Research on Future Skill Demands: A Workshop Summary

Margaret Hilton, Rapporteur, National Research Council

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RESEARCH ON FUTURE SKILL DEMANDS

A Workshop Summary

Margaret Hilton, *Rapporteur*

Center for Education

Division of Behavioral and Social Sciences and Education

NATIONAL RESEARCH COUNCIL
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Preface

Over the past five years, business and education groups have issued a series of reports indicating that the skill demands of work are rising, due to rapid technological change and increasing global competition. The reports call for rapid improvements in K-12 and higher education to prepare young people with the higher skills said to be required for the coming century (Business–Higher Education Forum, 2003; Partnership for 21st Century Skills, 2005). The National Academies report *Rising Above the Gathering Storm* (National Research Council, 2007a) argued that, to meet growing global competition for high-skill, high-wage jobs, the government should increase funding of research and development and strengthen the science and mathematics education of the nation's future workforce. The America Competes Act (Public Law 110-69), signed into law in August 2007, is designed to carry out the recommendations of that report.

Researchers have begun to study changing workplace skill demands. Some economists have found that technological change is "skill-biased," increasing demand for highly skilled workers and contributing to the growing gap in wages between college-educated workers and those with less education (e.g., Berman, Bound, and Machin, 1998; Acemoglu, 2003). Autor, Levy, and Murnane (2003a) found that computerization and globalization are driving increasing demand for skills in solving non-routine problems and effectively communicating complex information, along with basic reading, writing, and mathematics skills. Extending this analysis, Levy and Murnane (2004) call for reorienting K-12 education to help more young people develop problem-solving and communication skills in the context of existing school subjects.

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However, other studies of workplace skill demands have reached different conclusions. These differences result partly from differences in disciplinary perspective, research methods, and datasets. Economists focusing on supply and demand relationships often use data on wages and educational attainment as measures of demand for different levels of skill (Becker, 1964). For example, findings that technology is increasing demand for higher skills (e.g., Acemoglu, 2003) have been based on analyses of the growing gap in wages between college-educated workers and those with a high school diploma or less. Social scientists in other disciplines focusing on the content of jobs often use data from surveys, observations, interviews, and formal job analysis as measures of skill demand. Using these other measures, researchers have found that, in different work settings, technology may increase or decrease skill levels or leave them unchanged (e.g., Appelbaum, Bernhardt, and Murnane, 2003; National Research Council, 1999).

Some research draws on Bureau of Labor Statistics (BLS) databases of the mix of employment in various occupations and industries—both historically and projected for the future—to assess changing workplace skill demands. A few researchers have combined BLS data on changes in the mix of occupations with data derived from job analysis, such as the Dictionary of Occupational Titles (DOT), a large national database of the skills required in many occupations (Autor, Levy, and Murnane, 2003b). Some of these studies have reached quite different conclusions, depending on the elements of BLS data they incorporate. For example, in an early study looking ahead to the year 2000, Johnstone and Packer combined BLS projections of the fastest growing occupations with DOT data, concluding that "the new jobs in service industries will demand much higher skill levels than the jobs of today" (Johnstone and Packer, 1987, p. xiii). Thirteen years later, Barton (2000) combined BLS historical data and projections of the mix of occupations (not only the fastest growing occupations) with job analysis data and data from a national adult literacy study, finding that, on average across all occupations, the literacy requirements in 1986, 1996, and 2006 were the same.

The findings of all of these strands of research on changing skill demands are limited by available methods and data sources. For example, studies and BLS forecasts, often assume that computer technology remains unchanged over time, despite rapid advances in computers and artificial intelligence. BLS forecasting methods are limited by a lack of attention to possible labor market adjustments in response to changes in wages and a failure to accurately project both the rapidly evolving capabilities of computers and the ways in which firms respond to those capabilities (Rosenthal, 1997; National Research Council, 2000). Because case study research focuses on individual work sites or occupations, its results may not be representative of larger industry or national trends. At a more basic level,

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there is some disagreement in the literature about how to define "skill" (Attewell, 1990). In part because of such disagreements, researchers have used a variety of measures of skill, making it difficult to compare findings from different studies or to accumulate knowledge of skill trends over time (Handel, 2003).

In the context of this increasing discussion in the research literature and among policy makers, the National Institutes of Health and the Russell Sage Foundation asked the Center for Education to conduct a workshop on research evidence related to future skill demands. To ensure that the workshop would address the variety of research methods and datasets, the Center for Education assembled an interdisciplinary planning committee, which was chaired by Richard J. Murnane.

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Acknowledgments

This report is a summary of a workshop on research evidence related to future skill demands convened by the National Research Council (NRC). The workshop would not have become a reality without the generous support of the National Institutes of Health and the Russell Sage Foundation. Bruce Fuchs, director of the Office of Science Education in the National Institutes of Health, provided the initial catalyst for the project and served as a valuable resource for the staff and the steering committee. Russell Sage Foundation president Eric Wanner contributed helpful information about current research on workplace skills at an early stage of conceptualizing the activity, also sharing his views about the challenge of projecting future workplace skills at the workshop itself.

We thank our colleagues who served on the planning committee, each of whom brought deep and varied expertise to the process of planning the workshop. Their diverse disciplines and perspectives on how workforce skills may change in the future added greatly to the success of the endeavor. Although the planning committee played an important role in designing the workshop, they did not participate in writing this report.

We are especially grateful to the experts who quickly responded to our request for background papers on workforce skills: Eileen Appelbaum, Rutgers University; Heather Boushey, Center for Economic and Policy Research; Asaf Darr, University of Haifa (Israel); Stuart Elliott, National Research Council; Mary Gatta, Rutgers University; Michael J. Handel, Northeastern University; Fiona Murray, Massachusetts Institute of Technology; Suzanne Tsacoumis, Human Resources Research Organization; and Chris Wellin, Miami University of Ohio. Their papers provided a substantive context for the rich discussions that took place at the workshop.

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We also thank the many experts who participated as presenters, panelists, and discussants: Thomas R. Bailey, Columbia University; Harry J. Holzer, Urban Institute and Georgetown University; Janis Houston, Personnel Decisions Research Institutes, Inc.; Ken Kay, Infotech Strategies, Inc.; Peter Kemper, Pennsylvania State University; Martin Kenney, University of California, Davis; Samuel Leiken, Council on Competitiveness; B. Lindsay Lowell, Georgetown University; Peter McWalters, Rhode Island commissioner of elementary and secondary education; Paul Osterman, Massachusetts Institute of Technology; Dixie Sommers, Bureau of Labor Statistics; Ken Spenner, Duke University; and Susan Traiman, Business Roundtable.

This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the National Research Council. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We thank the following individuals for their review of this report: Paul E. Barton, Labor Market Projections, Educational Testing Service; Robert I. Lerman, Department of Economics, American University and Senior Fellow, The Urban Institute, Washington, DC; Ioannis Miaoulis, president, Museum of Science, Boston, MA; and Kenneth Pearlman, consultant, Creative Personnel Management Consulting, Sarasota, FL.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the report, nor did they see the final draft of the report before its release. The review of this report was overseen by Cary Sneider, Educator Programs, Museum of Science, Boston, MA. Appointed by the NRC, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the author(s) and the institution.

We are grateful for the leadership and support of Michael Feuer, executive director of the NRC's Division of Behavioral and Social Sciences and Education (DBASSE); Martin Orland, former director of the Center for Education; and Patricia Morison, interim director of the Center for Education and associate director of DBASSE.

Richard Murnane, *Chair*
Margaret Hilton, *Study Director*
Planning Committee on Research Evidence
Related to Future Skill Demands

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1

Framing the Research on Future Skills

WORKSHOP GOALS AND CHALLENGES

The goal of the workshop was to explore the available research evidence related to two important guiding questions:

1. What are the strengths and weaknesses of different research methods and data sources for providing insights about current and future changes in skill demands?
2. What support does the available evidence (given the strengths and weaknesses of the methods and data sources) provide for the proposition that the skills required for the 21st century workplace will be meaningfully different from earlier eras and will require corresponding changes in educational preparation?

At the workshop, Bruce Fuchs (National Institutes of Health) explained that these two questions emerged after he encountered Richard Murnane's work (Levy and Murnane, 2004). Fuchs said that Murnane described changing workplace skill demands "in the context of education with a clarity that I had not seen before," leading him to request the Center for Education to convene a workshop.

Russell Sage Foundation president Eric Wanner then described the challenge of addressing the two guiding questions. He warned that understanding both future workplace skill demands and educational needs is "an extremely hard problem . . . at the margins of our ability in social science to address in a responsible way." Wanner said the hypothesis that

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the underlying "drivers" of skill demand are changing is the catalyst for growing interest in future skill demands. But, he said, if this hypothesis is correct, it means that researchers cannot simply look at patterns of occupational growth from the recent past and project them into the future. He suggested focusing instead on analyzing how the drivers are changing, in order to project future demand for various kinds of occupations and skills. This would provide a basis for thinking about how to reorient the education system.

Wanner said that he and colleagues at the Russell Sage Foundation have been trying to address this complex problem for years, since launching a research program on the Future of Work in 1994. He acknowledged that the research program "actually looked at the recent past of work," examining why the wages of high school-educated workers have been in sharp decline over the past several decades. The research program examined several factors that might be reducing demand for—and wages of—high school-educated workers that are also on the agenda for this workshop, he said. These factors include changes in technology, increasing trade, offshoring of work, and immigration. However, Wanner said, research funded by the Future of Work program also found that an additional factor—the regulatory and labor market framework—is very important in determining wage levels.[1] He observed that, in the United States, 25 percent of all employed workers earn less than two-thirds of the median gross hourly wage of all employees. By comparison, he said, the proportion of workers earning less than two-thirds of the median gross hourly wage is 8.5 percent in Denmark, 12.7 percent in France, and around 20 percent in Germany and the United Kingdom (Lloyd, Mason, and Mayhew, 2008). These differences indicate that wage levels (including the declining wages for high school-educated workers in the United States) should not be viewed only as a reflection of the interaction of supply and demand but also as a reflection of labor market institutions that in turn influence workers' bargaining power.

Wanner's comments on wages reflect a major divide in research and policy discussions on changing skill demands. Economic research often views wage differentials as reflections of skill differentials and interprets the widening wage gap between high school-educated and college-educated workers as evidence of rising demand for higher skills (Levy and Murnane, 2004). Other research methods, however, may examine how a range of forces—such as management decisions, labor laws, and the strength of labor unions—influence job content, skill demands, and wage levels. At the workshop, the tension between these two research perspectives provoked

[1]This stream of research will be reported in *The Russell Sage Foundation Series on Job Quality in Advanced Economies* (case studies of 5 European nations), to be published in 2008.

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lively debates about the current and future skill demands of service occupations (see Chapters 4 and 7).

Overview of the Workshop

Workshop planning committee chair Richard Murnane (Harvard University) described how the workshop agenda would begin to address the challenges Wanner presented. He said that the first day would focus primarily on research on skill demands, and the second day would begin to address supply. The first day's session on polarization in the national labor market, between high-skill and low-skill jobs, was designed to help frame the subsequent discussions of skill demands of knowledge workers and service workers, he said. He explained that the workshop planning committee had decided it was not possible to examine changing skill demands across all occupations and industries within a day and a half workshop and had chosen instead to focus on these two job families, because they are large and rapidly growing. He also said that the scope of these two groups of jobs would be defined later by the presenters.

Murnane noted that the background papers on knowledge workers and service workers raise questions about whether skills are embedded in jobs, in people, or in communities of working colleagues (Darr, 2007a), illuminating the complexity of analyzing changing skill demands. These definitional questions are reflected in the variety of research methods and data sets used to study changing skill demands—each with its own strengths and weaknesses. He said he hoped this variety would generate discussion, while also cautioning that "there are real gaps in the methodologies for examining skills." To begin addressing these gaps and inform future research efforts, he said, the first day's agenda includes a session on research methods. Finally, he said, because the steering committee recognized that concerns about workforce skills are not new, they asked David Finegold to open the workshop with a brief history of past policy discussions on the issue.

The workshop agenda addressed skill demand and skill supply somewhat separately, in order to address the first guiding question of the workshop. (What are the strengths and weaknesses of different research methods and data sources for providing insights about current and future skill demands?) As noted above, one of the major divides in the research is between methods that focus on job content independent of demand and economic methods, which focus simultaneously on skill supply, demand, and wages. The planning committee structured some panels to address skill demand independent of skill supply in order to ensure coverage of methods focusing on job content, including research based in the sociology of work, qualitative studies of work, and research based on job analysis (see Chapters 3, 4, and 5). At the same time, the agenda included discussions of economic re-

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search (see Chapters 2 and 6). With this structure, the workshop addressed a variety of different research methods and data sources.[2]

In his overview of the workshop, Murnane said that the second day's discussions would begin to consider the implications for public policy and education. He cautioned, however, that time and budget constraints precluded an in-depth focus on education and training, suggesting that these questions might be addressed in other National Academies activities. As a result, the workshop only partially addressed the second guiding question of the workshop (see Chapters 7 and 8). The participants did not arrive at a shared definition of future skill demands meaningfully different from earlier eras and did not examine in depth the corresponding changes in educational preparation that would be required.

A BRIEF HISTORY OF DEBATES ABOUT SKILLS AND U.S. COMPETITIVENESS

David Finegold (Rutgers University) described three eras of public debate and discussion about workforce quality (Finegold, 2007).

1. The era of *A Nation at Risk* (National Commission on Excellence in Education, 1983), from about 1983 to about 1996. This era was characterized by concerns about the perceived low quality of U.S. education and its effects on the global competitiveness of U.S. manufacturing firms and workers, especially relative to Japan and Germany.
2. The era of the "war for talent" from about 1997 to about 2001, when the rapid growth of the nation's information technology industry, together with the impending retirement of the highly educated baby boom generation, drove concerns about skill shortages.
3. The era of *The World Is Flat* (Friedman, 2005), from about 2001 and continuing today, characterized by concerns about the loss of highly paid professional and technical jobs to other nations.

Finegold noted that, despite concerns raised in the first two eras, the United States remains the global leader among the world's economies, with growing productivity and output.[3] The continuing strength of the national economy is partly attributable to unforeseen events, such as the recession in

[2]One research method for understanding changing skill demands and educational needs—employer surveys—was discussed briefly at the workshop but was not explored in depth.

[3]For example, the U.S. gross domestic product increased by over 3 percent annually in 2004, 2005, and 2006, and, after growing more slowly at 0.6 percent in the first quarter of 2007, rebounded to 4 percent in the second quarter of 2007 (U.S. Bureau of Economic Analysis, 2007).

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Japan in the 1980s, which reduced competition from that nation, and the bursting of the dot-com bubble in 2000, which reduced demand for information technology talent. Finegold said he agreed with the argument made in Cappelli (2003) that the war for talent is overblown, and that the labor market is more flexible that most people recognize. For example, concerns about the loss of skilled baby boomers to retirement have been partly allayed as an increasing percentage of people over age 55 have participated in the labor force between 2001 and 2006 (Mosisa and Hipple, 2006).

Finegold went on to say that, while U.S. firms are doing well, policy makers and experts in the current era have questions about how many U.S. college graduates these firms will employ (see Chapter 3). He explained that China, already the world leader in low-cost manufacturing, is now investing in research and development of advanced service and manufacturing industries, and India is rapidly developing its software industry. Individual U.S. workers bear more of the risks of employment than in the past, as companies provide less job security and fewer health insurance and pension benefits (National Research Council, 1999). He said that the performance of U.S. students in international comparisons of science, technology, engineering, and mathematics education raises questions about their competitiveness as future workers. For example, the scores of U.S. 15-year-olds in mathematics literacy and problem solving were lower than those of 15-year-olds in most other developed nations participating in the Program for International Student Assessment (PISA) test in 2003 (U.S. Department of Education, 2004).

Nevertheless, Finegold, said, the nation's economy retains key strengths in workforce skills, as home to many of the world's best research universities, an innovation-friendly environment (including intellectual property protections and venture capital), and a population aware of the benefits of lifelong learning. He said that this workshop is one of several efforts to understand future skill needs, including a review of long-term skill needs in the United Kingdom (United Kingdom HM Treasury, 2006) and several National Academies studies (e.g., National Research Council, 2007a).

Throughout the day and a half workshop, other experts echoed the concerns Finegold raised about the competitiveness of the individual worker. In his final reflections, Murnane warned that U.S. democracy might become unstable if opportunities for upward mobility are lost due to the widening gap in wages between low-skill and high-skill jobs.

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2

Labor Market Trends: A Loss of Middle-Class Jobs?

To provide a framework for sessions focusing on skill demands in knowledge work and service work, two presenters provided an overview of broad trends in the labor market, which include rapid growth in high-wage and low-wage jobs.

OVERVIEW OF BLS PROJECTIONS TO 2014

Bureau of Labor Statistics (BLS) assistant commissioner for labor projections Dixie Sommers presented an overview of the BLS projections for the period 2004-2014 (Sommers, 2007). She explained that the BLS methodology begins with projections of labor force growth, which are combined with econometric models to project aggregate economic growth. From this, BLS derives final demand and output in major industry sectors. Next, BLS analysts translate output in each industry sector into occupational employment in that industry sector. Every two years, the BLS releases updated projections, and it regularly evaluates its projections after a ten-year projection period has ended to see how accurate they were. Sommers emphasized that the model assumes a long-run full employment economy.

Sommers outlined four broad trends in the BLS projections to 2014 (Saunders, 2005): (1) slower labor force growth than in previous decades; (2) an aging population and labor force; (3) a continuing shift of employment to service-producing industries;[1] and (4) strong growth in labor productivity. Overall, the national economy is projected to create 19 million

[1]BLS classifies industries into three large groups—goods-producing (manufacturing, mining, construction), agricultural (including forestry, fishing, and hunting), and service-producing. The service-producing group is often referred to as the service sector.

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new jobs and to generate an additional 34 million job openings due to retirements and job turnover.

Sommers said that future workforce skill demands may be derived from BLS projections in alternative ways. One approach is to look at the types of jobs that will exist in the future, since different types of jobs require different skills. Another approach is to look at wages, although wages are not a perfect measure of skills. Finally, one can look at the education and training requirements of jobs.

Turning to the first approach, Sommers presented a table showing how 10 large job families (referred to as "occupational clusters") are projected to grow or decline from 2004 to 2014 (Table 2-1). Among these 10 clusters, the two largest in 2004—professional and related occupations and service occupations—accounted for 19.6 percent and 19.0 percent, respectively, of all jobs.[2] These two clusters are projected to grow the fastest among the eight clusters over the decade, accounting for 21.0 percent and 20 percent of all jobs, respectively, in 2014. By comparison, the smallest cluster in 2004—farming, fishing, and forestry occupations—accounted for only 0.7 percent of all jobs and is projected to decline to 0.6 percent of all jobs in 2014 (Hecker, 2005).

The professional and related cluster and the service cluster are at opposite ends of the labor market in terms of education and wages. Most jobs in the professional and related cluster—such as health care practitioners and technicians; education, training, and library professionals; and computer and mathematical science professionals—require at least a bachelor's degree and pay high wages. In contrast, most jobs in the service cluster—such as those in food preparation and serving and in health care support—require no more than a high school diploma and pay low wages. Sommers noted that wage trends reflect these occupational trends. The largest number of new jobs created from 2004 to 2014 will be in the top-wage quartile, and the second-largest number of new jobs will be in the bottom-wage quartile, with fewer new jobs created in the middle quartiles.

Sommers reported that BLS has tried alternative approaches to address the challenge of analyzing the education and training requirements of jobs. In the past, BLS analysts tried to identify the education and/or training usually needed to become fully qualified in an occupation. Using this approach, they found that most job openings in 2014 will require short-term or moderate-term on-the-job training, while smaller numbers will require a bachelor's degree, a bachelor's degree with related work experience, an associate degree or postsecondary vocational award, or a master's degree. More recently, she said, BLS has used the education and training of people currently employed in various jobs as a measure of the education and

[2]A listing of the occupational groups included in these two clusters appears in Appendix B.

