want to study engineering and STEM at liberal arts schools.
- Ensure scientists and engineers are introduced to key commercialization knowledge in areas such as design, technology development, project management, finance, manufacturing, business development, entrepreneurship and marketing.
- Expand efforts to train more computational scientists and engineers across numerous fields to better leverage America's IT advantage. This includes training and attracting more individuals skilled in developing and applying modeling and simulation software.
- Develop a "CyberCorps" program to train more professionals to help governments, companies and other organizations fight cyber intrusions, cyber espionage and theft, and other cyber crime.
- Cultivate industry partnerships with academia so scientists and engineers in training can work on real-world, interdisciplinary problems.

Nurture the Next Generation of Entrepreneurs

Entrepreneurship is vital to the U.S. economy. Entrepreneurs, and new and young companies keep the economy robust, propel U.S. innovation and make the largest contribution to U.S. job creation.[103]

According to a 2011 Gallup Student Poll, 45 percent of students surveyed in grades 5-12 said they plan to start their own business and 42 percent said they would invent something that changes the world. In the survey, the vast majority of students demonstrated qualities characteristic of entrepreneurs, saying they are not afraid to take risks, even if they might fail, or that they never give up.

Recommendations

- Promote programs that inspire students to pursue entrepreneurship.
- Prepare the next generation of innovators by fostering entrepreneurial talent at all career stages, especially early in the training of students in science, engineering, business and law.

103. Who Creates Jobs? Small vs. Large vs. Young, John Haltiwanger, Ron S. Jarmin and Javier Miranda, Review of Economics and Statistics, 2013.

Nurturing Entrepreneurial Skills Among America's Youth

Many programs in the United States—from formal higher education courses and incubators, to summer camps and business plan competitions—seek to develop students' entrepreneurial knowledge and skills.

Higher Education. Each year, thousands of college students participate in more than 5,000 entrepreneurship courses at universities across the United States,[1] many studying at institutes and centers such as top programs (ranked by Princeton Review) at City University of New York's Lawrence N. Field Center for Entrepreneurship, University of North Carolina's Center for Entrepreneurial Studies, Washington University's (in St. Louis) Skandalaris Center for Entrepreneurial Studies, University of Michigan's Center for Entrepreneurship and Samuel Zell Lurie Institute for Entrepreneurial Studies, and Lehigh University's Baker Institute for Entrepreneurship, Creativity and Innovation.

Top undergraduate university entrepreneurship programs have characteristics in common: dozens of courses related to entrepreneurship; a high percentage of faculty who have started, bought or run a successful business; business plan competitions with cash prizes and awards; mentors who work with students; and strong alumni networks linked to business. Many students who participate in these programs go on to start their own companies. For example, over the last five years, graduates from Lehigh's programs have started more than 150 companies and raised more than $200 million in funding, and students from the City University of New York's programs have started 1,000 companies that have raised $70 million in funding.

Georgetown University's StartupHoyas provides academic, extracurricular and off-campus programs that encourage entrepreneurial thinking, teach entrepreneurship through the experiences of entrepreneurs, connect students to entrepreneurs and innovators, and encourage students to start their own ventures. For example, StartupHoyas Summer Launch Program is an incubator for current Georgetown students and recent graduates who want to launch a new venture. In the two-month program, participants are provided with workspace, mentored by faculty and experienced entrepreneurs, introduced to local investors and invited to networking events. Students can apply for a stipend to cover student loan payments for up to two years after graduation, as long as they continue to work on their start-up. StartupHoyas also sponsors several pitch competitions.

K-12. Other entrepreneurship education programs focus on K-12 students. For example, more than 500,000 students in grades 3-8 have participated in BizWorld, the largest teacher-led entrepreneurial program in the world. BizWorld, which began as a grassroots movement in Silicon Valley, gives students the opportunity to learn first hand how to start and operate their own business. Working in teams of six, students start, fund and run their own company in the friendship bracelet industry. In the 10-15 hour program, they learn basic business vocabulary, develop teamwork skills, learn to incorporate within the state, create the company's identity and business plan, pitch "venture capitalists" and sell stock in an exchange for initial funding, manage finances, design bracelets and create prototypes, manufacture bracelets, create a marketing campaign, sell their product to customers and calculate the bottom line to determine whether or not the company was profitable.

1. Entrepreneurship Education Comes of Age on Campus: The Challenges and Rewards of Bringing Entrepreneurship to Higher Education, Wendy E.F. Torrance and Jonathan Rauch, Ewing Marion Kauffman Research Paper, August 2013.