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TABLE 2-1 Bureau of Labor Statistics Employment Projections 2004-2014, by Major Occupational Group (numbers in thousands)

	Employment				Change	
	Number		%		Number	%
Title	2004	2014	2004	2014		
Total, all occupations	145,612	164,540	100.0	100.0	18,928	13.0
Management, business, and financial	14,987	17,142	10.3	10.4	2,155	14.4
Professional and related	28,544	34,590	19.6	21.0	6,046	21.2
Service	27,673	32,930	19.0	20.0	5,257	19.0
Sales and related	15,330	16,806	10.5	10.2	1,476	9.6
Office and administrative support	23,907	25,287	16.4	15.4	1,380	5.8
Farming, fishing, and forestry	1,026	1,013	0.7	0.6	–13	–1.3
Construction and extraction	7,738	8,669	5.3	5.3	931	12.0
Installation, maintenance, and repair	5,747	6,404	3.9	3.9	657	11.4
Production	10,562	10,483	7.3	6.4	–79	–.7
Transportation and material moving	10,098	11,214	6.9	6.8	1,116	11.1

SOURCE: Hecker (2005).

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training required. Using this method, BLS projects that in the year 2014, nearly half (47.1 percent) of all jobs will be filled primarily by individuals with no more than a high school diploma, another 28.4 percent will be filled primarily by individuals with some college education and about one-fourth (25.7) percent will be filled primarily by individuals with at least a bachelor's degree (Hecker, 2005).

Response

Sam Leiken (Council on Competitiveness) argued that forecasting future skill demands may not be as straightforward as Sommers' presentation of the BLS projections suggests. He noted that rapid technological change may have profound impacts on the labor market. Leiken expressed agreement with Peter Cappelli (2003) that the labor market will adjust to alleviate any potential labor shortage. At the same time, however, Leiken asked what the nation should do while waiting for labor markets to clear. He noted that the Council on Competitiveness is grappling with several policy questions related to the labor market, including what to do to help the majority of the future workforce that is already at work. He said that many workers do not manage transitions to new jobs well, particularly those laid off in manufacturing industries who must make a transition to the service sector. State and local employment systems for displaced and employed workers are not well linked to each other or to the education system. Referring to Finegold's presentation, Leiken said he was "not so sanguine" about the nation's ability to make lifelong learning a matter of habit. He also asked how to help young people and adults to be wise consumers of the array of educational and career options that are available.

TECHNOLOGICAL CHANGE AND LABOR MARKET POLARIZATION

Labor economist David Autor (Massachusetts Institute of Technology) argued that the labor market is growing increasingly divided (Autor, Katz, and Kearney, 2006; Autor, 2007a). First, employment and wages are growing at the top and bottom of the labor market—a process he called "polarization" of the labor market. Autor said that the rise in earnings inequality over the period 1963-2005 is well known, but few people realize that, during the 1990s, employment and wages grew at the bottom as well as the top, although much more rapidly at the top.

Second, Autor argued that computerization and outsourcing of work to other nations are both likely contributors to this polarization (Autor, Levy, and Murnane, 2003b; Levy and Murnane, 2004). The share of workers using a computer at work grew from 24 percent in 1984 to 56 percent

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in 2003, as the cost of computing continued its historic pattern of rapid decline. Because computers excel at routine tasks with specified rules—such as providing automated flight check-in at airports and other clerical tasks—computers often substitute for humans in carrying out such tasks. However, computers are not as good as humans at two types of nonroutine tasks: abstract tasks and manual tasks. When humans carry out abstract tasks (e.g., solving novel problems, developing and testing hypotheses, managing others), they often use computers to complement their skills. Because manual tasks often require adapting to changing physical and social environments (e.g., driving a truck through traffic, serving a meal), these tasks cannot be specified with rules and carried out by computers. Autor said that computers neither complement nor substitute for human skills in carrying out manual tasks (see Table 2-2).

Next Autor presented evidence in support of his contention that computers have indeed reduced demand for routine tasks and jobs over the past four decades (Autor, Levy, and Murnane, 2003b). He presented a figure depicting trends in the task composition of U.S. jobs from 1960 to 2002 (Figure 2-1). Compared with 1960, jobs requiring high levels of abstract tasks have increased, jobs comprised mostly of routine tasks have decreased, and jobs including many manual tasks initially decreased but then leveled off.

In the future, Autor said, there will be many high-education professional and managerial jobs (involving abstract tasks) and low-education service jobs (involving manual tasks), with fewer jobs involving routine

TABLE 2-2 Potential Impacts of Computerization on Three Major Task Categories

Type of Task	Task Description	Example Occupations	Potential Impacts
Routine	• Rules-based • Repetitive • Procedural	• Bookkeepers • Assembly line workers	Direct substitution
Abstract	• Abstract problem solving • Mental flexibility	• Scientists • Attorneys • Managers • Doctors	Strong complementarity
Manual	• Environmental adaptability • Interpersonal adaptability	• Truck drivers • Security guards • Waiters • Maids/janitors	Limited complementarity or substitution

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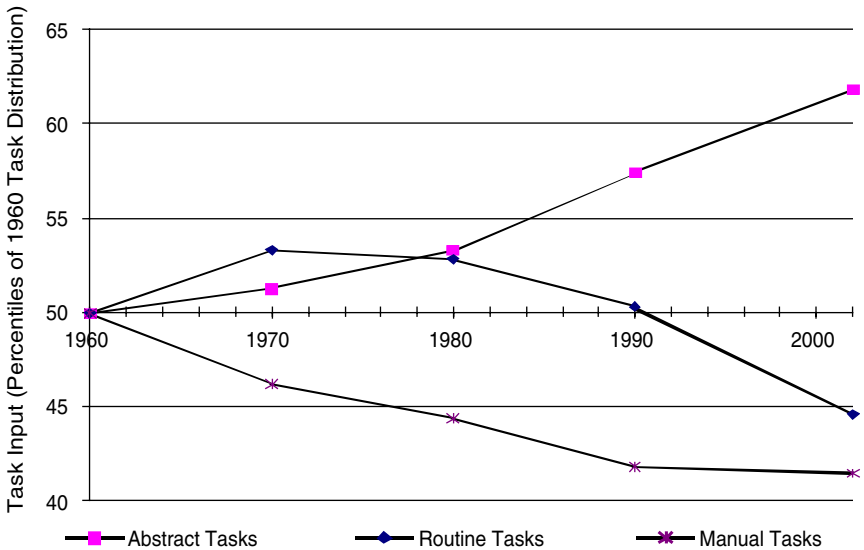

FIGURE 2-1 Trends in job tasks.
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tasks and paying middle-class wages. The same pattern of rapid growth in occupations at the high and low ends of the labor market is apparent in the United Kingdom (Goos and Manning, 2007) and Germany (Dustmann, Ludsteck, and Schoenberg, 2007). Autor said that service occupations (as defined by BLS, see Appendix B) will be increasingly important in the future, because they are difficult to automate and difficult to move offshore. These occupations do not require high levels of formal schooling but involve "natural" human skills—such as locomotion, visual recognition, and spoken language—that are in plentiful supply. In conclusion, Autor predicted further development of a "barbell"-shaped economy. He said that abstract analytical and problem-solving skills will be crucial, but not everyone will have an analytical job. The future economy will be not only a "knowledge" economy, but also a service economy.

Response

Janis Houston (Personnel Decisions Research Institutes) responded to Autor from her perspective as a corporate consultant. For the past 25 years, she said, she has worked with colleagues helping public and private organizations to analyze the competencies, skills, and abilities required for

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a single job or small groups of jobs, primarily for the purpose of developing selection and promotion criteria. Houston said she and her colleagues also do "job competency modeling," in which they identify the competencies that are most critical to have, across jobs, for a company to compete in the future. She agreed with Autor that abstract problem-solving skills, cognitive adaptability, and flexibility are increasingly important. However, despite his "compelling case" for polarization, she said she continues to see demand for mid-level skills used in carrying out routine tasks (Houston, 2007).

Based on a random sample of findings from both job analysis and job competency modeling in several large firms (including American Express, IBM, Boeing, and many large telecommunications and life insurance companies),[3] Houston said that she has observed growing demand for the following broad competencies:

1. Creative problem solving.
2. Complex communication skills, including knowing "the appropriate channels for getting things done," negotiating, influencing without authority, and team-building skills.
3. Adaptability (Pulakos, Arad, Donovan, and Plamondon, 2000). Houston said she has seen a "vast increase" in the importance of adaptability.
4. Self-management. With increased remote work, self-management and complex communication skills are more important, including knowing "when it is appropriate to make a phone call instead of an e-mail."
5. Self-development.
6. Systems thinking.

She has observed less demand for mathematics ability, which is in line with Autor's conclusions about declining demand for routine tasks, including routine mathematical calculations.

DISCUSSION

Moderator Peter Cappelli (University of Pennsylvania) kicked off the discussion with a comment on Autor's category of manual work, which, in Cappelli's view, requires some judgment. He said that, since the time of Frederick W. Taylor (1911), managers have tried to restructure manual tasks to make them routine, asking Houston if she has observed this pattern. She replied that she has seen mid-level, routine jobs being comput-

[3]Houston cautioned that this sample is not truly representative of all jobs, either in the United States or in the world of work generally.

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erized and moved offshore, but not manual jobs. In response to another question, Autor said it is important to recognize that the three categories of work he defined as abstract, manual, and routine "are fluid." There are powerful economic incentives for computer scientists to take tasks in the abstract or manual category and make them routine, he said (see Chapter 5 for further discussion of evolving computer capabilities). For example, automated systems for making an airline reservation using a phone tree may not provide high-quality service and may even waste some of the customer's time, but they are very inexpensive.

In response to a question, Houston indicated that companies view the six broad competencies she listed as important for lower level employees as well as those at higher levels. Although some of the competencies are likely to be most valuable in professional jobs, adaptability includes interpersonal adaptability and environmental adaptability, which are important in manual jobs. Autor agreed, saying these are "attributes or skills that anyone would want to have," and that the ability to solve an ill-defined problem is valuable whether one is in a managerial or customer service job.

Based in part on the workshop paper she coauthored (Gatta, Boushey, and Appelbaum, 2007b), labor economist Eileen Appelbaum (Rutgers University) questioned whether Autor assumed that, because service jobs such as child care workers receive low pay, they are unskilled workers performing manual tasks. She said that one "has only to look at France and the Netherlands to get a different picture" of child care workers as professionals engaged in abstract tasks. She suggested that, as the economy is increasingly dominated by service industries, researchers and policy makers should focus less on measuring quantities (a metaphor derived from manufacturing) and more on measuring quality of life (a metaphor more appropriate for services). She said she believes many service occupations require complex communication skills and asked Autor which jobs he includes in the service occupations category (see Appendix B).

Autor responded that, in health care, the BLS cluster of service occupations includes support occupations such as orderlies and nurse's aides, but not highly educated doctors or nurses. He agreed with Appelbaum that society has a choice about whether service occupations should be more highly skilled and paid. He said that debates about the intrinsic value of something versus its market value are often decided on the basis of supply. Things that may be intrinsically "extremely valuable" may not be highly paid "when they are abundantly supplied." Autor said that there are many workers who are capable of performing service work in the United States, and they receive low pay. In France, there are far fewer service workers, and they are more highly paid and highly skilled.

Labor economist Harry Holzer (Urban Institute and Georgetown University) cautioned that metaphors of an "hourglass economy" or "barbell

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economy" may overstate economic trends. He noted that many mid-level jobs are not disappearing—including jobs in technical support, crafts, health care support, and transportation—and will generate large numbers of new openings as the current job-holders retire. Holzer expressed concern that the popularity of the polarization metaphor is leading to a polarized education policy, focusing on college for all and standardized testing. While agreeing that he did not want to suggest that there are no mid-level jobs, Autor nevertheless argued that the current trend raises an important policy question about how to help people move from low-wage to high-wage positions if there are fewer jobs in the middle. He suggested that society would need to "find ways to ensure economic mobility is not further eroded" in the future.

Labor economist Larry Michel (Economic Policy Institute) asked whether his belief that "the jobs of the future are not going to be all that different than the jobs now" is correct. Sommers replied that some of the trends in the most recent BLS forecast to 2014 have been under way since the end of World War II. These trends include continued growth of industry sectors other than manufacturing and continued creation of new jobs due to technological change. Responding to Holzer's concern that the barbell economy metaphor has been exaggerated, Sommers noted that the economy still has many mid-level jobs. She provided the example of the office and administrative support job cluster, which included nearly 24 million jobs in 2004 and is projected to generate large numbers of replacement openings over the following decade (see Table 2-1).

Reflecting on the session, Cappelli highlighted two points. First, the focus of the policy discussion has shifted from concern about how skills affect firm competitiveness to concerns about how skills affect individual workers' careers and wages. Second, the adaptability of the labor market—as mentioned by Eric Wanner—makes it very difficult to forecast future skill demands. On the basis of these two observations, Cappelli offered a suggestion. He said that he often works with experts in decision science, who spend little time "fixating on point estimates, but instead focus on the robustness of the estimate or on alternative future scenarios" and suggested that these methods might be helpful to project future skill demands.

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3

Skill Demands of Knowledge Work

Opening this session, moderator Beth Bechky (University of California, Davis) explained that, after the previous broad overview of the labor market, it was time to "drill down deeper" into skill demands in selected groups of occupations. The steering committee chose to focus on "knowledge workers," a group that is similar to the rapidly growing Bureau of Labor Statistics (BLS) category "professional and related occupations," because knowledge workers are widely viewed as key to the nation's future international competitiveness (National Research Council, 2001, 2006). The focus of the session was two different types of knowledge work—information technology (IT) workers and scientific knowledge workers in the biotechnology industry.

KNOWLEDGE WORKERS AND FUTURE SKILL DEMANDS

Israeli sociologist Asaf Darr (University of Haifa) said that "an examination of the sociology of work practice can enrich our understanding of the future skill demands of the U.S. labor force." He explained that his paper reviews the debates in the sociological and business literature surrounding the term "knowledge worker" and the failure of both disciplines to define the term analytically (Darr, 2007b). In addition, he said, his paper calls for more research focusing on what knowledge workers do, what skills they possess and use, and how their work is coordinated and controlled.

The most important implication of his research, he said, is that the boundaries between knowledge and service work are blurring, creating an emerging group of "technoservice" occupations that challenge the historic

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structure of the national labor force (Darr, 2007a). He depicted the new group in relation to other occupational groups (see Figure 3-1), arguing that this group, which combines service, technology, and software application, makes up the core of the emerging knowledge economy. The group includes software application engineers, technical support, engineering and scientific consulting, software implementers, and detailers.

Darr observed that his view of the emerging occupational structure challenges the view of labor market polarization presented earlier (see Chapter 2). He said that the service sector is often described "as producing low-skilled and low-paid jobs," in contrast to the knowledge sector, made up of "highly skilled individuals who hold college degrees and enjoy . . . autonomy and a high salary." While he did not dispute the notion that the national labor market is polarizing, he is "opposed to the assumption that polarization occurs along the traditional service-knowledge divide."

Darr explained that he had conducted an ethnographic study of engineers engaged in selling real-time computing applications, interviewing the sales workers and also observing them at trade shows and in other settings. The research yielded two main conclusions. First, the traditional boundar-

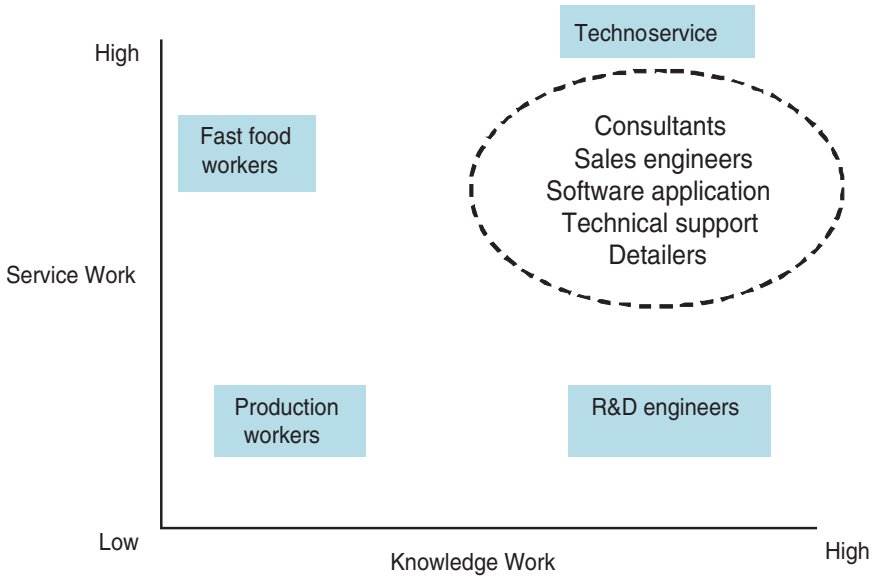

FIGURE 3-1 Occupational typology of service and knowledge work.
SOURCE: Darr (2007b).

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ies separating design, production, and sales work have blurred, making this industrial model of the division of labor obsolete. Technical workers engaged in design, who were traditionally buffered from market forces, today interact directly with customers. In this interaction, the customers are allowed—and even encouraged—to influence the design process. Reflecting this integration of formerly distinct activities, companies have shifted their emphasis from design and manufacturing to sales. Second, Darr observed a "blurring of cultural distinctions between technical and social skills." He found that, in their daily practice, sales engineers are simultaneously engaged in knowledge work and service work, deploying social and interactive skills that are closely intertwined with technical skills. He said that "as the technical complexity of sales increases, so does the need to depend on social and interactive skills."

Based on his research, Darr outlined several ways to strengthen engineering education. He said that, while others have already recognized the importance of including communication skills in the engineering curriculum (National Academy of Engineering, 2004, 2005), it would be especially valuable to require engineering students to work on customization projects as part of their undergraduate studies. Student internships focused on customization should teach students to negotiate technical details with clients and manage interviews "specifically structured to extract vital technological information about the client application," Darr said. He argued that this approach would support companies' growing emphasis on value-added processes and would improve the global competitiveness of U.S. technology firms.

Noting that engineers now change employers more frequently than in the past, as well as collaborating more often with other engineers inside and outside the firm, Darr said that they would benefit from a greater sense of engineering as a professional community. To help create such community, he suggested increasing the linkages between engineering schools, perhaps by engaging students from different schools and in different nations in shared design and customization projects. He argued that increasing students' knowledge of Chinese and Indian engineering practices would "improve the chances of American engineers leading the global engineering market rather than becoming its casualties."

Response

Ken Kay (Partnership for 21st Century Skills) said he agreed with almost everything Darr had said. Based on his 15 years of experience working with the information technology industry, Kay said, the trends Darr described are "unassailable." Commenting that U.S. education policy makers want to have a fight between skills and content, Kay said Darr's

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paper made the case "extremely eloquently" against such a dichotomy. He suggested that the paper offers a vision, not only for engineering education, but also for science, technology, and mathematics education, as interactive and personal skills are essential to success in each of these fields. Saying that "a much bigger vision" is needed for the fusion of content and skills, he asked whether such a fusion might be important to prepare students for mid-level and lower level jobs, as well as engineering jobs.

Kay noted that Darr described a business strategy in which an information technology or software firm has a general solution, which the sales and design staff then customize for individual customers. He argued that health care, education, and other industries are also adopting a similar "mass customization" strategy, asking Darr to apply the research method to other service industries. If Darr's findings were more widely applicable, Kay said, the nation would need much more research to document effective ways to teach and assess the fusion of content and skills not only in engineering education, but also more broadly. He expressed hope that the view of content and skills as fused, rather than separate, would find its way into education policy, including future metrics under the No Child Left Behind Act and future metrics for accountability in higher education.

THE KNOWLEDGE WORKER IN THE GLOBAL ECONOMY

Opening his presentation on globalization of knowledge work, Martin Kenney (University of California, Davis) said he would give special attention to information technology professionals because they make up a large majority of the current and projected future U.S. science and engineering workforce (Kenney, 2007).

Saying that there are many studies and estimates of the numbers of jobs that could potentially be moved offshore, Kenney cautioned that what the actual job losses might be is not yet known. Alan Blinder (2007) conducted a study indicating that up to 20 million jobs—in various occupations, not only science and engineering—might move abroad. The McKinsey Global Institute (2005) projected that, by 2008, 40 percent of all IT service jobs and 60 to 70 percent of professional engineering and mid-level management jobs in software development might move offshore. Lynn and Salzman (2007) identified a few cases in which U.S. IT service and software development companies are doing all new hiring of software engineers in India, and Indian engineers are using the newest software programs, while engineers based in the United States work with older "legacy" software.

According to Kenney, a recent National Research Council workshop (2007b) suggests that, in the fields of integrated circuit design and in software development, few advanced research jobs will move offshore. However, Indian integrated circuit design firms and software development

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firms engaged in development and less sophisticated research are growing rapidly, as are Microsoft research and development facilities in China and India. Kenney mentioned a study of radiology work by Levy and Goelman (2005) that illustrates the role of legal and regulatory barriers in reducing movement of work offshore. Finally, in biotechnology and pharmaceuticals, Kenney said, he expects the United States to retain its strong international advantage in research and development, predicting only limited movement of jobs offshore (Loffler and Stern, 2006).

In China, Kenney said, rapid development of IT manufacturing has attracted production engineering jobs from other nations, including Taiwan. The Chinese government and multinational corporations are making "massive increases" in research and development investments, and venture capital is flowing in. However, these investments have not yet led to "global class" technologies and services, as Chinese cell phone firms have recently lost market share in China to foreign firms. Generally, China is not competitive with India for providing offshore IT services to U.S. firms, Kenney said.

Kenney explained that India is rapidly becoming more internationally competitive. He presented two figures depicting the evolution of India's information technology sector, which grew increasingly sophisticated between 1995 and 2006 and now includes research and development, integrated circuit design, and packaged software (see Figure 3-2 and Figure 3-3). Ken-

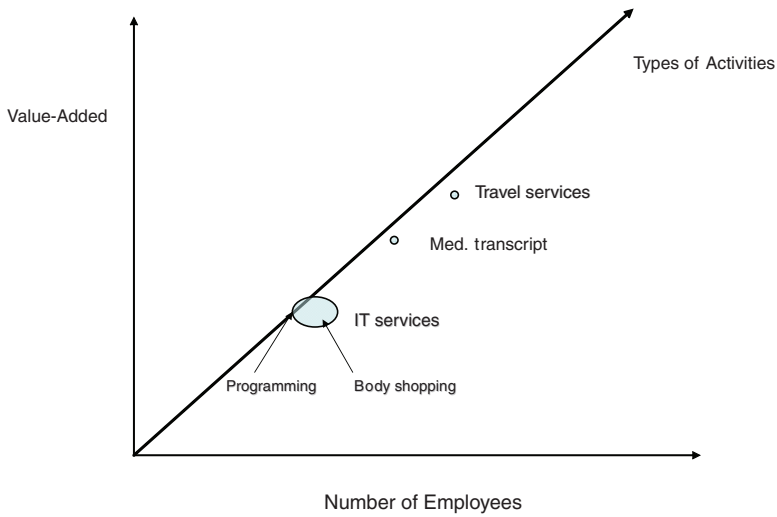

FIGURE 3-2 Information technology services in India, 1995.
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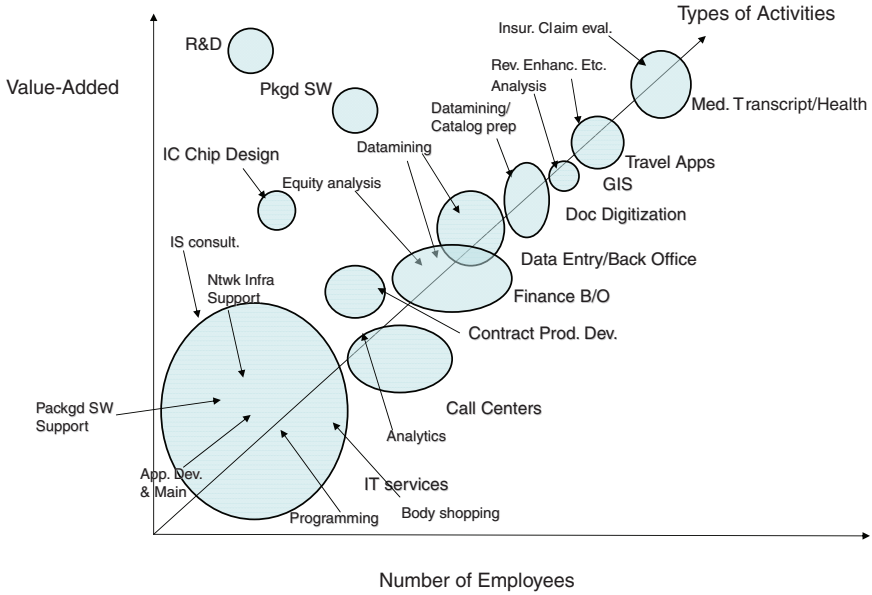

FIGURE 3-3 Information technology services in India, 2006.
SOURCE: Kenney and Dossani (2007). Reprinted with permission.

ney said that a major U.S. IT firm he consults with now views the Indian firm Wipro Technologies as an emerging competitor of such market leaders as IBM, Accenture, and EDS. This helps to explain why IBM, which had 60,000 employees (18 percent of its global workforce) in India in 2007, has announced plans to increase its employment in India to 100,000 by 2010 while simultaneously laying off waves of employees in the United States.

Kenney concluded that the rapid offshore movement of some scientific and engineering jobs—particularly those in IT services and software development—is likely to continue. Nevertheless, he provided several reasons for optimism, stating "we are an entrepreneurial society" and "the most innovative startups in the world are being established and funded in the United States." Echoing Finegold's earlier presentation, Kenney noted that the United States has flexible labor markets, cutting-edge consumers, and great universities.

To respond to these trends, "education is a key," Kenney said. He suggested focusing on IT training during the high school years, encouraging creativity and entrepreneurship, and requiring all undergraduates to spend at least one quarter abroad. Finally, he predicted that there is "little future" for those who cannot become knowledge workers.

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Responding to questions, Kenney said that the wages of Indian IT professionals with bachelor's degrees are growing rapidly but are still below U.S. wages. Kenney also said that the most important research questions about the growth of IT jobs in India are whether and to what extent these jobs are replacing U.S. jobs. He suggested that, given the continuing wage differential, American engineers would have to create higher value in order to maintain their higher wages. Referring to Darr's presentation, Kenney said that developing technoservice workers, with strong technical knowledge and social skills, is "where we need to go with our engineers."

KNOWLEDGE WORKERS IN BIOTECHNOLOGY: OCCUPATIONAL STRUCTURE, CAREERS, AND SKILL DEMANDS

Management professor Fiona Murray (Massachusetts Institute of Technology) reported that biotechnology firms headquartered in the United States employ about 200,000 people—which is about 80 percent of total global employment in biotechnology, but only 0.2 percent of the national workforce (Murray, 2007a). Addressing the question of why anyone would care about this small industry, Murray said that the industry is important to understand in itself and also "in terms of what it can tell us about science-based knowledge work more generally." She noted that the larger biosciences sector, of which biotechnology is a part, directly employs over 1 million people and creates millions more jobs providing goods and services to the industry and its employees. In addition, the industry is growing rapidly, employs many scientists, and pays an average wage of about $65,000 a year, compared with the average private-sector wage of $39,000 (Battelle Memorial Institute and SSTI, 2006). Based on all these aspects of biotechnology, Murray said, "we clearly care about jobs of this type."

Murray then observed that, unlike other industries, biotechnology is defined by the technologies it uses to make products, rather than the products themselves. Because these technologies can be used in various industry sectors, definitions of the biotechnology industry vary. A commonly used narrow definition for a "dedicated biotechnology firm" is a company founded primarily to commercialize biotechnology applications. Among dedicated biotechnology firms in the United States, nearly half focus on applications for therapeutics, another 12 percent focus on diagnostics, 10 percent on genomics, and 9 percent on industrial biotechnology (Ernst and Young Global Biotechnology Center, 2006). These firms are highly localized in regional clusters around Boston, Los Angeles, Washington/Baltimore, and a few other metropolitan areas.

Murray presented a conceptual framework for thinking about the skill demands of biotechnology work (see Figure 3-4). The initial phase of biotechnology work—for the many firms focusing on drug development—is

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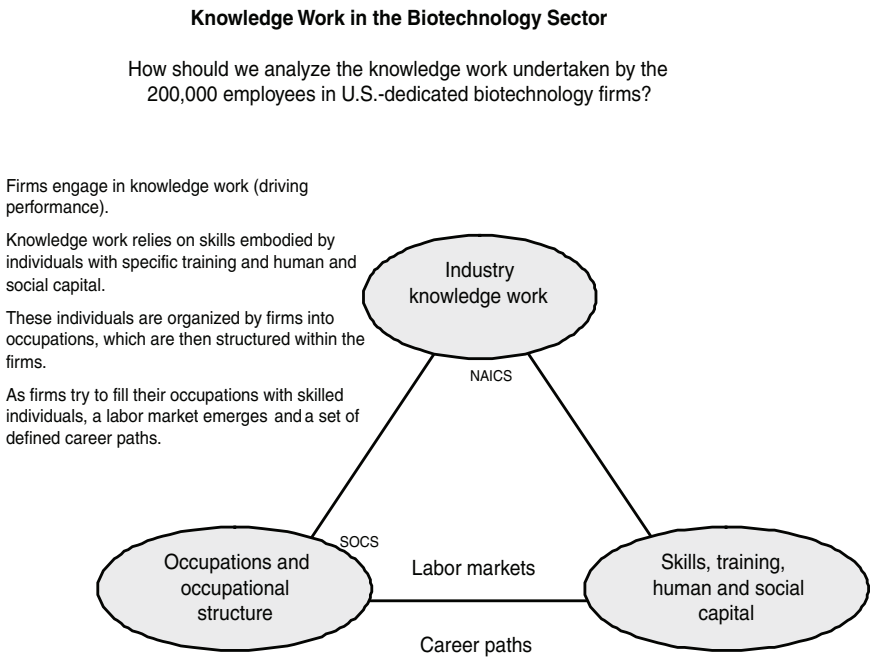

FIGURE 3-4 Framework for analyzing knowledge work in biotechnology.
SOURCE: Murray and Hsi (2007a).

discovery, followed by development, clinical trials, and manufacturing; the last two phases are sales and marketing. Murray emphasized that firms collaborate in many of these activities (Powell, Koput, and Smith-Doerr, 1996; Casper and Murray, 2004). For example, biotechnology firms often license and sponsor academic research (Edwards, Murray, and Yu, 2006). Through these collaborations, biotechnology scientists are engaged in a dense network of relationships with peers in academia, pharmaceutical firms, and other biotechnology firms (Murray and Hsi, 2007b).

Turning to skills and training, Murray said biotechnology work generally requires at least a bachelor's degree in one of a range of bioscience disciplines and employs many professional scientists with doctoral degrees. However, success in biotechnology also requires an appreciation for the potential commercial application of scientific knowledge, which is not always correlated with high-quality science (Gittelman and Kogut, 2003; Henderson and Cockburn, 1994). Because biotechnology research is more team-based than academic research, industry human resource directors say they particularly value collaboration and communication skills, Murray reported.

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With regard to jobs and career paths, Murray said that most scientific work takes place in the research and development phases. An executive chief scientific officer and one or more managers (scientists with doctorates) direct the work of individual contributors—both scientists and technicians. The later phases of the work, in clinical trials and manufacturing, employ fewer doctoral-level scientists. The industry also employs engineers. Murray said that dedicated biotechnology firms experience few major shortages of scientific skills, as their demand for relatively small numbers of scientists is generally met by the growing supply of scientists trained through public research funding. However, she said, there are a few isolated areas of skill shortages, driven by a mismatch between academic research agendas and industry needs. For example, in biology, the industry needs traditional skills in mammalian biology, physiology, and disease progression, which are less available than the molecular biology skills that are now widely taught. In chemistry, the industry has a continued need for medicinal chemists, while organic chemistry in universities has become increasingly focused on biology.

A more significant skills shortage results from "a mismatch in style of training," Murray said, as current doctoral training across the scientific disciplines does not develop the "soft" skills required by biotechnology firms. Doctoral training is too individual in its focus, does not develop teamwork skills, develops only a limited understanding of the broader context of science (including potential commercial applications), and trains students to be too highly competitive. Doctoral graduates lack the ability to design an experiment to solve a business problem, such as to assess how risky a drug might be or whether a process could be scaled up.

Future Trends in Biotechnology Knowledge Work

Murray said that biotechnology investors' demand for more rapid results is driving three broad trends in the industry. First, the work is being deskilled, as fewer new hires have Ph.D. degrees. For example, Genentech is reversing the stratification of its workforce, from 70 percent master's degrees and above to 70 percent bachelor's degrees and below. Second, the work increasingly requires integrated knowledge across scientific disciplines. Third, the work is being partitioned and moving offshore, with most rapid movement in chemistry. Although broad scientific skills in China and India still do not approach those of the United States, both nations are developing pockets of expertise in chemistry and biology, she said.

Murray concluded that the future direction of skills in biotechnology knowledge work depends on whether one views it as an art or a science. Those who believe that biotechnology knowledge work is an art will seek competitive advantage through people, building collaborative environments

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to attract top scientists. Those who see it as a science will try to improve efficiency, partitioning the work, employing more highly specialized technicians, and obtaining talent offshore. In reality, Murray said, most companies are using a mixture of both approaches.

Response

David Finegold first commended Murray for recognizing that the biotechnology workforce is part of "a wider ecosystem," including people in higher education, supplier firms, intellectual property attorneys, and venture capitalists as well as those directly employed in biotechnology firms. Second, he said, he is struck by commonalities among the skills she identified, the six broad cross-functional skills mentioned by Janis Houston, and the broad social and technical skills highlighted by Darr.

Finegold observed that Murray used an important source of data on biotechnology salaries (Radford Consulting). He said that some observers question whether salary levels are adequate, given the lengthy training required to enter this field.

He then agreed with Murray that there are two "very different stories" about the future of biotechnology. In one story, the few "really viable profitable clusters" of biotechnology companies, such as those around Boston and San Diego, will continue to grow and prosper as the source of global innovation. In the other story, Finegold said, these clusters will continue, but most new firms will not be created in the United States.

Observing that U.S. biotechnology firms are moving work offshore "earlier in the firm's life," Finegold offered the example of a company located quite close to his institution, Rutgers University, in New Jersey. This firm has rapidly added employees in New Jersey, growing from 50 to 150 workers in the past two years, Finegold said, but has also expanded in India. For every chemist in the United States, the company employs a support worker in India, and the U.S.-based chemists manage these Indian support workers on a daily basis. This model has been so successful that the firm's managers are thinking about how to apply it in toxicology and biology. Rather than taking an either/or approach to moving work offshore, the company plans to keep its core high-level scientific work in the United States, while seeking leverage by also using offshore workers. This is an example of a firm that is "literally being born global," Finegold concluded.

DISCUSSION

Moderator Beth Bechky asked the two speakers to comment on the importance of cross-functional skills not only among those with doctorates or engineering degrees but also among others employed in their respective

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industries. Murray responded that, among her master's of business administration students, many with backgrounds in engineering or science, the ability to communicate ideas "is still very challenging." Despite many years of effort and special courses focusing on communication, the skill needed "to stand up and make a convincing case . . . to a manager, a set of investors . . . is tremendously lacking," she said. She suggested providing students more opportunities to make presentations and receive feedback and integrating learning of communication skills with science content, rather than having separate communication classes. At the doctoral level, she said, employers say that they can find many people with the right scientific or technical skills, but they wonder whether these technical experts are "going to be team players." Murray said that current doctoral education focuses too much on giving people scientific knowledge and techniques, with little thought about helping students "to actually organize their education."

Murray said that almost all biotechnology employees, even those in manufacturing, have at least a bachelor's degree. Skills to interact with customers are critical, she said. Workers at all levels in the life sciences require the ability to manage complex relationships with other organizations. Murray argued that future scientists are not being trained appropriately to deal with these complex relationships, which confront them "very early on in their careers."

Darr said that abstract terms like "globalization" may cause frustration for sales engineers. He described an American engineer returning from Mexico, who complained about Mexican engineers, saying they were not "real engineers." Darr could see that this engineer could not communicate with his Mexican counterpart and did not know how to build a working relationship. In another case, Darr observed an American sales engineer return from Singapore with complaints about how the people there worked, which created a barrier to "the dialogue that was essential for the customization project he was working on."

Kay offered data supporting the argument that cross-functional skills are important in fields beyond IT and biotechnology. In collaboration with two other groups, the Partnership for 21st Century Skills surveyed human resource managers about their skill needs in 2006 (Casner-Lotto and Barrington, 2006). Among a list of 30 types of content knowledge and skills, respondents rated oral communication skills, collaboration skills, professional and work ethics, written communication, and critical thinking and problem solving as much more important than all other types of skills and knowledge. They also indicated that many new entrants, including four-year college graduates, were deficient in these skills.

Commenting on lower level employees' need for cross-functional skills, Finegold mentioned that Rutgers University had received state funding to link the biotechnology industry with community colleges and high schools.

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He said the university-community college-high school partnership plans to take approaches used successfully by the Keck Graduate Institute and the Massachusetts Institute of Technology to train master's degree students and transfer them to the high school level. These approaches integrate science, management, and people skills. For example, teams of high school students are developing business plans for new biotechnology companies and presenting them to venture capitalists.

In response to a question, Murray said that many biotechnology firms use stock options to supplement salaries, and that smaller firms offer smaller salaries but provide stock options to more employees. She observed that, in small start-up firms, employees typically work longer hours, "more like academic hours," than do employees in large pharmaceutical companies. Finegold added that using stock options to reward employees aligns well with the biotechnology business, in which developing a new drug may take 10 to 15 years. New, "cash poor" companies attract employees to join in the risk and offer the possibility of large rewards if the firm succeeds.

Responding to Murray's critique of the narrow focus of U.S. doctoral training, Kenney asked if this training has failed the biotechnology industry. Murray replied that it is difficult to address the question, "if people had been trained differently, would the industry have done better?" In the United Kingdom and Europe, doctoral training is even narrower, she said, noting that students studying in the United States must take two years of course work before starting their research. Murray said she was not calling for broader scientific training, but suggesting new approaches to develop the communications, teamwork, and other broad cross-functional skills that are important for the industry.

Kay agreed with Murray from the perspective of the IT industry. A start-up firm may have "a brilliant idea," but the challenge is to bring it to scale. This means not only programming the software correctly but also creating a team that can overcome barriers inhibiting growth. Success requires the ability to "be globally aware" and think about IT issues far beyond the development of the specific product. At least some of the scientists and engineers in the firm need such skills to translate the business idea into commercial success, Kay said.

Responding to a question from Paul Osterman (Massachusetts Institute of Technology), Murray said that, at Genentech, employees are now conducting experiments using biological cell systems that are "robust enough that you can actually work on them in a quite routine way." As a result, the company is increasing employment of specialized technicians who can operate certain types of equipment and work with animals, but who do not design the experiments. Osterman responded that this development at Genentech might relate to Autor's argument that computers are eliminating routine tasks and mid-level jobs. He noted that, while the routine work is

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being eliminated for the doctoral scientists, the company is creating a mid-level job for more people. He suggested that the creation of technician jobs in "this very high tech sector" could be significant in light of the questions raised earlier about the future availability of mid-level jobs.

Responding to the question of whether there is a national shortage of scientists Murray said that none of the companies she has talked with has suggested that there is a shortage of qualified chemists or life scientists. She said that employers' greatest concern "is not numbers, it is training." She cited the example of managers who told her they could interview hundreds of candidates for an organic chemistry position but wish they knew how to identify those candidates who "can behave collaboratively" and have the other broad competencies discussed at the workshop. She argued that the degree to which scientists have these other capabilities "really seems to be the problem."

Darr added that some companies choose to completely separate collaborative skills from technical skills. He studied one firm engaged in implementing new software for enterprise resource planning systems (i.e., large software packages integrating computer systems of different divisions or functions in a company). This firm hired two different types of people, including software engineers and another type who know the subject matter (the business function for which the software was being developed) and have good social and communication skills. The firm's customers see only people from the second group, who act as brokers between the customer and the software engineer. Darr said that this is another solution to the skills challenge that is "not integrated."

Bechky offered several concluding observations about the skill demands of knowledge work. First, in contrast to the public perception, this work requires not only abstract knowledge and technical skill, but also manual and social skills. She said that Darr's characterization of this complex blend within knowledge work as "technoservice" work is an important contribution. Referring to Autor's typology which distinguishes between abstract and manual work (see Chapter 2), Bechky said that technoservice work "incorporates both . . . abstract and manual tasks into the same work" and is found not only in biotechnology, engineering, and computer science, but also in many other occupations. For example, computer software engineers, one of the fastest-growing occupations according to BLS (Hecker, 2005), have this blend of technical knowledge and social skills. Second, Bechky said that knowledge work involves solving problems "under ambiguous conditions." As computers take over more routine work, she said, the remaining problems are more ambiguous, and solving them requires both individual knowledge and also the social and communications skills to draw on others' expertise (Levy and Murnane, 2004).