Founded in 1987 to inspire young people from low-income communities to stay in school and improve their academic performance, the Network for Teaching Entrepreneurship (NFTE) has worked with more than 600,000 young people, nurturing the entrepreneurial mindset and presentation, leadership and problem solving skills. Classroom lessons include the concepts of competitive advantage, ownership, opportunity recognition, marketing, finance and product development. At the "Buying and Selling" event, NFTE gives students funds to buy products at a wholesale district or warehouse club, which they then re-price to sell for a profit. In the innovation game, students take items such as paper plates and pipe cleaners, devise an invention and present it to the class, learning about consumer needs and the art of sales. On community walks, students look at businesses and speak with owners about identifying opportunities and competitive advantage. They prepare business plans with the support of coaches, which are presented in competitions judged by local entrepreneurs and business people. High school students 16 years of age or older, and ready to implement the business plans they created through the NFTE program, can apply for NFTE's Startup Summer, in which participants get an investment grant, stipend and opportunity to work with business coaches. NFTE's BizCamp, an intensive day camp program for students aged 13-18, offers classroom lessons on topics such as return on investment, supply and demand, and marketing. Campers come up with a business idea, and work to complete a business plan presented to a panel of judges for a chance to win seed capital.

Skill-up for the Energy Revolution and Sustainability

A 21st century energy transition, and new era of sustainability, energy innovation and market expansion present a golden opportunity to boost U.S. employment. The clean energy economy promises to create a range of new, well-paying jobs. Many of these jobs will be in the manufacturing sector producing clean energy vehicles, renewable energy systems, biofuels, advanced batteries, and other clean energy and energy efficient products.

There will be jobs for skilled workers such as architects, construction managers and carpenters building new and retro-fitting buildings to make them more energy efficient and sustainable, to conserve water and to use more environmentally friendly materials in their construction. In a recent study on green buildings, 51 percent of architects, engineers, contractors, owners and consultants participating in the study believed that more than 60 percent of their work would be green by 2015. Green building is becoming the standard practice in the United States, with the green share of nonresidential construction growing from 2 percent in 2005 to 44 percent in 2012.[104] Expertise will also be needed for industry transformation, as the industrial sector works to reduce its carbon footprint, reduce energy consumption and adopt more sustainable production practices.

The Department of Labor estimated that there were 3.4 million jobs associated with the production of green goods and services in 2011. Many of these jobs are in construction, manufacturing, and professional scientific and technical services.[105] Another study found that clean economy jobs paid on average 13 percent higher than the median for all U.S. wages.[106]