In closing, Bechky observed that organizations' needs for both technical

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and social skills in knowledge work create tensions around how to coordinate and control the work (e.g., Barley and Bechky, 1994; Owen-Smith, 2001). She noted that Murray had raised long-standing questions about how to help scientists (or other technical workers) develop the social skills they require when they are promoted to management positions. Bechky mentioned that there has there has been a great deal of research on matrix management as one approach to managing knowledge workers (e.g., Ford and Randolph, 1992). Despite such research, she said, many questions remain about how to organize knowledge work in a way that recognizes and rewards individuals' technical contributions while also recognizing that those technical contributions are in part a function of the individuals' social skills in a network of colleagues (Darr, 2007b; Murray and Hsi, 2007b).

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4

Skill Demands of Service Work

Introducing the session, moderator Peter Cappelli noted that, because researchers lack good measures of skills, it is difficult to assess changes in skill demands across the economy as a whole. He suggested that the approach taken in this session—examining skill in the context of a particular industry or occupation—would help to enhance understanding of "what skill means." Finally, he suggested that the upcoming discussions would indicate, as some of the previous sessions already had, that "there are many choices as to how these jobs are organized."

HIGH-TOUCH AND HERE-TO-STAY: FUTURE SKILL DEMANDS IN LOW-WAGE SERVICE OCCUPATIONS

Mary Gatta (Rutgers University) opened her presentation by emphasizing that many service occupations cannot be moved offshore (Gatta, Boushey, and Appelbaum, 2007a; Blinder, 2007). She said "face-to-face in-person jobs . . . need to be performed here in direct sight," and noted that the Bureau of Labor Statistics (BLS) projects that the service occupations cluster[1] will grow by 19 percent between 2004 and 2014, much faster than the projected 13 percent growth rate for all occupations (Hecker, 2005). A total of 11 of the 20 occupations that BLS projects will grow most quickly to the year 2014 are in the service occupations job cluster, and all 11 have

[1]See Appendix B for a list of the groups of jobs included in the service-occupations cluster.

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either very low or low annual earnings, less than $28,000 per year (Hecker, 2005; see Table 4-1).

Gatta explained that, because many service occupations require little formal education and pay low wages, economic studies often define them a priori as unskilled. In addition, she argued that the Dictionary of Occupational Titles "does not adequately measure or capture the skills in the service occupations" (Attewell, 1990; National Research Council, 1999). To avoid these weaknesses in national datasets, Gatta said, she and her coauthors turned to the case study and ethnographic literature to try to understand the skill demands of service occupations (Gatta, Boushey, and Appelbaum, 2007b). She cautioned that qualitative ethnographic studies provide rich data but use purposive rather than probability samples and investigate small samples of job holders (Sandelowski, 1995).

Gatta noted that a key feature of service work lies in its interaction between the service worker and the customer. She said that some researchers have argued that this interaction can be scripted and rationalized, so that "people are . . . in essence robots going through their work day" (e.g., Ritzer, 1996). Challenging this argument, Gatta described several studies that have reached quite different conclusions about the nature of service work. First, a seminal study of flight attendants (Hochschild, 1983) found that their jobs included not only serving the customer, but also smiling and conveying a bubbly personality—a form of "emotional labor" that is closely linked to the product being sold. Second, she noted that, although McDonald's Corporation tries to script and control the interactions of both workers and customers, the company also employs large numbers of supervisors to help counter workers respond to unusual and unpredictable customer demands (Leidner, 1993). Third, Gatta described studies indicating that service workers perform "articulation work," deploying a blend of emotional, cognitive, technical, and time management skills to quickly solve customer problems (Hampson and Junor, 2005).

In her own ethnographic study (Gatta, 2002), Gatta said, she found that restaurant servers were required to engage and build rapport with multiple customers seated at multiple tables, use micro computers to capture food orders and process credit card payments, and steer customers toward higher priced items without appearing to be manipulative. Another study (Newman, 1999) found that fast food workers were required to listen carefully to customers and communicate effectively with them, send out a rapid stream of instructions to coworkers, check the orders, receive money, and make change.

Gatta said that recent research also illuminates the need for aesthetic skills in many service occupations, including hospitality industry employees, who must have the right appearance and personality, and sales assistants, who must present a fashionable appearance. Luxury hotel workers must

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be familiar with local night life, theater, and restaurants at different price points and apply observational and active listening skills to discern a guest's needs and to personalize and customize the guest's experience.

In addition to other skills, service occupations often require caring skills, including nurturing, communicating, and making the client or customer happy, Gatta said. Because service occupations are often filled mostly by women and these caring skills are viewed as natural feminine qualities, the skills are neither recognized nor rewarded (England, Budig, and Folbe, 2002). At the same time, however, the jobs are divided by race, as white women interact with customers in the front of the restaurant, hotel, or other service location, and women of color work in less visible jobs as maids and dishwashers, in which wages are even lower.

Gatta said that the theory of skill-biased technological change suggests that the introduction of computers increases demand for (and wages of) highly skilled workers. However, although computers have been integrated into many types of service work, these workers' wages have not risen. Referring to the finding by Autor, Levy, and Murnane (2003a) that computers complement workers in nonroutine cognitive tasks, Gatta suggested that the theory does not apply well to service workers because their nonroutine social skills and caring skills are poorly defined and are not seen as a complement to computer technology. In fact, she said, one study found that in jobs requiring high cognitive skills, social and interactive tasks were considered special skills and rewarded with higher pay, but in jobs demanding lower levels of cognitive skills, social and emotional tasks were seen as making the job more interesting and attractive to employees without the need for additional pay (Glomb, Kammeyer-Mueller, and Rotundo, 2004).

In closing, Gatta noted that the majority of those who will make up the U.S. workforce over the next 20 years are already at work (National Center on Education and the Economy, 2006) and called for addressing the workforce "literacy crisis." She noted that workers displaced from manufacturing have not been trained in the social and interpersonal skills needed for the rapidly growing service occupations. Finally, she called for further research to more clearly define the social and interactive skills—both to guide retraining programs and so that these skills might be better rewarded in the labor market.

Response

David Autor commented on the three main arguments Gatta presented (Autor, 2007b). The first argument was that service occupations are "here to stay." Autor agreed with this argument, stating that service occupations are difficult to automate or move offshore. At the same time, he noted that these jobs do not require extensive formal education because they use

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TABLE 4-1 Occupations with the Largest Projected Job Growth, 2004-2014

National Employment Matrix Code	Title	2004 Employment (in thousands)	2014 Employment (in thousands)	Quartile Rank by 2004 Median Annual Earnings[a]	Most Significant Source of Postsecondary Education or Training[b]
41-2031	Retail salespersons	4,256	4,992	VL	Short-term on-the-job training
29-1111	Registered nurses	2,394	3,096	VH	Associate degree
25-1000	Postsecondary teachers	1,628	2,153	VH	Doctoral degree
43-4051	Customer service representatives	2,063	2,534	L	Moderate-term on-the-job training
37-2011	*Janitors and cleaners, except maids and housekeeping cleaners*	*2,374*	*2,813*	*VL*	*Short-term on-the-job training*
35-3031	*Waiters and waitresses*	*2,252*	*2,627*	*VL*	*Short-term on-the-job training*
35-3021	*Combined food preparation and serving workers, including fast food*	*2,150*	*2,516*	*VL*	*Short-term on-the-job training*
31-1011	*Home health aides*	*624*	*974*	*VL*	*Short-term on-the-job training*
31-1012	*Nursing aides, orderlies, and attendants*	*1,455*	*1,781*	*L*	*Postsecondary vocational award*
11-1021	General and operations managers	1,807	2,115	VH	Bachelor's degree or higher, plus work experience
39-9021	*Personal and home care aides*	*701*	*988*	*VL*	*Short-term on-the-job training*
25-2021	Elementary school teachers, except special education	1,457	1,722	H	Bachelor's degree
13-2011	Accountants and auditors	1,176	1,440	VH	Bachelor's degree
43-9061	Office clerks, general	3,138	3,401	L	Short-term on-the-job training

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53-7062	Laborers and freight, stock, and material movers, hand	2,430	2,678	VL	Short-term on-the-job training
43-4171	Receptionists and information clerks	1,133	1,379	L	Short-term on-the-job training
37-3011	***Landscaping and groundskeeping workers***	***1,177***	***1,407***	***L***	***Short-term on-the-job training***
53-3032	Truck drivers, heavy and tractor-trailer	1,738	1,962	H	Moderate-term on-the-job training
15-1031	Computer software engineers, applications	460	682	VH	Bachelor's degree
49-9042	Maintenance and repair workers, general	1,332	1,533	H	Moderate-term on-the-job training
31-9092	***Medical assistants***	***387***	***589***	***L***	***Moderate-term on-the-job training***
43-6011	Executive secretaries and administrative assistants	1,547	1,739	H	Moderate-term on-the-job training
41-4012	Sales representatives, wholesale and manufacturing, except technical and scientific products	1,454	1,641	VH	Moderate-term on-the-job training
47-2031	Carpenters	1,349	1,535	H	Long-term on-the-job training
25-9041	Teacher assistants	1,296	1,478	VL	Short-term on-the-job training
39-9011	***Child care workers***	***1,280***	***1,456***	***VL***	***Short-term on-the-job training***
35-2021	***Food preparation workers***	***889***	***1,064***	***VL***	***Short-term on-the-job training***
37-2012	***Maids and housekeeping cleaners***	***1,422***	***1,587***	***VL***	***Short-term on-the-job training***
53-3033	Truck drivers, light or delivery service	1,042	1,206	L	Short-term on-the-job training

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TABLE 4-1 Continued

National Employment Matrix Code	Title	2004 Employment (in thousands)	2014 Employment (in thousands)	Quartile Rank by 2004 Median Annual Earnings[a]	Most Significant Source of Postsecondary Education or Training[b]
15-1051	Computer systems analysts	487	640	VH	Bachelor's degree

NOTE: Service occupations are highlighted in bold italics.

[a]The quartile rankings of annual earnings are categorized as follows: VH = very high ($43,600 and over), H = high ($28,580 to $43,590), L = low ($20,190 to $28,570), and VL = very low (up to $20,180). The rankings were based on quartiles using one-fourth of total employment to define each quartile. Earnings include wage and salary.

[b]The Bureau of Labor Statistics places an occupation into one of 11 categories that best describes the postsecondary education or training needed by most workers to become fully qualified. For more information about the categories, see Bureau of Labor Statistics, March 2004, *Occupational Projections and Training Data*; *2004-2005 Edition, Bulletin 2572*; and Bureau of Labor Statistics, 2007, *Occupational Projections and Training Data, 2006-2007 Edition, Bulletin 2602*.

SOURCE: Hecker (2005, Table 3).

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"natural" human skills, such as visual recognition and fine motor coordination and spoken language. He presented an analysis of BLS occupational data showing that over the period 1980 to 2000, service occupations were the only low-skilled occupational group that grew in numbers.

The second argument was that service jobs require adaptive skills, emotional labor, and other skills that are not adequately rewarded. Autor agreed that service work is important and difficult, but, he argued, it is paid little because it is not scarce. He suggested that people might pay a high premium for the first hour of service in a restaurant or in house cleaning, but because many workers are willing to provide these services, the "equilibrium wage" is much lower.

Autor then addressed the third proposition in Gatta's paper—that the gender and racial composition of people employed in service occupations contributes to their low wages. He presented his own analysis of BLS data indicating that there is not a clear relationship between the extent of female employment and wages in various service occupations. He argued that the service occupations cluster, with 51 percent female employment, is not as female dominated as three other occupational groups—technicians, sales, and administrative occupations—in which employment is 59 percent female yet wages are relatively high. However, Autor emphasized that, in comparison to other occupational clusters, the service occupations cluster employs more high school dropouts and more minorities.

While stating that he agreed with the paper authors that it is important to think about what can be done to improve the quality of service jobs, Autor also noted that policy options related to improve these jobs all have "downsides." One option is to simply accept a world "of many McJobs," with low wages and few benefits, he said. Another is to expand government subsidies for such important services as health care, child care, and education, but such subsidies would be vulnerable to changing political winds. Another possibility would be to regulate the employment of service workers through such approaches as government licensing of the occupations or by mandating higher wages or training levels, but these steps would be likely to reduce employment in these occupations and make it difficult to obtain services (Kleiner, 2006). Finally, he said it is a fallacy to believe that wages of service occupations can be set at a high level because the jobs are not easily moved offshore. He said that services will continue to compete for other uses of customers' money, and if services become too expensive, customers will demand less of them.

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SKILL DEMANDS AND TRAINING NEEDS OF PAID CAREGIVERS OF OLDER ADULTS

Chris Wellin (Miami University of Ohio) opened with a quotation, explaining that, although written to describe children's care for elderly parents, it was equally applicable to paid care work:

> Care involves the constant tension between attachment and loss, pleasing and caring, seeking to preserve an older person's dignity and exerting unaccustomed authority, overcoming resistance to care and fulfilling extravagant demands, reviving a relationship and transforming it (Abel, 1990, pp. 204-205).

Perhaps the best way to understand care work, Wellin said, is to recognize that these workers act as an extension of family members. He said that the quotation was important because it not only focuses on instrumental tasks, such as bathing and dressing, but also recognizes "the interpersonal and emotional relations in which the tasks are embedded"(Wellin, 2007a).

Wellin described his perspective on care work as ethnographic—one that recognizes the cultural and organizational context of the work (Wellin, 2007b). Historically, he said, these jobs "were defined by their place at the bottom of a status hierarchy" in hospitals. Although they now work in nursing homes and in the community as home health workers, where they no longer play a marginal role on the caregiving team, he said that these earlier views of their work still "cling to the workers."

Briefly describing the demographic trends driving demand for low-wage caregiving work, Wellin noted that, by the year 2025, more than 20 percent of the U.S. population will be over the age of 60, with the fastest growth among those over 80 "for whom disability rates are really high." Given the natural limits on the possibilities for medical intervention to improve the health of older, disabled people, care focuses on making them comfortable, both physically and mentally. As a result of these trends, demand is growing for caregivers. Two groups of caregiving occupations—nursing aides, orderlies and attendants; and personal and home care aides—are among the ten occupational groups with the largest projected job growth over the decade from 2004 to 2014 (Hecker, 2005).

In 2004, nearly 3 million low-wage care workers were employed in the United States, including 1.45 million nursing aides, orderlies and attendants; 701,000 personal and home care aides; and 624,000 home health aides (Hecker, 2005). More than 90 percent of care workers are women (Eaton, 1999). Over one-third are African-American, 67 percent have a high school diploma or less education, 25 percent have at least one child aged 5 or younger, and one-third have family incomes below 150 percent of the poverty level (Potter, Churilla, and Smith, 2006). Hourly wages are low,

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ranging from less than $7.00 per hour to over $8.00 per hour for a certified nursing assistant working in a hospital, and job turnover is high.

Wellin explained that care jobs are growing much faster in community-based settings (home care or assisted living) than in hospitals or nursing homes, both because of efforts to contain rising public expenditures for care and because federal law requires provision of care for the disabled in the least restrictive setting possible. In these settings, caregivers work for "clients," rather than caring for "patients" in hospitals or "residents" in nursing homes. Because clients demand more personalized, tailored care, the worker has greater freedom and an opportunity to provide "total care." At the same time, however, this is where wages are the lowest and the worker lacks any support from colleagues.

The work is complex because it requires intimate contact—"encroachment on adult privacy and dignity"—with individuals who vary widely in their preferences, abilities, and disabilities, Wellin said. He argued that, even more than the other types of interactive service work that Gatta described, low-wage care work is viewed as natural, instinctual work done by women and their families. In fact, a worker who behaves in a more "professional" manner, such as taking too much time to attend to an individual patient's needs or trying to communicate about the patient with an attending physician, is likely to be penalized or fired.

In institutional settings, Wellin said, low-wage care workers provide over 80 percent of direct care and "nearly all of the social contact and support." Typically, both caregivers and care recipients describe their relationship as if they are family members. For care recipients, sharing their life story is important to maintain a sense of identity, and the caregiver plays an important role in this.

Retaining low-wage care workers is often difficult, Wellin said, citing a survey that found that only half of certified nursing assistants were still in that occupation two years after certification. He noted that research has identified several factors associated with higher retention, including a lower number of beds, a lower ratio of staff to residents, nonprofit status, a higher quality of care, and involvement of staff in training and care planning. These factors lower turnover, even when wages remain low, he said. In addition, cultural and ethnic similarity enhances recruitment and retention by providing a supportive community, Wellin said, citing as an example the fact that many Filipinos work as home health aides in the San Francisco area.

Training of Low-Wage Care Workers

Wellin explained that current training of low-wage care workers stresses instrumental tasks, basic medical knowledge, resident safety and rules, with little attention to "psychosocial care skills." Training and certification

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requirements vary widely across the states. Some care workers receive in-service training in basic nutrition, infection control, and safe transfer techniques to avoid occupational injuries that are among the highest of any job in the national labor market. Less often, they are trained in resident rights and ethical concerns, dementia care, family stress issues, communication, and spiritual counseling (Wellin, 2007b).

Training is important because many workers view their jobs as a "longer term career choice," Wellin said. He noted that the occupation is an "anomaly" combining "high commitment, a high sense of mission, with low occupational stability and rewards." He reminded the audience that the shift to community-based care increases not only the technical-medical, but also the psychosocial skill demands of the work, and that the growing population of elderly people with more serious disabilities, including dementias, also increases the complexity of the work.

Wellin argued that training to meet these growing skill demands must be "intertwined," incorporating both low-level medical training and training in psychosocial skills. Workers should be trained in basic human development and adult aging and in communication skills, recognizing the care worker's key role in extending the preferences of the individual in a "very vulnerable situation." Finally, he strongly supported including low-wage care workers in ongoing assessment and modification of plans for the care of those they work with as "perhaps the most powerful way to apply their knowledge."

The delivery of this training should be integrated with the particular needs of the work setting, Wellin suggested. For example, as nursing homes and facilities are increasingly licensed to meet special needs, such as dementia, workers could be trained and certified in skills related to these needs. Portable certification would be valuable for care workers moving from one job to another. In closing, Wellin argued that the fates of the higher wage knowledge workers discussed in the earlier session and the predominantly female care workers he described are "intertwined." The quality of life of the professional or knowledge worker who is working "intense hours and long hours" may be defined by the continuity and quality of the child care and elder care provided to family members (Wellin, 2007b).

Response

Peter Kemper (Pennsylvania State University) opened by explaining that he has a rather different perspective, as an economist interested in long-term care policy and currently engaged in an evaluation of a program designed to improve the quality of care and the jobs of care workers. First, he said he agrees with Wellin that direct care requires many skills. Kemper said that Wellin's argument that caregivers' tasks "require complex, em-

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pathic and embodied practices" (Wellin, 2007b, p. 17) is "right on target" and consistent with the knowledge and adaptive skills discussed in the knowledge worker session, "making this a high-skill job in some important respects."

Second, Kemper agreed that the training of care workers should recognize their important role not only in health care but also in enhancing quality of life by providing psychosocial care. In addition, he said, Wellin's argument that care work should be personalized should also inform education and training policies.

Third, Kemper commented on the need for "a living wage for such workers, and to attach employment to basic fringe benefits" (Wellin, 2007b, p. 41). Although the work is valuable, he said, raising wages would be difficult because the demand is "derived." Although the growing elderly population is a large force driving demand, Medicaid is the primary payer for care and policy keeps Medicaid reimbursement low. Kemper said that, as the private pay market grows, the "two-tier market . . . will get worse as time goes on" and that wages will rise "at some level." He suggested thinking about wages and quality of care together, citing the example of the Better Jobs Better Care demonstration program (Institute for the Future of Aging Services, 2007), which is based on the idea that improving the jobs of direct care workers will improve quality of care and care recipients' quality of life.

Kemper offered several observations about education and training. First, improving the training of care workers and their supervisors could play a role in improving job quality, which would help attract workers to care jobs and help them advance their careers. Second, he suggested that society as a whole needs "a broad education on disability," as many people lack awareness about what it means to live with disability. This would be similar to education about awareness of, and respect for, other cultures and education about diversity. Kemper suggested that public education about disability should include a component emphasizing the "rewards and possibilities" in caregiving careers.

Kemper said that many people view care work as a dead-end career, because many direct care workers are not interested in moving up to nursing jobs. However, there are specialized positions, such as those of medication aides and dementia aides, and government policies can support certification of these specialties. In addition, there are opportunities to take on some supervisory responsibilities as a peer mentor or team leader. He said that the Better Jobs Better Care demonstration is providing training in these areas and in cultural competence and person-centered care. The program provides modest amounts of training that are compatible with full-time work.

Kemper said that training of managers and supervisors is critical, as

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care workers "don't leave their job; they leave their supervisors." These supervisors tend to be registered nurses, whose education does not develop supervisory skills. Finally, Kemper concluded that, because few caregiving skills are employer-specific and job turnover is high, employers lack incentive to train,[2] so public policies are needed to support training.

DISCUSSION

In response to Cappelli's question about whether skill demands of service jobs are rising, Wellin reiterated that care workers have moved out of hospitals—where they were part of a large team including nurses, doctors, and perhaps a social worker or member of the clergy—and into nursing homes, assisted living or home health care, where they are the primary caregivers. This shift greatly expanded their skill demands, he said.

Eileen Appelbaum said that the skill demands of service jobs will depend on "what we want to say about the quality of services." For example, the New Jersey Supreme Court ruled that children ages 3 to 6 are entitled to a free quality education, and that providing this level of quality would require more highly skilled early childhood teachers. To implement this ruling, Appelbaum said, the state has established a new teacher certification program for lead teachers in early childhood classrooms, and assistant teachers are obtaining associate degrees through an apprenticeship program that includes on-the-job training with classroom training. Speaking to the audience, Appelbaum asked whether, if they had a young child or grandchild of 2 or 3, they would want that child to interact daily primarily with a person who cannot speak English. "If we are talking about having quality of services," she said, "then we need to be thinking about the quality of training." In addition, she said, as more organizations reduce layers of supervision, employees more often are assigned work through an e-mail message or other written instructions. Arguing that "most of these jobs that we consider low-skill now require literacy," Appelbaum expressed grave concern about current national literacy levels (Kutner, Greenberg, and Baer, 2006). Because many adults with "basic" or "below" basic literacy levels are at work and have family responsibilities, she suggested thinking about how to use technology "to make literacy training flexible in time and space."

To summarize Appelbaum's argument, Cappelli suggested that service work could be performed at very different levels and that, if society decided that the services should be provided at a higher level of quality, then the

[2]Kemper was referring to human capital theory (Becker, 1964), which suggests that employers will invest in training for skills specific to the firm, but they will not pay for general training to develop skills that could be used in another firm.

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skill demands would rise as well. Appelbaum responded: "absolutely." Gatta then mentioned that the hospitality industry in New Jersey is partnering with community colleges to develop a system of skills certification, training, and job ladders for casino workers, with the goal of reducing turnover and increasing the skills and quality of these jobs.

Paul Osterman commented on Autor's statement, in his response to Mary Gatta, that every option for improving the quality of service job has a "downside." Osterman asserted that Autor views any option that might interfere with labor supply and demand as an "imperfection" in the labor market. Osterman pointed out that both he and Autor enjoy tenured positions, and this kind of imperfection "seems like the natural state of affairs," yet, when workers organize a union to protect their interests, economists tend to view this only as an imperfection. Osterman reminded Autor of his earlier study (Autor, Levy, and Murnane, 2003a) about a bank that introduced technology in two different departments. One department introduced technology in a way that created very routine, fast-paced jobs, and the other department integrated tasks, creating jobs that required higher levels of abstract reasoning and were more productive, and raised the salaries accordingly. Osterman said the study revealed that employer choices about how to organize work are influenced not only by constraints (or "imperfections") in the labor market, but also by values. He suggested being open to the possibility of organizing work in ways that provide gains for both employees and employers yet do not interfere with supply and demand forces (e.g., Osterman, 2000).

Autor responded that simply "exhorting people to see" that low-wage service work involves many unrecognized, valuable skills would not affect their wages. He argued that he does not view all alternatives for improving the quality of service jobs as imperfections. For example, he said, he views training not as a "distortion" in the labor market, but rather as an investment. Autor went on to say he thinks that the U.S. labor market is "operating relatively well, given the availability of skills and supply and demand," but "that doesn't mean there aren't ways to push it in the direction that all of us would be happy about." Cappelli responded that there were debates in the early 1990s about how to encourage firms to organize work in ways that enhanced job quality, skills, and wages (e.g., Commission on the Skills of the American Workforce, 1990), but there were never clear answers.

Appelbaum responded by reminding the group that Eric Wanner had talked earlier in the day about the important role labor market institutions play in constraining employers' choices. She said that, if the federal government required higher minimum wages, employers might choose to invest more in training to increase the productivity of these more expensive employees. She again suggested focusing on the quality of the service, arguing that, if society decides that children, old people, disabled people, and

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other vulnerable groups must receive high-quality service, then the service workers would require higher skills. Wellin added that the current backlash against managed care and baby boomers' more aggressive demands on the health care system might raise public awareness of the value of direct care work and workers. Sam Leiken asked what mechanisms are in place—such as consumer satisfaction surveys—to judge the quality of elder care services. Kemper responded that measures of the quality of physical and medical care are available, but it is much more difficult to measure the quality of psychosocial care. He said that some early efforts are under way to assess the extent to which different nursing homes have moved toward person-centered care.

Autor interjected that immigration policy is an "incredibly central" aspect of the current structure of service occupations. He said one reason these jobs are "low wage and low skill" is that there is an abundant supply of people with little formal education "who are willing to take those jobs at those wages." Although low-wage personal service jobs cannot be moved to India, he said, it is possible to bring in labor from the rest of the world to do these jobs.

Mary McCain, (Techvision 21 Consulting Group), said that the "exciting" discussion of future skills and competencies should be grounded in the realities of a public and private education and training system that is "at best possibly dysfunctional." Based on her experience working with companies, she noted that employers find it extremely difficult to find and pay for training, as well as to find employees with enough basic education and language ability to learn. She echoed Appelbaum's concern about the large fraction of the national workforce with basic or below basic literacy levels.

Gatta commented that some employers in the health care and hospitality industries have moved toward integrating basic literacy with occupational training, working with public education institutions to create the curriculum. Gatta said that it is a particular challenge to create training, career ladders, and certification systems that can help low-wage, entry-level workers advance their skills and careers.

Suzanne Ripley, an expert on disability (Academy for Educational Development), warned that it is important to distinguish between elder care provided in the home and care provided in institutional settings. She said that, in Virginia, an individual can hire his or her own caregiver, with only a minimal background check, and that the caregiver's work is not supervised or monitored. Ripley expressed concern that the panelists had not mentioned the problem that direct care workers' lack benefits, describing this as "an overwhelming difficulty in recruiting or retaining staff," especially because so many women with children work in these jobs. In addition, Ripley said, Medicaid, which pays for these workers, is a form of welfare,

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and such jobs "don't pay well." She asked how to direct public policy and public attention to the need to provide benefits and a living wage to direct care workers.

Cappelli concluded the session by noting that its value "to help us understand the various choices that are made that shape skill requirements and skill demands." He specifically noted the importance of choices about the level of service that is provided and employer choices about how to organize and reward work.

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5

Promising New Data and Research Methods

Moderator Christopher Sager (University of Central Florida) introduced the speakers, promising a lively discussion of new data and research methods for analyzing changes over time in workplace skill demands.

FEASIBILITY OF USING O*NET TO STUDY SKILL CHANGES

Industrial/organizational psychologist Suzanne Tsacoumis provided an overview of the Occupational Information Network (O*NET) database and described its potential for researching recent changes in skill demands and projecting future changes (Tsacoumis, 2007a).

She explained that, during the 1930s, the U.S. Department of Labor (DOL) created the Dictionary of Occupational Titles (DOT), a compilation of occupational data from trained job analysts who observed and interviewed workers. The DOT was updated several times over the following decades, and the 1991 edition included information on about 12,000 occupations. A DOL advisory panel, convened in 1990 in response to increasing criticism of this large, expensive, and inflexible job catalogue (e.g., National Research Council, 1980), recommended creating an electronic database that would collect more information and rely primarily on surveys of jobholders to update information on jobs. This led to creation of O*NET, which uses a common language to describe many occupations, facilitating comparisons and analysis.

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Overview of the O*NET Database

Tsacoumis described two core elements of O*NET—the content model and the occupational taxonomy. The content model, based on extensive research on job analysis (Peterson, Mumford, Borman, Jeanneret, and Fleishman, 1999), organizes job information into six broad categories (see Figure 5-1). There are three types of information related to the individual worker: (1) characteristics, such as abilities the worker brings to the job; (2) requirements for entry into the occupation, including skills, knowledge, and education; and (3) experience required for entry, including training, skills, and licensing. The content model also includes three types of information related to the job: (1) occupational requirements, such as what work activities are performed; (2) workforce characteristics, including information on projected demand for this occupation; and (3) occupation-specific information, including tasks and technology. Tsacoumis explained that within each of these six broad categories there is a wealth of additional information and descriptors (Tsacoumis, 2007b).

Although the O*NET occupational information was originally structured according to the Occupational Employment Statistics classification system of the Bureau of Labor Statistics (BLS), an Office of Management and Budget directive in the year 2000 led to a reorganization of the in-

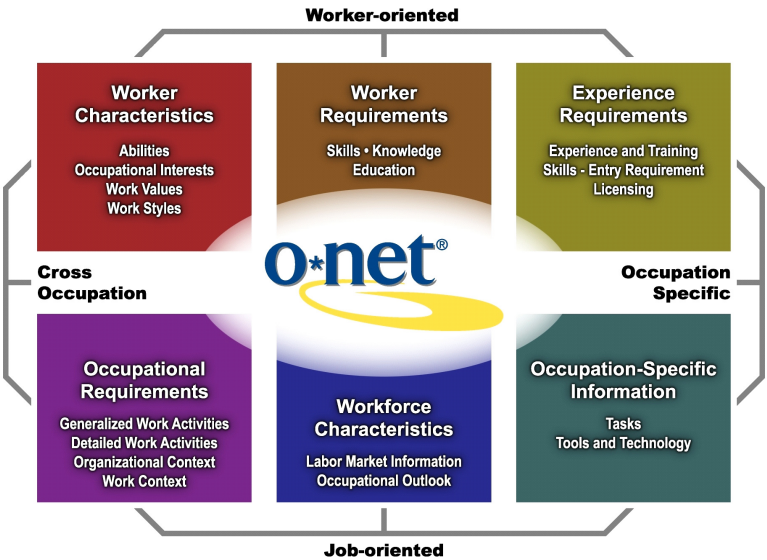

FIGURE 5-1 The O*NET content model.
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formation to align with the Standard Occupational Classification (SOC) system.[1] The current taxonomy, known as O*NET-SOC 2006, includes 812 SOC occupations for which data is being gathered. The National Center for O*NET Development, which develops and maintains the database, obtains most of the data related to these occupations from job incumbents. The center regularly surveys workers in targeted occupations to obtain information on job tasks, skills, and the education and training required to enter the occupation. However, the center obtains information on abilities from a different source—trained job analysts, who review the other types of updated information provided by the job incumbents and rate the ability levels required for various jobs. This approach was selected because "the constructs that are represented by . . . abilities are . . . harder for some people to understand," Tsacoumis explained. All ratings, by job analysts and by job incumbents, are carefully analyzed in terms of reliability, interrater agreement, and standard errors of the mean in order to evaluate and improve data quality.

Tsacoumis said a "rigorous sampling activity," including random sampling of businesses and employees in those businesses, is used to identify job incumbents. The sampling procedures and questionnaires were developed on the basis of extensive review of the literature and were pilot-tested for effectiveness. As a result, they have had a high response rate, with 70 percent of businesses and 66 percent of employees in those businesses agreeing to complete the online surveys.

Tsacoumis explained that several different O*NET databases have been developed over the past decade. When the content model was initially created, in the mid-1990s, it was populated with the only source of job information available at that time—data collected by job analysts for inclusion in the DOT. She said this was called the analyst database. However, since 1998, most information has been obtained from job incumbents. This information is updated and released to the public in a new O*NET database every six months. Currently, she said, O*NET-SOC 11.0 includes updated information on 680 occupations.

Uses of the O*NET Database

Tsacoumis said that many individuals and organizations use O*NET for a variety of purposes. Students and educators use it to understand what occupations are available and plan for future careers. Job seekers use it to access information on demand for various occupations and the types of

[1]Tsacoumis explained that analysts developed an comprehensive system of crosswalks, allowing comparison of information from the O*NET-SOC 2006 with information from the DOT and other occupational information systems (Tsacoumis, 2007b).

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skills, knowledge, abilities, and education required for entry into those occupations. However, she said, the question of the day is how O*NET can be used to assess current and future skill demands.

First, she said, some organizations are already using O*NET to project future skill demands. The Projects Managing Partnership, a collaboration that includes DOL and several other organizations, has linked O*NET data with BLS occupational projections in order to project future skill demands and potential skill gaps in different states. Using this approach, the state of Illinois recently projected potential shortages of 15 skills in the year 2012; the largest projected skill shortages are in reading comprehension, active listening, speaking, and writing (Ginsburg and Robinson, 2006). Other organizations have linked skills information from O*NET with data from BLS and the Census Bureau to analyze supply and demand of skills in local labor markets.

Second, Tsacoumis suggested that researchers may want to consider using the various categories of O*NET information, not just the information on skills to study changes in skill demands. For example, information on generalized work activities or abilities may be valuable for some studies. She outlined several different options for using data from O*NET to investigate changes in skill demand over time. One option, she said, would be to compare information from the earlier analyst database with information from the updated O*NET-SOC 11.0 database. These longitudinal data could be used to assess any changes in skill demands in one or more of the 680 occupations in the current database, and the data could be analyzed in a variety of ways. A second option would be to couple O*NET information with BLS occupational employment survey data to identify rapidly growing occupations and examine the skills, abilities, or other characteristics of these occupations.

PROJECTING THE IMPACT OF COMPUTERS ON WORK TO 2030

Economist Stuart Elliott (National Research Council) described an approach to projecting the impact of computers on work as well as a pilot application of the approach. He emphasized that his goal was not "to claim that the results are right," but "to get help from all of you" about how the approach could be improved in the future (Elliott, 2007a).

Elliott explained that his focus on the year 2030 resulted from his interest in rapidly evolving computer technology and in K-12 education. Based on his expectations that major changes in education might be needed to respond to rapidly developing computer capabilities and that it would take at least a decade to implement such changes in schools, he said it was important to "shift your focus into the future." Referring to an earlier presentation (see Chapter 2), Elliott said that David Autor had focused on ex-

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amining technological changes that occurred in the past. Elliott advocated looking "forward rather than backward" in order to avoid missing possible "substantial changes" in work "until it is too late" to make the required changes in education. He emphasized that it is time to seriously examine the possibility "of computers being able to do effectively all human skills."

Elliott described the two main elements of his proposed approach. First, he examined computer capabilities through the lens of human skills. He said that O*NET provides a taxonomy of human skills, serving as a guide for examining the computer science literature in order to compare human and computer skills. Second, he used the current research literature in computer science to predict future computer capabilities, by assuming that ideas now being discussed in the research would be developed in the next decade and widely diffused in the following decade (Elliott, 2007b).

Describing his pilot application of the approach, Elliott noted that, among the many sets of descriptors included in the O*NET database (O*NET Online, 2007), he focused on abilities. He examined 52 different dimensions of ability included in O*NET and discarded 30, based on his belief that computers are already better than humans along these dimensions. Elliott explained that he then grouped the remaining abilities into four categories: (a) language, (b) reasoning, (c) vision, and (d) movement. He said that the questionnaires used to collect information from job incumbents for the O*NET database include "anchoring tasks," which help to define seven levels of abilities in these categories. For example, on the language abilities scale, reading a street sign is rated at 2, as a low-level task, writing a letter of recommendation or giving multistep instructions is rated at 4, a medium level, and the high level task of giving a lecture on a technical subject is rated 6.

Next, Elliott said, he looked for recent articles in the journal *Artificial Intelligence* that described active research programs in enough detail to be compared with the abilities ratings in O*NET. For example, research currently under way in the area of computer language abilities aims to provide customer service for sales and repairs (Barbuceanu, Fox, Hong, Lallement, and Zhongdong, 2004) and to describe the movement of cars in a traffic video (Nagel, 2004). Based on his expectation that these projects will be developed over the next decade and widely deployed in the following decade, he placed expected computer language abilities in 2030 at 4, a medium level, on the 7-point O*NET scale. After applying the same steps to the other groups of abilities, he estimated that computer reasoning ability would be at level 5, vision at level 3, and movement at level 3 by the year 2030.

Cautioning that "you are not supposed to believe any of this," because it is just a pilot effort, Elliott went on to describe the third step, in which he compared the projected ratings of computer abilities with the current levels of human abilities in various occupations included in the O*NET database.

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For example, O*NET data indicate that, on average, top executives have an ability level of 5 in language, 5 in reasoning, 4 in vision, and 2 in movement (see Table 4-1). Because the language and vision abilities are higher than those projected for computers in 2030, he said, he does not project a major impact on top executives. However, he did project that computers would be capable of substituting for most K-12 teachers whose abilities are currently rated in the O*NET ability scales at 4 in language, 4 in reasoning, 2 in vision, and 2 in movement, and for most workers in food service, retail service, and other occupations. His overall projection is that computer abilities could substitute for human abilities in occupations that currently employ 60 percent of the national workforce (see Table 5-1).

Elliott explained that, although he did not mean to suggest that there would be no teachers in 2030, he does think it is possible that teachers at current ability levels would be replaced over time with teachers possessing higher levels of ability. He also noted that his pilot analysis focused narrowly on cognitive abilities, when, in reality, teachers also play a social and emotional role in children's development. Elliott suggested that a similar approach could be used by examining O*NET measures of social and emotional skills and examining current research aimed at engaging computers in social and emotional reasoning and interaction.

Elliott concluded that the real bottom line of his analysis is that projecting future computer abilities is a very important part of any effort to project future skill demands. He argued that it is possible to project future computer and human abilities in a systematic way and that his preliminary results from the pilot analysis suggest that such a systematic approach would be worthwhile.

RESPONSE TO TWO PRESENTATIONS

Sociologist Kenneth Spenner (Duke University) commented on the two presentations described above.

Response: Feasibility of Using O*NET to Study Skill Changes

Spenner concurred with what he described as the most important part of the paper by Tsacoumis—her conjecture that O*NET could be used to research changing workplace skills over time. While agreeing with her that O*NET could be used to "produce a full map of both the content and compositional shifts in the United States economy,"[2] Spenner identified six key methodological challenges.

[2]See Spenner (1983) for a discussion of "content" shifts (changes of the skill required in individual jobs) and "compositional" shifts (changes in the mix of occupations in the national economy).

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TABLE 5-1 Projected Displacement by 2030 in Major Occupational Groups

Major Occupational Group		Percentage of Total Employment	Percentage Displaced Within Group
11-0000	Management	6	41
13-0000	Business and financial operations	3	32
15-0000	Computer and mathematical science	2	21
17-0000	Architecture and engineering	2	11
19-0000	Life, physical, and social science	1	10
21-0000	Community and social services	2	36
23-0000	Legal	1	6
25-0000	Education, training, and library	6	74
27-0000	Arts, design, entertainment, sports, and media	2	50
29-0000	Health care practitioners and technical	5	10
31-0000	Health care support	2	29
33-0000	Protective service	2	16
35-0000	Food preparation and serving related	8	88
37-0000	Building and grounds cleaning and maintenance	4	78
39-0000	Personal care and service	3	81
41-0000	Sales and related	11	93
43-0000	Office and administrative support	17	90
45-0000	Farming, fishing, and forestry	1	43
47-0000	Construction and extraction	5	39
49-0000	Installation, maintenance, and repair	4	12
51-0000	Production	7	53
53-0000	Transportation and material moving	7	64
TOTAL		100	60

NOTE: This table projects the portion of 2004 employment vulnerable to displacement by computers given the current skill sets used in each major occupational group. It does not reflect changes to employment that might occur from restructuring occupations toward higher level skills.
SOURCE: Elliott (2007b).

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First, he asked whether DOL would retain all the data at different time periods and make them accessible to researchers. Second, noting that earlier data were obtained from job analysts (as the pilot version of O*NET was populated with information from the DOT) while more recent data have been provided by job incumbents, Spenner asked about the validity and reliability of comparisons between these two types of job information. Third, he said that the occupational classification system used to organize the data had changed more than once during the first seven years of populating O*NET. Crosswalks between the systems "can be extremely messy or indeed even inadequate" if, for example, an occupation at one point in time splits into multiple occupations at another point in time.