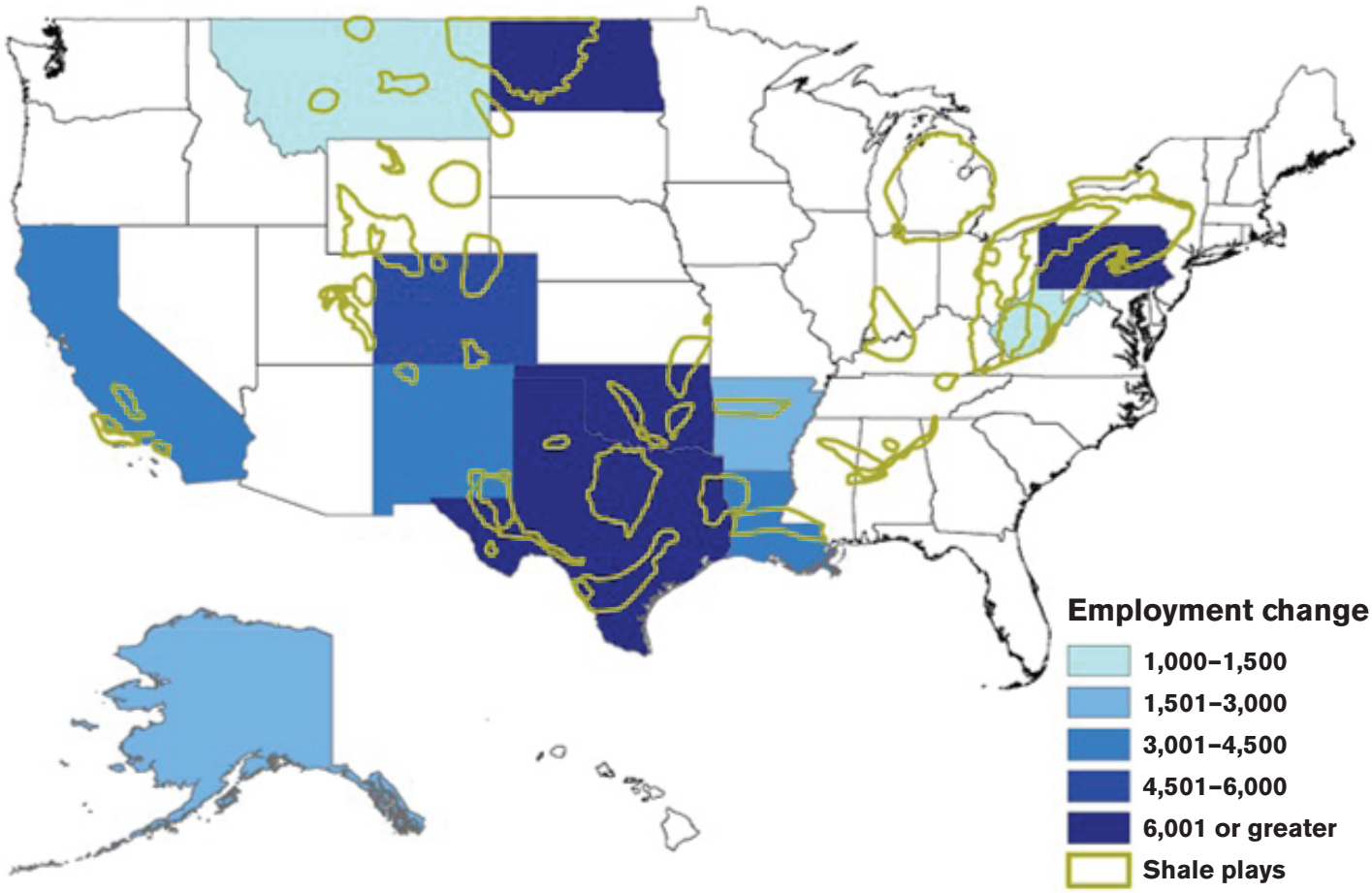
104. World Green Building Trends, McGraw Hill construction, 2013.

105. Green Goods and Services Summary, Employment in Green Goods and Services–2011, Bureau of Labor Statistics, March 19, 2013.

106. Sizing the Clean Economy, A National and Regional Green Jobs Assessment, Brookings Institution Report, July 13, 2011.

Figure 23. States with oil and gas employment change greater than 1,000, with U.S. shale plays, 2007-2012

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages Program



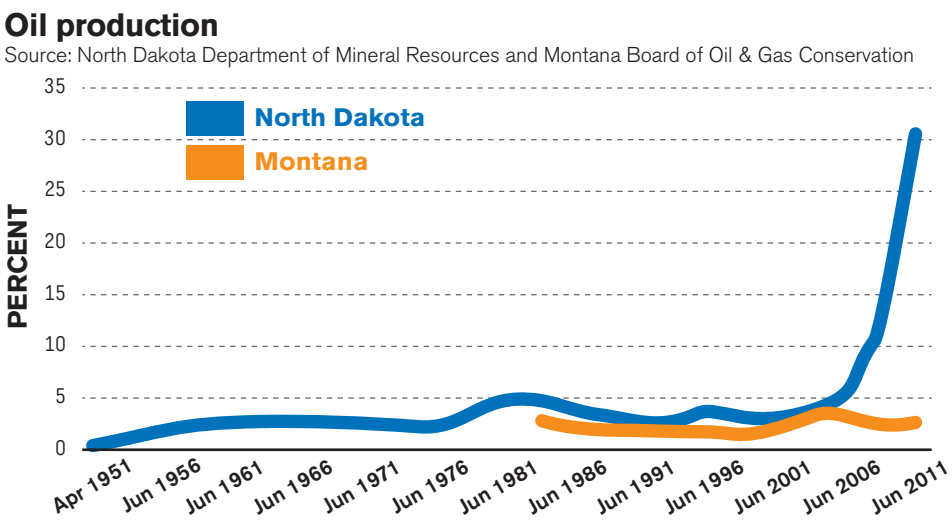
The energy sector's employment has been growing around the country. In the latter half of the 19th century, the first oil well was drilled in Titusville, Pennsylvania in 1859, igniting the country's first oil boom. Today, Pennsylvania is leading a new once-in-a-century energy revolution, a shale oil and gas boom brought about by new technology and driving employment growth in these industries. For example, from 2007 through the end of 2012, total annual average employment in all U.S. industries decreased by 3.7 million jobs, or 2.7 percent. In contrast, over the same period, the U.S. oil and natural gas industry grew by more than 135,000 jobs, a 31.6 percent increase. Texas, traditionally a major oil- and natural gas-producing state, recorded the largest numerical increase in oil and natural gas employment over the 2007–2012 period—64,515 (an increase of 33 percent). Pennsylvania had the second-largest numerical employment gain, increasing by 15,114 (259 percent). In North Dakota, employment in the oil and natural gas industry increased by 12,477, which was the largest percentage increase (354 percent).[107]