Fourth, Spenner asked whether there were any "built-in dependencies" in the ways a single job is analyzed at different points in time. He noted that, if job incumbents or analysts were allowed to see earlier ratings and simply update them, this would be "a potential serious methodological limitation," as happened when the third edition of the DOT was used to update the fourth edition (Cain and Treiman, 1981). Fifth, he asked which of the "over 200-plus items that only an industrial-organizational psychologist could love" that are included in the O*NET database would provide the best measures of skill. Spenner said that Tsacoumis (2007b) had acknowledged the continuing debate among industrial-organizational psychologists about the quality of such O*NET descriptors as skills, knowledge, and generalized work activities.

Finally, noting that a planned O*NET data file on new and emerging opportunities would be "a fascinating source of new data," Spenner encouraged also creating a data file on dying occupations.

Response: Projecting the Impact of Computers on Work in 2030

Spenner described Elliott's paper as "fascinating" and encouraged the audience to read it. He said that Elliott had introduced a new approach to projecting skill demands by examining the detailed literature on a specific technology and projecting changes under a set of assumptions to "signal possible levels of skill change in the economy." Saying he expected that Elliott's "astounding" prediction that computers might displace about 60 percent of the workforce "both raises some eyebrows and generates some discussion," Spenner said he would focus on some major methodological issues and "absolutely heroic assumptions" that would need to be resolved in order to move the approach beyond the pilot version.

First, Spenner questioned the assumption that the exponential increase in computer processing power observed over the past century (Moravec, 1999) would continue unabated over the next few decades. He said that his colleagues in computer science had mentioned that such factors as

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computer memory, input-output transfer speeds, power demands, and even heat might constrain the rate of future advances. Spenner suggested that a revised methodology could model different scenarios about the rate of improvement in computer processing power.

Second, Spenner asked whether the sample of articles Elliott had reviewed is representative of the current state of knowledge about artificial intelligence, noting that it is possible to expand the sample. He suggested inviting a group of artificial intelligence experts to independently review the sample of articles Elliott had selected to assess their usefulness as a basis from which to "extrapolate computing technology developments."

Third, Spenner asked whether the pilot method had used the right measures of skill within the O*NET taxonomy. He suggested inviting expert industrial-organizational psychologists to evaluate the decision to use the ability descriptors in comparison to the skills and knowledge descriptors or other measures included in O*NET.

Fourth, Spenner suggested that Elliott had used "dead reckoning" when reviewing a group of articles describing artificial intelligence research projects and then rating the computer ability levels in terms of the O*NET ability scales. He joked that Elliott might be "perfectly valid and reliable" now, but that he was worried about what might happen if Elliott decided to shift fields. To address this problem, Spenner suggested inviting expert job analysts to score and rate the selected articles about artificial intelligence "as though they were scoring and rating an occupation."

Fifth, Spenner described weaknesses in the model of technological and occupational change in the pilot study. In this model, he said, technology is adopted "swiftly, smoothly, and efficiently." However, studies of the history of adoption of other technologies, ranging from railroads to electricity to flexible manufacturing systems, illuminate a more "jerky, discontinuous, and problematic" process (Cyert and Mowery, 1988; Granovetter and McGuire, 1998). Spenner said that, in the pilot model, technology affects jobs in only one way—by destroying them. He said the model does not allow for "compositional shifts" (changes in the national mix of occupations), although previous research suggested that such compositional shifts may have a greater impact on overall national skill demands than "content shifts" (changes in the skills required within jobs) (Spenner, 1983).

To illustrate this weakness, Spenner said that, if the model had been applied 30 years ago, it would have correctly predicted that the introduction of digital telephone switching systems would eliminate telephone operators—a direct content shift. However, the model would have totally missed the compositional shifts that took place as digital switching technology enabled an "explosion" of new industries and occupations built around 800 numbers, including jobs in telephone call centers and telemarketing. In another criticism, Spenner said that Elliott's model of technological change

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excludes production functions, switching costs, opposition by groups of workers, and "any effects from the organizational environment." At times, Spenner said, the model seemed to have "annihilated all economists and sociologists," leaving only industrial-organizational psychologists.

Finally, Spenner observed that the model assumes that all change driven by computer technology upgrades skill demands and eliminates occupations. "To my knowledge," he said "this would be the first known example of a technological change in the past 200 or more years that had that specific signature." Spenner concluded that, despite all of these reservations, he believes that the pilot model has "great promise" and that it would be worthwhile to improve it in some of the ways he had suggested.

A NEW SURVEY OF WORKPLACE SKILLS, TECHNOLOGY, AND MANAGEMENT PRACTICES

Sociologist Michael Handel (Northeastern University) said he had just finished collecting data in the first wave of a new survey focusing on skills, technology, and management practices, known as the STAMP survey (Handel, 2007a, 2007b). He explained that the survey was motivated by research on several important policy questions, including the growth of wage inequality; employment and earnings of less skilled workers; racial and ethnic inequalities in the labor market, and transitions from welfare to work. In addition, Handel noted that there is continuing concern about the quality of education, particularly in terms of its role in supporting U.S. international competitiveness. Finally, he said that journalists and the public are interested in how work is changing. He asserted that press accounts and some government reports, such as the secretary of labor's Commission on Achieving Necessary Skills (U.S. Department of Labor, 1991) assume that "change is unprecedented. It is rapid. It is ubiquitous and it is accelerating."

To inform all of these concerns and assumptions about the workplace, Handel said, the STAMP survey focuses on four key questions:

1. How many jobs require what levels of various skills, computer use, and participation in employee involvement practices? In other words, what is the skill profile of American jobs?
2. How are skill requirements, technology, computer use, and employee involvement related to each other?
3. What are the effects of skill requirements, computer use, and employee involvement on wages, working conditions, and other job characteristics (e.g., work intensity, layoffs, job satisfaction)?
4. What are the trends in types and levels of skill requirements, technology use, and employee involvement practices, in their interre-

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lationships and in the relationships between those three variables and wages, working conditions, and other outcomes?

Handel said that researchers had long recognized a "data gap" regarding workplace skills and had periodically called for improved measures, as early as 1983 (Spenner, 1983) and as recently as 2002 (U.S. Department of Health and Human Services, 2002). Noting that the last comprehensive national survey of the quality of work was conducted in 1977 (Quinn and Staines, 1979), Handel said that the STAMP survey tries to fill this gap.

Turning to the sample and survey administration, Handel described STAMP as a random-digit-dial telephone survey of employed wage and salary workers in the United States who are at least 18 years old. The first wave of the survey was conducted, using English and Spanish questionnaires, in 2005. The sample size is slightly over 2,300, and the survey uses a refreshed panel design similar to what was used in the Quality of Employment surveys in the 1970s (Quinn and Staines, 1979). Handel explained that he hoped to reinterview as many people as possible 3 years after the initial survey administration, and he will also interview a new, smaller sample to address expected attrition from the original panel. The second wave of data will be designed to be "fully representative of the labor force at that time," to allow models of career growth and trend analyses.

Handel then presented an outline of the survey content (Box 5-1), noting that it addresses cognitive skills that would be of interest to educators—such as reading and writing and mathematics—and also interpersonal job tasks and physical job tasks. The survey also addresses questions about worker autonomy and includes an extensive battery of items on computer and noncomputer technology. In addition, he explained, the survey addresses employee involvement, job downgrading, and job satisfaction—all topics that have been part of a public debate about the availability of "good jobs" versus "bad jobs." To address all of these topics, the survey includes 166 questions and takes about 28 minutes to complete.

Handel said the measurement philosophy of the survey is to obtain individual-level data. He explained that, because he was not satisfied with existing measures of skills, he tried to write questions focusing on objective behavior and to make both the questions and response options intuitively meaningful to respondents. The questions were designed to cover the three survey domains of skills, technology, and employee involvement, aiming to capture the full range and levels of complexity in these domains. As an example, Handel presented the questions about mathematics, which include "filters," such as "Do you use mathematics on your job in any way?" Those who respond affirmatively are asked first about the use of addition, subtraction, multiplication, and division and then about the use of any more complex forms of mathematics, such as algebra, geometry, trigonometry,

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BOX 5-1
Content of the STAMP Survey

- **Skill and Task Requirements**
  - Cognitive skills
    - Math, reading, writing, documents
    - Problem-solving
    - Education and training requirements
  - Interpersonal job tasks
  - Physical job tasks
- **Supervision, Autonomy, Authority**
  - Closeness of supervision, autonomy, repetitiveness
  - Supervisory responsibilities over others
  - Decision-making authority over organizational policies
- **Computer and Other Technology**
  - Machinery and electronic equipment
    - Mechanical and electronics knowledge
    - Set-up, maintenance, and repair
    - Equipment and tool programming
  - Computers
    - Frequency of use
    - Use of 14 specific applications
    - Use of advanced program features, specific and new software
    - Training times
    - Complexity of computer skills required
    - Adequacy of respondents' computer skills
    - Computer experience of nonusers in prior jobs
- **Employee Involvement**
  - Job rotation, cross-training, pay for skill
  - Formal quality control program
  - Teams activity levels, responsibilities, and decision-making authority
  - Bonus and stock compensation
- **Job Downgrading**
  - Downsizing, outsourcing, technological displacement
  - Promotion opportunity
  - Work load, pace, and stress
  - Reductions in pay and retirement and health benefits
  - Strike activity
- **Job Satisfaction**

SOURCE: Handel (2007a).

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statistics, and calculus. Handel noted that these questions, as well as the survey questions on reading and writing, refer to "concrete behaviors, concrete tasks that generalize across occupations."

Handel then presented preliminary survey results. Although 94 percent of respondents reported using at least simple levels of mathematics at work, only 22 percent said they use more complex mathematics, and the number who said they use calculus is only 5 percent. Similarly, a high percentage of people reported writing at work, but only about one-fourth write documents as a regular part of their work day. Turning to results in the domain of computers and technology, Handel said that 16 percent of respondents indicated that they had been introduced to new software that took more than a few days to learn, and only about 12 percent indicated that they used macros or formulas when interacting with spreadsheets. He explained that the questions had been specifically designed to measure the level of complexity in respondents' use of computers.

In the domain of employee involvement and management practices, Handel said that about a quarter of respondents reported belonging to a work team. However, because the research shows that the word "team" may have a variety of meanings (Appelbaum, Bailey, Berg, and Kalleberg, 2000), the survey included a battery of items to elicit information about team activities. The responses indicate that about 17 percent of the sample participated in a team that had responsibility for quality improvement.

Handel ended by identifying several possible extensions of the survey. He noted that, if the survey was repeated, "it could be a social indicator for monitoring trends." In addition, survey results (from employees) could be linked with data from employers or with test score data. For example, data from the national assessment of adult literacy (Kutner, Greenberg, and Baer, 2006) could be calibrated against workers' reported use of reading, writing, and mathematics on the job from the STAMP survey.

Response

Sociologist Arne Kalleberg (University of North Carolina, Chapel Hill) commented that Handel's paper not only "very nicely" frames debates about the quality of work, but also provides measures that "permit us to . . . assess many of the hypotheses" about work proposed by research in a variety of disciplines. Kalleberg said that the "well-designed" survey provides nationally representative data on such questions as what proportion of the workforce uses different levels of mathematics. He predicted that the survey results would provide the basis for many types of analysis, including correlations between work activities and the demographic characteristics of workers.

Kalleberg suggested that the survey results could be used to examine

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Autor's ideas about the extent to which different groups of occupations may be automated in the future (see Chapter 2). Another possibility would be to compare the survey findings with O*NET, for example by examining the correlations between the survey results and O*NET job descriptors. However, he noted that the survey measures cognitive skills, such as mathematics, reading, and writing, in more detail than social and emotional skills. Referring to the argument that social and caring skills required in jobs filled mostly by women are not fully recognized or rewarded because these skills are viewed as natural feminine qualities (Gatta, Boushey, and Appelbaum, 2007a), Kalleberg warned that, to the extent that this argument is correct, that bias would be built into Handel's survey.

While commending the coverage and strength of the survey, Kalleberg also identified several limitations. First, he noted that, to date, the survey has been conducted only at a single point in time, using a cross-sectional research design. Second, he said the survey was small, especially in comparison to the regular Current Population Survey used by BLS in developing employment projections. Third, he observed that the survey focused on "workers' perceptions," which are useful for describing job characteristics, but less useful for obtaining information about the firm or organization. Kalleberg said that a survey of this type might be most valuable when used in conjunction with data from other sources. Fourth, Kalleberg predicted that, when Handel submitted papers to journals, he would be asked questions about causality, such as, "Does skill cause wages or do wages cause skill?" To make causal arguments, Kalleberg suggested drawing on qualitative data.

Stating that the "real value" of the survey lies in the trend analysis, Kalleberg said he would have taken a different approach than Handel had. Kalleberg stated that survey researchers always face trade-offs between using earlier items to allow a trend analysis or developing better items in order to more accurately measure the phenomenon being studied. Kalleberg then compared example items focusing on worker autonomy. The STAMP survey item asks, "How much freedom do you have to decide how to do your job in your own way, rather than following a fixed procedure or supervised instructions?," allowing responses ranging from zero, no freedom, to 10, complete freedom. The 1977 Quality of Employment survey asked about autonomy as follows "I have the freedom to decide what I do on my job. One equals strongly disagree. Five equals strongly agree." While acknowledging that Handel's new item was "better" than the earlier survey item, Kalleberg said that it was not "that much better," pointing out that changing the item made it impossible to examine trends in worker autonomy going back 30 years. Kalleberg said he would have chosen to use the earlier question rather than creating a new "optimal question."

Kalleberg then commented on the possibility of conducting future

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waves of the STAMP survey to monitor long-term trends in workplace skills, technology, and management practices. While acknowledging that the second wave of the survey is probably already under way, he advised Handel to wait longer than three years. Kalleberg suggested that three years might not be enough time to assess change over time in workplace skills and especially to analyze and revise the survey. He questioned whether the research design used in the Quality of Employment survey—which surveyed a refreshed panel of respondents in 1973 and again in 1977 (Quinn and Staines, 1979) had yielded very useful information and whether it is an appropriate model for the STAMP survey. Kalleberg advised Handel to take three or four more years to publish—and obtain reactions to—findings from the first wave of the survey and to use the feedback to improve the next wave of the survey.

DISCUSSION

Moderator Sager asked Elliott whether it would be possible to retrospectively apply his method to assess how accurately it might have forecast past changes in technology and employment. He also suggested that the method might be more successful at predicting that an occupation was going to "experience turmoil" than at predicting that an occupation would be completely "annihilated."

Elliott responded that Spenner's use of the term "annihilated" suggested that there would be 60 percent unemployment as a result of new computer capabilities, but this did not accurately describe his findings. Elliott emphasized that his analysis focuses on the distribution of skills, predicting that computers would eliminate some portion of this distribution and that employment would then be clustered in other parts of the skill distribution. Stating that he is not concerned with which occupational titles are attached to those skill distributions, he agreed with Sager, saying that his method could be described as predicting that an occupation "whose current skill cluster is likely to be completely replaced by computers" would either "go through some transformation . . . or be obliterated." Commenting on the idea of applying the method historically, he said it would be possible to go back in time and predict how such technologies as mechanical calculators and engines would replace human skills. However, he said he is not sure how to approach an important element of such a retrospective study—searching for clear examples in which technology was capable of replacing human skills but did not do so.

Sager suggested that teachers, managers, and service workers who interact directly with other individuals in "a dyadic relationship" might be difficult to replace with computers. He argued that a manager may be able to motivate an employee because of a human, or emotional, commitment,

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not by perfectly applying management by objectives or other management techniques. Elliott responded that it is important to "think carefully" before assuming that interpersonal human relationships could not be replaced by computers. He pointed to the example of the Eliza computer program, created by Joseph Weizenbaum of Massachusetts Institute of Technology in 1966 (Weizenbaum, 1966). Although the program was based on scripts and simply reflected what someone said to it, Elliott said, many people reacted "in a strongly emotional way to having what felt like an intimate interaction with the computer."

Elliott said that he could not answer a question about why technology had not yet succeeded in improving educational outcomes. He said that research is currently under way to assess which technologies have positively affected student learning, but he cautioned that this research focuses on technologies that had been developed 10 to 15 years earlier, while his paper looked ahead to educational technology that may be available in the future.

David Autor made two comments on Elliott's paper. First, he asked why Elliott had proposed that computers would have an absolute advantage over humans within a certain time frame and had not considered the comparative advantage of human labor. He noted that, in a standard economic model, there are gains from trade between two individuals, even when one has an absolute advantage in multiple activities. He argued that it is important to think about activities in which human labor is "specifically appropriate" and computers act as a complement, rather than a substitute. Autor challenged the proposition that the nation would "run out of jobs," arguing that modern American society has an "endless ability to create activities for ourselves and do things that other people value." Finally, he said that he found the model very mechanistic in its assumptions.

Elliott responded that he is not predicting the disappearance of jobs, at least in the short run, but that the comparative advantage model does not apply to the "end state" he predicts. He said that, in the short run, as long as people have an absolute advantage in some tasks, then companies will engage them for those tasks. The long-term situation, in which computers "are effectively able to do everything . . . better than people" and the economy could operate without humans, is not the same as an international trade situation, he argued. In the trade situation, he said, although the people in the other country might not be absolutely better in any of their skills, their need for goods and services would drive them to continue finding ways to arrange trade. Elliott asserted that, in the future, when computers have the "absolute advantage on all skills" and no human labor is required, there will be no need to "trade" or consider comparative advantage between human and computer skills.

Regarding the argument that people will create new jobs, Elliott said

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that it is not applicable within the framework of his approach. He explained that his framework focuses on the cognitive processes people use to perform jobs, and human cognitive processes are limited. He said that it was not possible to imagine other tasks or occupations that humans might take on after computers are capable of carrying out all cognitive tasks that humans currently perform.

Autor suggested that Elliott's analogy is that humans are something like horses, which no longer have any advantage relative to cars and now live in country clubs. Unlike horses, however, humans are "residual claimants"[3] on the activities they formerly carried out and so are unlikely to be "used as pet food." Autor said that, if this analogy is correct, the U.S. economy should have already eliminated human employment, since farming and manufacturing have already been heavily automated but this is "absolutely contrary to what has occurred," as the national economy experiences full employment. Finally, Autor suggested that it would be worthwhile to continue to discuss the absolute advantage of humans and computers in another venue, and Elliott agreed.

In response to a question, Tsacoumis said that the concept of "competencies" is an important part of the discussion of future work. Sager explained that industrial-organizational psychologists consider individual characteristics, such as abilities, interests, and personality, as somewhat basic, one-dimensional constructs. These individual characteristics combine with experience, training, and feedback in the development of skills, such as skills to operate a cash register or to effectively interact with customers. Sager said that competencies are larger, multidimensional constructs that include skills, behaviors, and sometimes personality characteristics (e.g., Marrelli, Tondora, and Hoge, 2005). Sager said that defining competencies through competency modeling studies might be helpful for companies to communicate their values to employees, but that competencies might be less useful for social scientists, because they are such multidimensional concepts.

Helen Ladd (Duke University) asked Elliott who would program the computers if computers were to take over teachers' skills, and Elliott responded that researchers in computer science are currently finding answers to that question. Ladd said that software is not yet capable of responding to the variation in what children need to know and be able to do. Elliott responded that his model indicates that teachers currently use cognitive abilities that "lie within research that is being done in computer science" and that software programs using the full range of teachers' abilities would be developed over the coming two decades.

[3]In legal terminology, residual claimants are those with a claim on any remaining income of a bankrupt firm and may include shareholders, employees, and creditors (see Black, 1999).

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Turning to Handel, Ladd said that as she thinks about how to improve high school education in North Carolina she sees a danger in his survey results. She said some people might conclude, based on his finding that only 19 percent of the workforce uses algebra, that it was no longer necessary to teach algebra to most high school students. She suggested that emphasizing the larger educational goal of helping people "to think, using lots of different tools or approaches" might be more important than focusing on one or more particular school subjects. Handel responded that his main objective had been to provide a "reality check" to speculations about the skills required for work. Acknowledging that advanced knowledge of school subjects opens "avenues of opportunity" for people, Handel agreed with Ladd that the goal of education should be to teach people to think. He concluded that he was not arguing for less education "but perhaps for more reason in the debates over education."