These jobs involve drilling of wells; extraction which includes operating, developing and producing oil and natural gas fields; and supporting activities for oil and natural gas operations, including exploration, excavation, well surveying, casing work and well

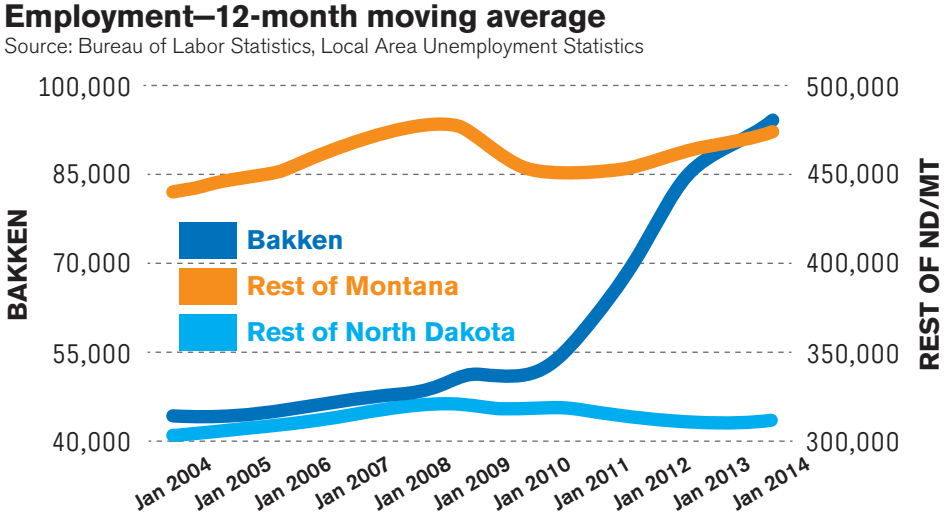
107. Employment Changes in the Oil and Natural Gas Industry, by State, U.S. Bureau of Labor Statistics, April 4, 2014.

Figure 24. Snapshot of the Shale Oil and Gas Revolution: The Bakken Oil Boom Driving Employment
Source: Federal Reserve Bank of Minneapolis

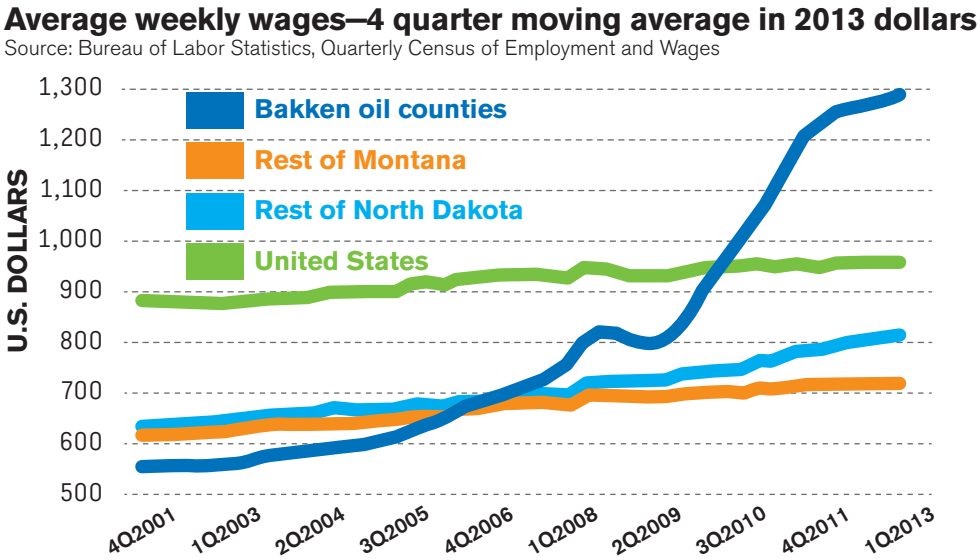
The Bakken oil boom dwarfs previous oil production expansions in Montana and North Dakota, more than five times larger than the oil boom in the 1980s.