Sager concluded the session with several observations. First, he said that future-oriented job analysis methods face a trade-off, between the length of the time horizon and the strength of the inferences. Some techniques—such as Elliott's pilot approach—look further out on the time line but have "relatively weak inferences," he said, while other techniques—such as using the O*NET data to analyze skill changes over time—might be used to project changes much closer in time, with stronger inferences. Emphasizing the importance of understanding these trade-offs, he said he would place the papers on future skill demands in knowledge work and service work somewhere in the middle. He said that the authors of those papers had identified some "forward-looking" occupations and industries, but that he did not know whether these examples were representative of future work more generally.

Second, he cautioned that, although large-scale efforts to analyze many jobs are valuable for assessing changes in workplace skill demands, such efforts always face a trade-off between parsimony and verisimilitude. A very simple, parsimonious model of job skills may be powerful but not provide "a rich representation of reality," whereas a more complex model, including detailed job information on many occupations, may be expensive and cumbersome to maintain. Sager suggested that the developers of O*NET tried to change the DOT to increase verisimilitude, without creating the system too large to maintain. He observed that, "it remains to be seen" whether the O*NET designers made the right choices and whether the government will continue to pay for additional data collections to maintain the large O*NET database.

Third, Sager said that, in comparison to the DOT, the O*NET provides "a much richer opportunity to assess its reliability and validity." He cited as an example the ratings that job analyst make of the types and levels of abilities for various occupations. One way to answer reliablity is to com-

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pare different job analysts' ratings of a particular ability, such as reading, required for a particular occupation, to see how much they agree. Another approach is to compare different job analysts' ratings of 52 O*NET abilities for a particular occupation, to see how much they agree about which abilities were most and least important. In addition, it is possible to compare ratings of a particular ability across different jobs. Sager noted that all of these types of analysis can be done and have been done (Peterson, Mumford, Borman, Jeanneret, and Fleishman, 1999; see also Tsacoumis, 2007b). Overall, he observed, the O*NET developers had "done fairly well" in addressing the reliability and validity of judgments about job skills and abilities, unlike the DOT, in which many ratings were made based on the "judgment of one analyst [in] one circumstance."

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6

Skill Supply and Demand

On the second day of the workshop, the focus shifted from skill demand to the national supply of skill, and the balance between supply and demand. Arne Kalleberg opened the session by reflecting on the previous day's discussion of skill demand.

REFLECTIONS ON SKILL DEMAND

If current trends continue, Kalleberg said, job growth will be concentrated in high-wage professional, technical, and managerial jobs and in low-wage service jobs, raising questions about future prospects for upward career mobility. He called for further study of possible growth in mid-level jobs, noting that Genentech Corporation is an example of increased employment of mid-level technicians (Murray and Hsi, 2007a).

Kalleberg argued, however, that these current trends may not continue, as future changes in jobs will be affected by social choices and employer decisions about how to organize work. He observed that the diversity of service work—including highly paid knowledge workers, low-wage service workers, and technoservice workers who combine both types of work (Darr, 2007b)—highlighted a key point: service work can be performed at different levels of quality (see Chapter 4). "If we decide as a nation to take better care of our citizens, our elderly, our children, and are willing to pay for it," he said, many low-level service occupations might be transformed to mid-level occupations.

Kalleberg said that a key question from the previous day is the extent to which future work will be performed in the United States or offshore.

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He noted that Autor had suggested that routine jobs that could be digitized were most likely to be outsourced (Autor, 2007a), but added that regulatory mechanisms—which reflect political and social choices—would also be likely to affect the extent of outsourcing (Levy and Goelman, 2005).

Commenting on disagreements about the extent to which different categories of jobs—such as "routine" jobs or "service occupations," required higher or lower skills, Kalleberg said that these reflected deeper disagreements about how to define "skill." He observed that the Bureau of Labor Statistics (BLS) examines skill in terms of wage levels, education and training requirements, and the educational attainment of the labor force (Sommers, 2007). He described the O*NET database as a "positive step" toward improved definitions of skill, and observed that Handel had developed new direct measures of skill for his survey (see Chapter 5). Asserting that definitions of skill remain "contested" (e.g., Attewell, 1990), Kalleberg argued that, without agreement on an overall measure of skill, it might not make sense to ask whether the skill demands of work are increasing or decreasing; he suggested asking instead about how different dimensions of skill may be changing.

Kalleberg observed that one of the most important themes of the previous day is that society constructs workplace skill demands, through choices about how to package tasks together into jobs and occupations. He called for greater awareness of this theme, recognizing that not only labor markets, but also workers and skill definitions, are adaptable. He then reflected on debates about the factors determining wages for various jobs, including skills, the supply of labor, institutions, and other factors, noting that the research is unclear on this point.

In contrast to these many areas of uncertainty and disagreement, Kalleberg said he had observed much agreement about another important topic—the kinds of competencies and skills that would be required in the future. He repeated the list of skills that Houston presented, including creative problem solving, complex communication skills, adaptability, self-management, personal development, and systems thinking. Kalleberg asserted that these skills would be likely to be required in all kinds of jobs, especially if policies are created to upgrade the skills of low-wage jobs. He suggested—rather than researching the links between this list of skills and changes in the workplace (he noted the example that self-management is important because many firms now employ fewer supervisors)—taking the list "as a given." Kalleberg suggested that education and training policies focus on this list of broad competencies as the kinds of skills needed in the future labor force, while also continuing to teach basic skills of reading, mathematics, and thinking.

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PANEL DISCUSSION OF SKILL SUPPLY AND DEMAND

Kalleberg then moderated a panel discussion of skill supply and demand, including labor economists Peter Cappelli and Harry Holzer and sociologist B. Lindsay Lowell. Each panelist was invited to make brief opening remarks, followed by discussion among the panelists and then discussion with the audience.

Opening Remarks

Peter Cappelli: Is the Future Skill Supply a Public Policy Problem?

Cappelli argued against using input-output models to approach skill questions as if they were engineering problems, saying that such an approach might suggest that "inexorable" developments in technology would require "a particular level of skill." He said that the earlier workshop discussions had shown that social and economic choices had a strong influence on skill requirements. As further evidence of the influence of social and economic choices, he said that researchers had found that numerically controlled machine tools affected skill demands quite differently in different settings, depending on management choices, the power of unions, wage levels, and other factors (Shaiken, 1986; Adler and Borys, 1989).

Cappelli noted that the earlier discussions had not focused on the supply and price of labor at different skill levels, and the relationship between these variables. He said that a large supply of low wage labor influences employers' choices about how to organize work, including its skill demands. To illustrate this point, he described his experience working in Bahrain, United Arab Emirates. He observed white-collar professionals working in modern office buildings using laptops, just as professionals do elsewhere in the world, but also saw construction workers carrying cement on their heads and digging holes with shovels, lacking any modern technology. Cappelli said that the contrast can be explained by the nation's guest worker program, which provides very low-skilled labor from South Asia. As a result, the price of construction labor is very low, and construction firms do not need to invest in cement mixers, tractors, or other technology. Summing up his point, Cappelli said that wage levels affect employer's choices about skill requirements, and the wage levels are "very much a function of labor supply."

Next Cappelli addressed the common argument that the U.S. labor force is shrinking. He presented population profiles from several countries (U.S. Census Bureau, 2007), noting that the population of most industrialized countries in Southeast Asia is expected to shrink dramatically by the year 2025 because of declining birth rates. Presenting a population profile

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for Spain, he observed that the populations of most European nations are also expected to shrink rapidly because of large declines in birth rates. In contrast, the population of Afghanistan and many other Arab countries is expected to grow rapidly. He then presented the U.S. population pyramid, stating that it is more evenly balanced than either of those two groups of nations and that the United States is the only developed nation with a growing population. Cautioning that population is not the same as labor supply, he said that BLS projects that the growth rate of the labor force will begin to slow down. He said that the most recent projected growth rate (an average of 1 percent over the decade 2004-2014) is only 0.2 percent lower than the growth rate from 1994 to 2004 (Toossi, 2004), describing this as a very small change, "particularly given how imprecise these estimates are." Cappelli went on to argue that some workers are retiring later than in previous generations, at age 68, and that it is "very easy" for people to return to work after retiring.

Cappelli said he had become interested in the question of whether the national labor supply is adequate because so many employers told him they were concerned about shortages (Cappelli, 2003). He refuted the idea that a nation requires "a bigger labor force in order to grow," saying that the U.S. economy is now 8 times larger than during World War II, but with a labor force only twice as large. He noted that simple input-output models that fail to fully account for productivity growth—such as those used by BLS—would require the U.S. labor force to be four times as large as it was to sustain the nation's level of economic activity at the time of the workshop.

Going on to what he described as his "punch line," Cappelli said that employer concerns about possible labor shortages are not completely erroneous but reflect the fact that employers are no longer developing skills internally (Cappelli, 2007). He noted that Osterman had done some of the early research on internal labor markets (Osterman, 1984), showing that companies that had formerly hired entry-level people and trained and promoted them over time no longer did so. Cappelli cited a study by Taleo, a manufacturer of employment software, which found that, among firms using its software, about two-thirds of all job vacancies were filled by outside hires (Cappelli, 2007). Cappelli said that the trend of outside hiring, rather than internal development and promotion, is most apparent in Silicon Valley, where technology firms rely almost entirely on colleges and universities to provide the specific skills they need (National Research Council, 2001).

Cappelli concluded his description of the current balance of skill supply and demand by asking whether or not it is a policy problem. He asserted that "employers would clearly like it to be a public policy problem," making the education system responsible for developing the skilled employees

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they require. He recalled that employers expressed similar concerns in the 1980s, despite higher unemployment rates at that time, because they were no longer prepared to train new employees. He argued that employers' current concerns reflect their demand for employees with the right attitudes, discipline, and "the skills to step immediately into the job and start doing the work." Describing this demand as a "huge and quantum paradigm change," Cappelli asked whether policy makers should assume responsibility for meeting it.

Harry Holzer: Possible Imbalance in Skill Supply and Demand

Holzer said that, although he took concerns about the future skill supply more seriously than Cappelli, he agreed that attempts to accurately project demand for skills and supply of skills in order to compare them and map areas of shortage are "wrong, a completely noneconomic way of thinking."

Holzer said that two trends—the retirement of baby boomers and immigration patterns—could cause problems in the future national skill supply (Holzer and Nightingale, 2007). He predicted that, over the next 20 to 30 years, the retiring baby boomers would be replaced by immigrants who, on average, had "considerably less formal education and training and skills." Taken together, these two trends imply that the "aggregate quantity of skills in the labor market is declining," he said. Holzer cautioned that his prediction assumed that current trends in educational investment, immigration, and retirement would all remain unchanged. He challenged Cappelli's arguments about increased working among older workers, noting that adjustments in retirement behavior varied by income level and educational attainment (Abraham and Houseman, 2007). Holzer said it is easier for educated professionals to continue working into their seventies than for those who had worked in construction or other physically demanding jobs.

Holzer said he expected that, because of these two trends, there would be some slowdown in the supply of skills and that, if demand continued to grow, there would be "some imbalance in the labor market." Acknowledging that the labor market would adjust to any imbalance, he argued that the adjustment did not mean that "there is no issue and no problem." Holzer went on to suggest that the growth of income inequality over the previous 30 years is due not only to institutional and organizational factors, but also to growing demand for skills, so that a possible future slowdown in the skill supply might lead to still further increases in inequality. He expressed concern that the rising costs of higher education are making it more difficult for students from low- and middle-class families to graduate, predicting that continued increases in college costs would exacerbate inequality.

Turning to skill demand, Holzer observed that the earlier discussions

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had highlighted uncertainties about the future. To illustrate the uncertainties, he noted that Richard Freeman had recently written a paper arguing that any future declines in skill supply due to baby boomer retirements would be more than offset by movement of jobs (and skill demand) offshore (Freeman, 2007). Holzer questioned Freeman's conclusion, referring to an analysis by economist Edward Leamer (2007), which refutes Thomas Friedman's argument that the world is flat (2005). Holzer said that, while there is likely to be an increase in movement of work offshore, arguments about a "massive flight of skilled jobs" are probably exaggerated.

Holzer went on to say that, despite these uncertainties, he expects a "modest slowdown" of skill supplies, and he ventured several guesses about the future. First, he predicted that there would be "major pockets of tightness in certain labor markets," especially when jobs were difficult to outsource and could not easily be filled by immigrants. He said this included some health care, skilled construction, and manufacturing jobs, observing that these are mid-level jobs that would generate large replacement demand as the baby boomers retired over the coming decades. Holzer said that immigrants would be unlikely to fill these mid-level jobs, because most immigrants are either highly skilled or low skilled. He suggested there might be long-term shortages of skilled workers in a range of health care occupations, because (as Peter Kemper had mentioned) federal reimbursements constrain costs and wages in this sector.

Second, Holzer predicted that inequality in the labor market would continue and possibly increase. He reiterated his view that increases in inequality are due in part to a lack of skills at the low end of the labor market, such as among high school dropouts. He said that the lack of broad competencies—not only among dropouts but also among some high school graduates—is clearly constraining these individuals' ability to advance in the labor market. Holzer cautioned that data on the labor market experiences of disadvantaged young men are weak because the Current Population Survey and the decennial census do not reach all of them (Holzer, Edelman, and Offner, 2006). He also repeated his earlier concern that the rising costs of higher education might exacerbate inequality in the labor market.

Third, Holzer said that employment insecurity may grow in the future. While cautioning that the data are mixed, making it difficult to "make a strong claim," he predicted that outsourcing of jobs and creation of new jobs with different skill demands could reduce employment security. He suggested three types of policies to address different aspects of insecurity. First, to help people adjust to possible future changes in jobs and skill demands, he mentioned policies to help young people and working adults develop the broad competencies discussed earlier. For example, policies could support community college programs for upgrading the literacy, broad competencies, and technical skills of adults. Second, predicting that

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there would continue to be many low-wage workers, he suggested a mix of policies to increase their earnings, as others had recommended (e.g., Osterman, Kochan, Locke, and Piore, 2001). For example, low-wage workers' incomes could be supplemented through the earned income tax credit. He suggested combining "sticks," requiring higher wages—such as a higher minimum wage, increasing unionization, and collective bargaining—with "carrots," such as tax credits and technical assistance. This combination of policies, he said, might induce more employers to train their workers and pay them higher wages.

Holzer concluded by advocating a third type of policy to help workers in the face of increased insecurity—federal insurance systems. He suggested "lifelong learning" insurance to help adults who need retraining due to a job change, improved unemployment insurance, and universal health insurance not tied to employment. Finally, he suggested a system of federal wage insurance to help reduce the loss of wages that workers may experience when changing jobs.

B. Lindsay Lowell: Future Immigration Trends

Lowell (Georgetown University) opened with an overview of the current immigration system, including permanent visas, temporary visas, and illegal immigration (Lowell, 2007). He observed that about 800,000 people receive permanent visas each year, with a backlog of about 2 million people waiting for such visas. Another 500,000 to 800,000 people enter each year on temporary visas, including H1-B visas for skilled workers and H2-B visas for less skilled agricultural workers. Between 500,000 and 700,000 illegal immigrants also enter the United States each year. Noting that most of the illegal immigrants lack a high school education, whereas most temporary visas and some permanent visas are given to highly educated workers, Lowell agreed with Holzer that the educational attainment of the immigrant labor force is a "barbell distribution, a little heavier on the bottom than the top."

Lowell said that many highly educated immigrants are employed in science, technology, engineering, and mathematics (STEM) careers, in contrast to the popular perception of immigrants as unskilled. Between 1990 and 2000, the immigrant share of all doctorates employed in science and engineering fields grew from 24 to 38 percent, he said, while the share of younger doctorates in these fields (under the age of 45) increased from 26 to 52 percent. Given these high percentages of immigrants in STEM fields, Lowell questioned employers' claims that they need a larger supply of foreign-born STEM workers (e.g., Business Roundtable, 2005).

Turning to the question of future immigration levels, Lowell presented a chart depicting the growth of college-educated citizens in many different

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nations, noting the rapid growth in India, China, and Mexico (Lowell, 2007). He said that highly educated people with graduate degrees in STEM fields are very mobile, and that about 30 to 50 percent of all such STEM professionals worldwide are employed in the United States. Lowell suggested that immigrants would fill a large share of the vacancies in BLS projections of large and fast-growing occupations to the year 2014. For example, he found that, in the 15 fastest-growing occupations (as projected by BLS—see Hecker, 2005), immigrants would make up 45 percent of medical scientists, 27 percent of computer software engineers, 18 percent of personal and home care aides, 17 percent of database administrators, and 17 percent of postsecondary teachers.

In order to assess how policy changes might affect future levels of immigration, Lowell presented an analysis of a Senate bill debated in spring 2006 (Senate Bill 2611), which would have increased the number of visas available to highly skilled computing and engineering workers by five- to six-fold. Comparing his projections of the number of new immigrants who would use these visas with BLS projections, Lowell found that, if this number of visas became available, by the year 2017, there would be 20 percent more foreign-born computing and engineering workers in the United States than could be absorbed by the available jobs (Lowell, 2006). He said that Congress continues to debate bills that would increase immigration levels without any consideration of "best guesses about future demand." For example, he noted that Congress is considering increases in visas for scientists and engineers, although BLS had decreased its 10-year projection of growth in STEM occupations from 50 percent in 2002-2012 (Hecker, 2004) to 30 percent in 2004-2014 (Hecker, 2005) and despite the fact that there has been no growth in these occupations over the period from 2000 to 2005.

Lowell then shared some projections by Jeffrey Passel of the Pew Hispanic Center (2003). He noted that earlier Census Bureau projections had assumed that immigration would drop slightly around 2010 and then resume growing from around 2020 through 2050, in response to rising demand associated with baby boomer retirements. He said that, after being surprised by the 2000 census and other data showing that immigration had increased much more than had been anticipated, most experts were now predicting higher levels of immigration. Lowell said that Passel's baseline projections indicate that immigrants would drive about 85 percent of future population growth to the year 2050 and make up about 19 percent of the national population in 2050. He reminded the audience that this was an average across all occupations and industries and that the share of immigrants in some sectors (such as STEM) is likely to be much higher.

Focusing on the skill composition of the future immigrant labor force, Passel projected that the proportion with less than a high school diploma would remain stable, while the share with a college degree would grow

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dramatically, Lowell said. As a result, he said, the foreign-born share of all college graduates in the United States would show a "remarkable" increase, from 15 percent today to 20 percent in the year 2050.

In conclusion, Lowell addressed the important question of how employers and individuals would respond to possible future laws that would increase visa levels. He argued that the response would be positive and that immigration levels would increase, for several reasons. First, he said, employers always take advantage of any increases to hire relatively low-cost labor. Second, he said that research shows that immigrants are driven by family networks, a lower "reservation wage," and willingness to accept working and living conditions that native-born U.S. workers might not. Because of these factors, Lowell said, he and other experts are projecting large increases in immigration, regardless of future demand. Third, he said that econometric models of immigration have found that wage gaps are a major driving force. He noted that wage gaps between the most developed nations (such as the United States) and the less developed nations have been growing and are likely to remain high, despite recent wage increases in China and India. Fourth, he argued that the "population gap" between the most developed and least developed nations would grow quickly. Reminding the audience of the population pyramids Cappelli had presented earlier, Lowell said that, as young people in less developed countries reached the "migrant prone" ages of between 20 and 30, they would come to the United States seeking work.

Finally, Lowell said that policy debates were focusing on how to liberalize and admit more immigrants without really addressing how to enforce immigration laws. Although policies that would better match immigrants to the available jobs might be desirable, he has observed very little consideration of such policies.

Panel Discussion

Cappelli reiterated his contention that the retirement of the baby boom generation would not cause the U.S. economy to collapse, noting that the high school class of 2007 is the largest in the nation's history. He also cautioned that education is not the same thing as skill, noting a study of information technology (IT) workers in the early 1990s that found that only a small fraction had degrees in IT fields.[1] Noting that demands for specific skills and education were "fungible" to the extent that employers would provide specialized training, Cappelli asked Holzer which aspects of the future skill supply he was most concerned about.

[1]An analysis of IT professionals in 1998 found that less than half had a bachelor's degree with a major or minor in computer science or information science (Ellis, 2000).

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Holzer replied that he is concerned about the share of workers with the broad competencies discussed earlier, not only the share with college degrees. Holzer noted that, because the largest group of immigrants has little education and few skills, they would increase the share of the national workforce that is not capable of moving into mid-level jobs. He emphasized that he does not consider this possibility a "catastrophe," noting that it might draw attention to the need for policies to reduce inequality. Clarifying that he was not arguing that the national economy is "going to collapse because of the baby boomer retirements," he nevertheless predicted that there would be increased tightness in certain markets for skill. Responding to another question, Holzer said that, if demand for skills keeps rising as it has in the recent past, the skill supply might not keep pace, for two reasons he had already mentioned—the immigrants making up a growing share of the labor force would have fewer college degrees than the retiring baby boomers they replaced and rising college costs would make it harder for lower to middle-income people born in the United States to obtain college degrees.