Employment levels have doubled in the Bakken area since 2009.



Average wages in the Bakken Oil counties are high ($1,290 weekly) and rising.



construction. Beyond within-sector employment, oil and gas industry activity also directly supports output and employment in other domestic sectors, such as suppliers of pipe, drilling equipment and other drilling materials.

These industries have good jobs with high and rising wages, with average annual pay growing by a larger amount than in the national economy. From 2007 to 2012, the U.S. average annual pay increased by $4,831 (10.9 percent), to $49,289. Over the same period, workers in the oil and natural gas industry saw, on average, an annual pay increase of $13,624 (14.6 percent). In 2012, the average annual pay in the industry was $107,198, which is $57,909 higher than the average annual pay across all industries.[108]

Recommendations

- Skill-up for sustainability. Teach and develop skills in sustainability to increase U.S. workers' competitiveness as sustainability rises on the corporate agenda, and becomes a greater factor in global hiring and investment.
- Skill-up for the energy revolution. Commit one percent of Federal agencies' R&D budgets to competitive, portable, undergraduate and graduate fellowships in energy-related disciplines for U.S. students.
- Offer Federal scholarships to U.S. post-secondary students who commit to a minimum period of service in an energy-related career in the governmental, academic or non-profit sectors.
- Classify and widely publicize demand-driven needs for energy-related occupations, through the Department of Labor, and align government resources to support skills training in these energy fields.
- Create a $300 million "Clean Energy Workforce Readiness Program" at the Department of Labor to foster partnerships with industry, educational institutions, workforce organizations and the military.

Expand Access to and Transform Systems for Acquiring Work Skills

Continuous learning and frequent new skills acquisition are becoming the norm. Society must discard the illusion that people should find one-time training early in their lives to be sufficient for life-long productivity.

Support Technical and Professional Skills Development

Technical skills development is a pathway to a good job for many, while technical skills updating is vital for many incumbent workers. But the message that manufacturing, craft and other skilled labor are important is largely missing in the educational system. Shop classes continue to disappear from high schools. Vocational and technical schools are often unfairly characterized as a compromise rather than a valid choice, even though, among many young people, making things has been revived as both an avocation and path to defining one's career. Regardless of the depth of technical ability or formal education needed to do a job, young people need to know that there is opportunity for those who master a craft, apply their mastery productively and are eager to keep learning. "Re-establishment of shop class," and delivery of Career and Technical Education (CTE) can provide skills and experience in expressive, constructive work in both traditional and more contemporary forms—from machinist to welder to health care technician to IT worker.

For many students and working adults, community colleges have important advantages over traditional university-based education. These include: open admissions policies, lower costs, more occupational oriented curricula and more flexible class schedules that help accommodate students who are older and working.[109] It is not surprising then that, of all U.S. undergraduates, almost half are in the Nation's community colleges. For example, a recent study found that more than 65 percent of post-secondary

108. The Marcellus Shale Gas Boom in Pennsylvania: Employment and Wage Trends, Monthly Labor Review, February 2014.

109. Community Colleges, A Route of Upward Economic Mobility, Natalia Kolesnikova, Federal Reserve Bank of St. Louis, March 2009.

students entering computer/information science started at public two-year colleges and less selective institutions, or enrolled in sub-baccalaureate programs such as certificate or associate's degree programs.[110] Even if they do not earn a degree, studies have found that students who attend community college earn 9-13 percent more than students who have only achieved a high school diploma, and their earnings increase with each additional year of schooling. Older displaced workers also increase their earnings by participating in retraining at community colleges.[111]

In addition, community colleges are often more in tune with the needs of employers than other education institutions. Strong partnerships enable students and employers to better adjust for future skills markets and develop area- and production-based curricula.

Apprenticeships and other professional work programs offer other pathways to skill development and careers. In a recent survey, 49 percent of hiring decision makers believe that expanding apprenticeships and professional work programs for college students would better prepare them for the workplace—an answer three times more popular than increasing government investments in STEM education, increasing private sector investments in training new hires or developing outcomes measures to evaluate the quality of colleges.[112]

Recommendations

- Develop programs that expose students at the secondary and post-secondary education levels to opportunities in the skilled trades, and provide vocational and technical training to better prepare them for apprenticeships and other employment opportunities when they enter the workforce.
- Elevate Career and Technical Education (CTE) programs as priorities for Federal, state and local governments along with high schools, universities, community colleges, national laboratories and industry. Strengthen them through partnerships with business or labor that prepare students and workers for good jobs that fill labor market needs.
- Integrate academic education and technical training programs across universities and community colleges to ensure that students who participate in CTE programs are taught to rigorous standards aligned with technical and industry requirements, while maintaining their options to pursue formal higher education degree programs. This includes establishing flexible pathways for advanced degree acquisition.
- Establish a portable CompetePass available at Department of Labor one-stop training centers that can be used by eligible workforce entrants, unemployed and incumbent job holders to secure skills in certified employer-, academic- or labor-sponsored training programs that meet industry-driven skills requirements in high growth job sectors.
- Form partnerships—among Congress, the Administration, industry, academia and labor—to establish a strong manufacturing skills training capability in the development of the national network of advanced manufacturing clusters.
- Develop state-of-the-art apprenticeship programs for 21st century manufacturing in concert with industry and labor leaders. This includes launching a national manufacturing apprenticeship program operated through shared staffing and financial contributions from labor and industry.
- Community colleges should work with employers to target specific skills gaps, and develop and provide accelerated training to unemployed and transitioning workers as well as filling the immediate needs of business.

110. Chen and Weko, 2009, Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education. Washington, DC: National Center for Education Statistics. Page 5. Retrieved from http://nces.ed.gov/pubs2009/2009161.pdf.

111. Community Colleges, A Route of Upward Economic Mobility, Natalia Kolesnikova, Federal Reserve Bank of St. Louis, March 2009.

112. Preparing Graduates for Global Success, Northwestern University, 2013.

Maker Movement: Building a Creation Nation

America has always been a nation of tinkerers, inventors and entrepreneurs. Today, advances in technology are empowering these innovators as never before. A "Maker Movement" is growing across the country, fueled by the creativity and ingenuity of independent makers, designers and artisans, enabled by the convergence of new technologies such as $1,000 3D printers, laser cutters, easy-to-use design software, low cost electronics and desktop machine tools. Growing access to the "desktop factory" is putting the power of production and the ability to make almost anything—from doorknobs to drones—into the hands of the masses.

An ecosystem for makers is taking shape with specialty hardware suppliers, fab labs and Makerspaces springing up around the country, 3-D printing services, crowd sourced financing, maker networks and on-line knowledge sharing. At Maker Faires around the country, thousands of makers come together to show their wares and learn from each other. Makers tap channels such as Quirky, Etsy, Craigslist and ebay for product sales.

The Maker Movement is reaching American schools, encouraging students to invent, exciting them about making things and laying the groundwork for a new generation of engineers, manufacturers, high-tech innovators and entrepreneurs.

The rise of the Maker Movement is a huge opportunity for the United States. Much like computing technology and the Internet lowered the barriers to entry for digital start-ups, the Maker Movement is changing the economics of production and creating a launching pad for innovators, aspiring entrepreneurs, business start-ups, small business growth and new jobs.

- Base stackable credentials on competency and experience rather than classroom credit to maximize training efficiency and encourage adult learners to further their education and training.
- Build effective public-private partnerships in which community colleges collaborate with state and regional governments, and local industry to create degree and training programs that support economic development efforts, business recruitment and business growth.
- Explore successful skill development models for small and midsize business-pooled workforce training programs. Joining forces to address skills needs can allow smaller businesses to scale and tailor training programs to meet the wide array of requirements for present and anticipated talent.

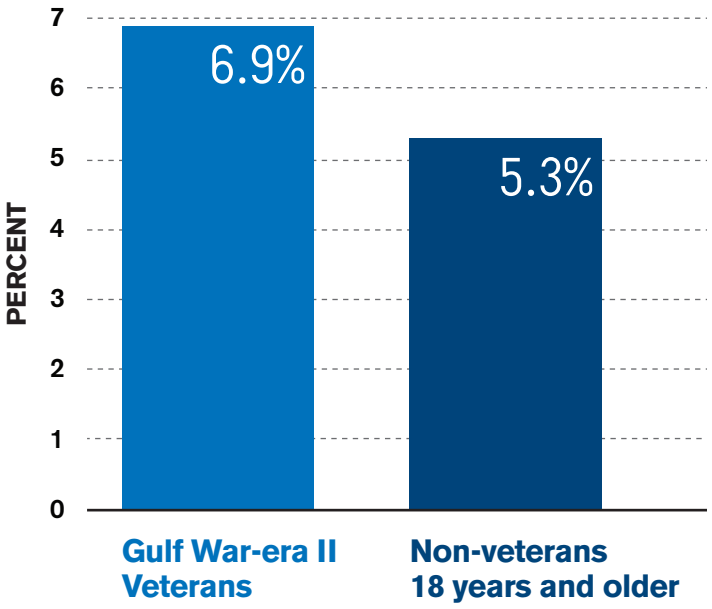
Establish New Pathways to Transition Veterans Into the Workforce

America's young military veterans returning from the wars in Iraq and Afghanistan need skills for jobs in the civilian economy. In the decade since the September 11th terrorist attacks, more than two million Americans have been deployed to Iraq and Afghanistan.[113] Although many of these soldiers are still active in the military, thousands have completed their service commitment and received an honorable discharge. Many of these young veterans return home only to face a new challenge: getting a civilian job. Veterans returning from the Iraq and Afghanistan wars have an unemployment rate of 6.9 percent, higher than their civilian labor counterparts.[114] This rate of unemployment for American veterans is discouraging given their sacrifice and service to the country. Too many are left without a job, or must settle for a low paying job with little opportunity for advancement.

113. Tan, Michelle. 2 million troops have deployed since 9/11, Marine Corps Times, December 18, 2009.

114. Table A-5. Employment status of the civilian population 18 years and over by veteran status, period of service, and sex, not seasonally adjusted, Bureau of Labor Statistics, U.S. Department of Labor; Gulf War-era II are veterans that served during the period September 2001-present.

Figure 25. Unemployment Rate, December 2014
Source: Bureau of Labor Statistics, U.S. Department of Labor



Recommendations

- Establish a Federal "Veterans in Manufacturing Program" to create opportunities for America's soldiers. Create a public-private partnership through the Department of Defense to identify opportunities for newly returning and older veterans to skill up for the manufacturing workforce.
- Expand programs such as Helmets to Hardhats® and project labor agreements/community workforce agreements to hire and train active military personnel, disadvantaged youth and unemployed veterans for successful careers in the skilled trades.

UA Veterans in Piping Program

Veterans in Piping is an outstanding example of programs creating new pathways for America's military veterans to skill up for the manufacturing and technical workforce. VIP is operated by the United Association of Plumbers and Pipefitters (UA)—a union representing 370,000 plumbers, pipe fitters, welders and other trades workers. UA has one of the most extensive training programs of any union in the world, investing more than $1 million weekly to ensure that members are prepared for the future.

America's young military veterans returning from the wars in Iraq and Afghanistan need skills to get jobs in the civilian economy. At the same time, many employers report difficulty finding skilled welders. Launched in 2008 in partnership with the U.S. military, the UA's VIP training program has proven to be a solution to these two national needs by offering high quality training to U.S. veterans and active duty military personnel preparing to leave the service.

The 18-week VIP program trains veterans to enter the pipe trades, such as welding and HVACR service. Since UA's local partners administer VIP, training can be accessed in many locations across the country. Veterans bear no cost to participate in VIP; training is paid for by UA and its industry partners. In the first two-weeks of VIP, trainees are provided counseling to help them reintegrate into the civilian workforce. After counseling, veterans participate in classroom and hands-on training.

Upon completing the program, veterans receive valuable industry-recognized certifications and an offer of direct entry to a UA apprenticeship.

In the United States, welders trained in the latest technologies are in demand. The Bureau of Labor Statistics projects that, between 2014-2024, there will be an average of more than 14,500 job openings annually for welding, soldering and brazing workers due to employment growth and to replace workers exiting the occupation. Top wages for occupations such as welders, and HVACR mechanics and installers can reach $60,000 to $70,000 annually.

The VIP has been a success. VIP has trained hundreds of veterans with a job placement record of more than 80 percent. With their new skills, and military mindset and skillset, employers find these new welders are great employees—technically proficient, work task efficient, with the ability to work in teams and a drive to get the job done right. With opportunities for advancement in the field, veterans stay motivated to work hard and learn more. Achieving professional accreditation through UA's certification program helps provide employment security, because employers see welders with certified skills as more attractive and lower risk job candidates.

Keep Mature Workers Competitive in the Labor Market and Productive in the Work Place

America's aging demographics have significant implications for the labor market. One trend is life-spans and work-spans are longer, with many people working well into their 60s and 70s, a dramatic shift from even a half-century ago. Baby boomers—roughly 75 million of them—are moving from the prime working age group of 25 to 54 years old (with labor force participation rates of about 80 percent), to an older age group with much lower participation rates (around 40 percent).

While the 16 to 24 year old labor force is decreasing and 25 to 54 year olds growing modestly, the 55 and older group is growing significantly. The Bureau of Labor Statistics projects that the number of workers in the 55 years and older group will grow by almost 20 percent over 2014-2024, almost four times the 5.0 percent growth projected for the overall labor force. The older group's share of the labor force has been increasing for more than two decades. In 1994, about 12 percent of the labor force was 55 years and older; in 2014, the share was 21.7 percent, and is expected to increase to nearly 25 percent in 2024. Also growing, the 65 to 74 year age group is expected to increase its presence in the labor force from 6.8 million in 2014 to 10.6 million in 2024, a considerable increase in this age group's labor force participation.

Despite an aging workforce that must keep their skills up-to-date, the practice and policies of the higher education system continue to favor traditional, financially dependent 18 to 21 year old high school graduates who enroll full time. The vast majority of adult learners are financially independent, work part time or full time, have dependents and many

responsibilities that compete for their time, energy and financial resources. In addition, government-supported training programs are focused largely on the unemployed and disadvantaged worker groups. U.S. education and training institutions need to develop greater and more convenient access to education and skills development to support this aging population of workers.

Recommendations

- Revise the Workforce Investment Act to establish public-private partnerships to provide skills assessments, training and career advisory services to mature job seekers.
- Encourage postsecondary institutions to offer education and training options that address the needs of mature workers, including offering education and training at times, in places and with curricula delivery that are accessible to mature people who are working full time.
- Design job-training programs to support mature workers who are in the workforce (as opposed to programs that target new workforce entrants or the unemployed). This includes offering training and job placement services at times and in places that are accessible to mature people who are working full time.
- Provide incentives for co-op and internship programs for mature workers.
- Develop new tools and initiatives at regional workforce entities, and improve systems to connect mature workers to new career pathways in high-demand, high-wage jobs.
- Offer advice, networking events, resources and services to mature workers at the regional level.
- Integrate new mature worker initiatives into economic development strategies and programs.

Develop Better Labor Market Information Systems

As technological change and innovation barrel forward, how employers identify and communicate their skills needs to students, educators and workers, and how educators and workers respond to them, will be crucial to American competitiveness and efficient deployment of our human capital to the most promising economic opportunities.

The most effective community colleges have long been engaged with their local business communities to better respond to the needs of employers by tailoring curricula to workplace demands. Better application of current labor market data and forecasts would allow education and training institutions to better align their programs of study and workforce development with employer needs. This information would also help students and workers make more informed choices in their efforts to acquire new knowledge and skills.

Recommendations

- Create stronger feedback loops for industry to communicate its needs to educators, students, and job seekers, for example through industry advisory committees, surveys of employers, having industry professionals serve as part time faculty, and faculty participation in industry conferences and symposia.
- Universities, community colleges and other education institutions should be more proactive in identifying and adapting to the needs of employers, and current and future workers.
- Increase opportunities for experiential learning, such as internships, to provide students with a better understanding of the needs in industry and the workplace.

About the Council on Competitiveness

Who We Are

Founded in 1986, the Council on Competitiveness is a non-partisan leadership organization of corporate CEOs, university presidents, labor leaders and national laboratory directors committed to advancing U.S. competitiveness in the global economy and a rising standard of living for all Americans.

Dedicated to building U.S. prosperity, the Council plays a powerful role in shaping America's future by setting an action agenda to assess U.S. competitiveness, identify emerging forces transforming the economy, catalyze thought leaders who drive change and galvanize stakeholders to act.

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How We Operate

The key to U.S. prosperity in a global economy is to develop the most innovative workforce, educational system and businesses that will maintain the United States' position as the global economic leader.

The Council achieves its mission by:

- Identifying and understanding emerging challenges to competitiveness
- Generating new policy ideas and concepts to shape the competitiveness debate
- Forging public and private partnerships to drive consensus
- Galvanizing stakeholders to translate policy into action and change

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