Holzer asserted that the continued rise in the wage gap between high school and college-educated workers provides evidence of growing skill demands, but Cappelli argued that this growing wage gap results from the "collapse" of wages for high school-educated workers in the early 1990s.

GENERAL DISCUSSION

Responding to a question about immigration from Africa, Lowell said that there has been a large increase in migration of highly skilled Africans to the United States over the previous 10 to 20 years. He said that the level of "brain drain" from some of the smaller Sub-Saharan African nations is extremely high, and that some researchers are studying this phenomenon. Responding to another comment, Holzer said that some jobs being filled by immigrants—such as those in nursing—could be filled by native-born Americans if they had improved access to education and training. He noted that there is strong labor market demand for nurses, but that efforts to help more Americans obtain the credentials needed for this profession—such as by helping them enroll and graduate from four-year college programs—have not been as successful as hoped. Cappelli argued that many people are aware of the growing demand and want to enter nursing education programs, but the problem lies in constraints on these programs' ability to grow.

David Finegold said he expected that, in the future, more science and technology graduates in China and India would choose to work in their home countries, rather than emigrate to the United States. Lowell responded that, although there might be some truth to this argument,

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the "population gap" between the developing world—the source of most skilled immigrants—and the developed world, including the United States, is "really astounding." He argued that, despite the growing availability of higher education in STEM fields in India and China and the growing job markets there, many young STEM professionals will continue to emigrate to the United States. He said that wage differentials will continue to be the driving force in immigration, and that increasing the education of young people in other nations actually gives them a stronger incentive to bring their skills to the United States, where the rewards for such skills are higher. Lowell concluded that he could not foresee any future shortage of high-skilled immigrants to the United States.

Joining the discussion, Cappelli said that, although employers assert that they need more visas for foreign-born engineers to work in the United States, because not enough native-born students are studying engineering, the reason few young people born in the United States are studying engineering school is that the jobs do not pay as well as jobs in other fields. Bringing in more immigrant engineers would simply reduce wage levels further, Cappelli said. He suggested that, if the labor market adjusted to the current situation by increasing wage levels, that adjustment might be good for workers. Phrasing it as a question, he asked, "Is it a crisis if employers have to pay more for some of these skills?"

Herman "Bud" Meyers (University of Vermont) suggested that, rather than asking whether the policy community would take on the task of providing skilled labor to employers, Cappelli might rephrase the question to ask whether policy makers would partner with companies, encouraging them to invest in the education system. In Vermont, he said, property taxes are inadequate to fund education, and financial support from employers is essential. Cappelli responded that employers might choose to leave Vermont, locating in other states that do not seek such investments. He noted that North Carolina had attracted some large manufacturing firms by promising to provide all workforce training costs. He repeated his earlier point that the greatest change in employers' behavior is their shift to outside hiring, rather than internal development of employees. He predicted this change would lead to more layoffs during downturns and more hiring when business is good, saying that policies would be needed to help workers with more frequent employment transitions.

Kalleberg concluded the session with several observations. First, he said that the panelists had reinforced his view that future skill demand could not be forecast with any accuracy. Second, he said that the number of workers appeared adequate to meet demand, but that there might be shortages of skills in certain sectors. Reflecting on the point that immigrants will provide the main source of employment growth in the coming decades, Kalleberg called for developing effective ways to teach immigrants teamwork, com-

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munication, and other broad skills. Finally, Kalleberg said, the discussion of skill supply and demand highlighted the potential value of policies aimed at encouraging employers to choose the "high road"[2] by increasing workers' skills, productivity, and wage levels.

[2]Choosing the "high road" refers to reorganizing work, increasing worker training, and adopting other human resource practices that enhance skills, productivity, and wages (Appelbaum and Batt, 1993; see also Center on Wisconsin Strategy, 2007).

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Implications for Education and Training

Moderator David Finegold opened the panel discussion with brief introductions, inviting each panelist to offer opening remarks.

OPENING REMARKS

Economist Tom Bailey (Columbia University), explaining that he had studied the relationship between education and the workforce during the 1980s and 1990s (e.g., Berryman and Bailey, 1992), said that the discussion of the importance of social as well as technical skills in knowledge work was very similar to discussions at that time. He suggested that the workshop participants read the 1991 report of the secretary of labor's Commission on Achieving Necessary Skills (SCANS—U.S. Department of Labor, 1991), saying it identified the same list of important workplace skills that were discussed the previous day.

However, Bailey observed that one change since the 1990s is that, at that time, experts believed that students did learn the important workplace skills in college, and so they focused on high school and on the success of Japan and Germany in developing their workers' mid-level technical skills.

Noting that nearly 20 years have passed since the SCANS commission identified the need for broad social, interpersonal, and problem-solving skills and that cognitively based theories of education that emphasize teaching such skills became widely accepted, Bailey asked what had happened. He described "the discovery, once again, that our workers don't have soft skills" as "discouraging."

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Bailey said that, for the past 10 years, he has been studying community colleges, and that he is surprised to hear predictions of fewer mid-level jobs at a time when community colleges are growing. Noting that about half of all undergraduate students are enrolled in two-year institutions, he questioned whether the barbell image of the employment structure might be overblown. Bailey suggested that advancing the nation's capacity for research, development, and innovation would require many mid-level technical support workers, as well as scientists and engineers. Observing that several speakers had expressed concerns about educational equity and access to higher education for people in the United States, he suggested that these concerns were also important from an international perspective. He said that those who fear educational improvements in competitor nations (such as China and India) sometimes fail to recognize that those nations are home to "hundreds of millions of people who are completely illiterate." He warned that there could be a danger in "trying to motivate educational reform by economic anxiety."

Turning to the role of community colleges, he said that about one-fourth of all students transfer to four-year colleges and obtain a bachelor's degree, and that many other students obtain associate's degrees related to specific occupations. Bailey observed that many nurses, police officers, firefighters, and emergency medical technicians are trained in community colleges. In addition, he said, community colleges are increasing their recruitment of diverse students for two-year programs linked with four-year colleges to train future teachers. Following up on the earlier discussion about nursing education, Bailey noted that such programs are so expensive that community colleges often lose $3,000 to $4,000 annually for every nursing student they enroll.

Addressing the difficulty of accurately forecasting future skill demands, Bailey said many community college administrators, faculty, and students have strong relationships with local companies. He suggested that "they don't really need to have a forecast" because they had "good contact, day-to-day" with employers. Noting that immigrants are expected to comprise a rapidly growing share of the labor force, Bailey noted that many immigrants are already attending community colleges and that community colleges could help them develop broad skills, soft skills, as well as technical skills.

Bailey's last points focused on the challenge of "tremendous inequality" in community colleges, in both access and outcomes. He said many students do not complete two-year degrees, about 20 percent do not complete even 10 credits, and that these problems are most frequent among low-income and minority students. Bailey said researchers and policy makers do not know how to address these problems and called for studies of programs that are successful in retaining and graduating students. Finally, he ad-

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dressed financial issues, noting that public community colleges receive less state funding per student than four-year colleges, yet they enroll a population with greater learning needs.

Paul Osterman opened his remarks by agreeing with Cappelli that education is not the same as skill, citing the example of the Massachusetts Institute of Technology's highly regarded admissions director, who had recently been fired for lying about her educational credentials years earlier.

Expanding on the argument that employers have choices about how to organize work and pay their workers, Osterman cited a study that found that, among employees with similar levels of skills and education, the firm in which they were employed accounted for 30 to 50 percent of the variation in wages (Goshen, 1991). He said that Holzer had found that, among low-wage workers with equal amounts of human capital, changing to a different firm led to a statistically significant increase in wages. In addition, he argued that firms employing many low-wage workers were less likely to provide training than other firms.

Asserting that mid-level jobs would continue to be available in the future, Osterman noted that 28 percent of all jobs were filled primarily by individuals with some college in 2004, a percentage projected to remain the same in 2014 (Hecker, 2005). Osterman said that "abstract" tasks, as defined by David Autor (see Table 2-2), could be performed by individuals with mid-level skills. Referring to Bureau of Labor Statistics (BLS) projections that the cluster of "professional and related" occupations will grow most quickly between 2004 and 2014, Osterman said that 40 percent of workers employed in this cluster in 2006 had less than a college degree.

In terms of education and training policy, Osterman said that using the list of broad workplace skills identified by Houston as a guide might be valuable for the school system, but this approach would be "very bad policy" in the field of job training. In the past, he said, job training providers would simply "imagine" what skills were needed and train people in those skills, but current best practice is based on ongoing discussions with employers. In some cases, training providers and employers jointly design the training curriculum, he said (Osterman, 2006).

He said that another important aspect of current best practice involves helping employers not simply to train their employees, but also to reorganize work and adopt other human resource strategies in order to increase productivity and job security.[1]

Osterman said that large nonprofit or quasi-public firms (such as hospitals and banks) were more willing than other firms to respond to government policies and programs designed to encourage training and work

[1]As noted earlier, this broad approach is sometimes referred to as "moving to the high road."

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reorganization (see Osterman, 2006, for examples). But because low-wage workers employed in smaller firms would not be helped by policies that only encouraged companies to increase training and re-organize work, he said that additional policies would be required. Osterman said these policies might include a higher minimum wage, increased union representation, requirements tied to economic development incentives, and other types of labor standards (Osterman, 2006).

Peter McWalters, the Rhode Island commissioner of education, said he represented an education "industry" that had traditionally differentiated among students, so that 30 percent met high academic standards at high school graduation, 30 percent dropped out, and another 40 percent graduated without meeting academic standards. He said that this system had begun to change only in response to business concerns, leading to the current standards-based educational reform movement.

McWalters said his "first battle" was to try to bring all students to a higher academic standard, so that a high school diploma represented a concrete series of skills and types of knowledge. Saying that efforts to establish a rigorous high school exit standard aimed to change the "paradigm" of education, he observed that the current teacher workforce was not capable of such a major change. By third or fourth grade, he said, the students who read on grade level and can think conceptually are grouped together, and teachers who work with these students help them to further develop their "higher order thinking" skills. However, teachers who are assigned students in the lower groups tend to emphasize continual review. Cautioning that he was overstating the case to present a "dramatic" picture of the situation, McWalters argued that teachers and schools do not yet accept the idea that, beginning around the third grade level, they must teach reading comprehension, critical analysis, and other "higher order" skills to students who do not already possess them.

McWalters said that, while he had been focusing on this first battle, the workshop was leading him to realize that students also need to develop broad social and cognitive skills and the ability to apply knowledge. However, he cautioned that any conversation about these other needs would inevitably focus on increasing the levels of content knowledge, because large-scale state assessments focus on knowledge, rather than on what students can do. He emphasized that he and other education officials are trying to establish high school exit standards and that they lacked good measurements for nonacademic skills. Disagreeing with Bailey, he said that cognitively based theories of education—in which teachers engage students, assess their developing understanding (or misconceptions), and "scaffold" their learning on an ongoing basis (National Research Council, 2005)—had not reached the school system.

Saying that he now views the broad competencies as "hard" skills,

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not "soft skills," McWalters said he would need help in developing assessments of these skills and in teaching them, beginning in the early grades. Currently, he said, "the longer you are in school, the further away you get from using anything you are learning."

Reflecting on how the U.S. school system compares with that of other nations, he observed that, in Singapore, corporations, public policies, and the wider culture all support the expectation that students will perform well, regardless of gender, and in all subjects, including mathematics. He contrasted this with the United States, where the wider culture does not prevent a tenth-grade student from dropping out of high school.

McWalters said he would look for similar agreement about expectations and support from the policy and business communities in the United States. He recalled successful efforts with committed, supportive corporate partners, including Danny Wegman, president of Wegmans Food Markets, Inc., and partners at the Kodak and CVS Corporations. He agreed with Osterman that larger firms with roots in the community are more likely to partner with him than smaller firms and also agreed with Cappelli that it would be difficult to obtain business support. McWalters concluded by repeating his commitment to graduating students prepared for work or college. He said this would require changing both sides of the current system—bringing higher academic standards to the vocational side and the workplace competencies and new assessments of these competencies to the academic side.

Susan Traiman explained that she worked on education and workforce issues for the Business Roundtable, an organization of business executives focused on public policy issues affecting the economy. Noting that she had missed parts of the first day of the workshop to respond to congressional debates about immigration reform and trade, and that Congress was considering policies to ensure that more Americans benefit from globalization, she said that the workshop discussions were very critical and timely.

Traiman observed that the previous speakers had concluded that it is not possible to predict the future mix of occupations, but that they had a good sense of the broad competencies needed for the future workplace. She warned against an unspoken assumption that high-skill jobs would be filled by more intelligent people and low-skill jobs by those with less intelligence. This assumption, she said, might lead to the conclusion that it would be a waste of time to educate and train those whose jobs do not require the broad competencies or high levels of education.

Traiman suggested that the need for skills in science, technology, engineering, and mathematics may be broader than the projected future demand for scientists and engineers. Referring to a study that found that 20 percent of chief executive officers of Fortune 500 companies majored in engineering

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(Felicelli and Allen, 2006), she suggested that education in these areas may develop thinking and analysis skills useful across a range of jobs.

Focusing on next steps, she disputed those who argued that the education system wanted only to maintain the status quo, stating that education was "constantly" going through reforms. She observed that many teachers and school administrators embraced the findings of the SCANS report in the early 1990s (U.S. Department of Labor, 1991). Schools began to emphasize the teaching of teamwork, communication, and other soft skills, with little attention to content knowledge. More recently, she said, the standards movement had placed great emphasis on content and less emphasis on soft skills. Traiman called for teaching both content and skills simultaneously, saying "we have got to be able to walk and chew gum at the same time." She cautioned that few teachers in K-12 and higher education are prepared for this integrated approach.

PANEL DISCUSSION

Finegold asked the panelists to comment on what lessons had been learned about teaching the broad competencies since the release of the SCANS report (U.S. Department of Labor, 1991). McWalters replied that many high schools are engaging students in presentations and projects designed to develop their communication skills while also providing them opportunities to demonstrate their skills and knowledge. He suggested introducing these approaches at younger grades, including the critical middle school years. He said the middle school years are the most important time to integrate high expectations for skills and knowledge in "powerful wraparound systems." The challenge to any attempt to move beyond traditional academic content, he said, is the lack of good, easily accessible assessments. He mentioned that Vermont had introduced portfolio assessments, but dropped them after only a few years due to concerns about reliability and validity.

Agreeing that the difficulty of assessing broad skills is one factor that has discouraged educators from focusing on them, Bailey said that efforts to develop common expectations for the content knowledge required for high school graduation and college entrance could present another barrier to emphasizing the skills. He said that many entering community college students with B averages in high school were required to take one or two years of remedial classes to develop the content knowledge needed for college-level course work.

McWalters observed that, at the elementary school level, students are grouped for science and mathematics instruction, and weaker students spend years reviewing basic arithmetic. As a result, he said, it is not surprising that some students say they hate mathematics. He said that, although

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some change is under way, elementary school science instruction generally emphasizes facts, with little emphasis on the processes of science. Finegold responded that a recent National Academies study focuses on new approaches to engage elementary school students in science learning (National Research Council, 2007c).

GENERAL DISCUSSION

Chris Wellin asked about the age of community college students and about what supports might be needed to help mid-career adults in the future, when layoffs may be more frequent. Bailey responded that, over the previous five years, the average age of the community college student had declined as the institutions attracted more young high school graduates. Nevertheless, he said, the community college population is generally older than the four-year college population. He observed that few data are available about the age of students participating in the many rapidly growing noncredit classes offered by community colleges, noting that many college graduates with liberal arts degrees take these classes to obtain specific job skills. Bailey expressed concern about these data gaps, saying that information is lacking about whether noncredit classes are simply subsidizing training for local employers or about the outcomes for participants.

Osterman said that there are data showing that middle-aged people who lose their jobs suffer "very substantial earnings losses." He said there are few evaluations of dislocated worker programs, although he is aware of some successful programs that enroll adults in technical training programs at community colleges.

Larry Mishel asked why, in current debates about high school reform, anyone who suggests that not everyone needs to attend college is called an "elitist." He said he found this charge confusing, given the BLS statistics indicating that only about 24 percent of the workforce have a bachelor's degree or higher and another 29 percent have some college (Hecker, 2005). McWalters said that, if school systems were able to graduate students with high reading comprehension and other academic skills, as well as communication skills, problem-solving skills, adaptability, flexibility, and the other broad competencies, he would consider those students both college-ready and work-ready. Since he cannot predict what occupations may be in demand in the future, he said, his job is to develop the most "universal" skills. Traiman said that, when reformers talk of preparing high school students graduates for college and work, this is shorthand for the real goal of preparing students for some form of postsecondary education or training after high school. Bailey said that, among students in eighth grade in 1988, over three-fourths had participated in some type of postsecondary education by 1994 (U.S. Department of Education, 1998), indicating some

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progress toward increased access to higher education. Ideally, he said, effectively preparing young people for work should also prepare them for college, although not necessary for four-year college.

Finegold, observing that many community college students enroll in general education classes in preparation for transfer to four-year colleges, suggested working with employers to more clearly define educational paths leading to mid-level occupations. He predicted that young people would respond to labor market "signals" about the potential future earnings in occupations requiring only an associate's degree. McWalters suggested that these signals should begin in middle school. He noted that many 14- and 15-year-olds who get jobs unrelated to school would benefit from internships related to possible future careers or, at the least, career exploration activities.

Offering his perspective on how the education system has responded to the SCANS report, Ken Kay said that, although the report outlined skills for all students, some of the skills were quickly viewed as important only for vocational education students who would not attend college. He said that, at that time, there were no discussions clarifying that social and interpersonal, skills are important for professionals and other college-educated workers. Other broad skills, such as problem-solving and critical thinking, were viewed as important only for gifted students.

Bailey agreed, reiterating his view that, during the 1990s, most people believed college students developed the broad competencies. However, he said, most college faculty lack training in teaching generally, including the teaching of problem-solving skills, communication skills, and other broad skills. Kay responded that he sees K-12 systems as more willing to explore these broad skills than higher education, which is focused on deep content knowledge in disciplinary "silos." Traiman, noting that higher education has a powerful influence on K-12 education, said that, if leading universities were to require the broad skills in addition to academic content knowledge, high schools and high school students would respond.

In response to a question about education in science, technology, engineering, and mathematics, Traiman said that the business community is considering marketing techniques that could be used to try to educate and excite the public about careers in these fields. In response to a question about the No Child Left Behind Act, McWalters said he supported the law's underlying idea—that the states should make high-quality education accessible and measure their progress toward this goal with disaggregated data on different student groups. However, he said that the mechanisms for implementing the law, including the tests used as measures, are problematic. He suggested continuing the policy agenda embodied in the law in order to encourage education systems to think about accountability for helping prepare all students for college or work, but he warned that states have

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not been positioned to deliver on the equity component of this agenda. He said the states are unprepared to help their urban school systems with the resources and technical assistance required to help all students succeed.

Responding to a question about what problem education and training policies aim to address, Osterman responded that the problem is equity, rather than productivity or international competitiveness. He disagreed with Cappelli's assertion that few firms provide training, stating that companies "do a great deal of internal training when they need to" (Osterman, 2006). Bailey agreed that equity is the most serious problem to solve, noting that half of the students from families in the lowest income quartile do not attend college, while almost all students from families in the highest quartile do attend college. Mary Gatta said that she had been involved in establishing a career resource center in science, technology, engineering, and mathematics for 7th to 12th grade students, introducing both boys and girls to nontraditional careers, such as nursing for boys. Federal support provided under the Perkins Career and Technical Education Act allowed the center to operate without need for tuition, recruiting students from low-income neighborhoods, she said. She said that the center is an example of the possibilities for addressing the equity problem in the context of workforce development. Traiman said that equity is important, but that education and training also play a key role in enhancing U.S. international competitiveness.

Christopher Sager noted that existing credentials and certifications of work readiness, such as the Equipped for the Future credential developed by the National Institute for Literacy and the U.S. Chamber of Commerce (University of Tennessee, 2004), considered problem-solving and the other broad skills. He suggested examining these efforts to learn more about which skills are considered important for work readiness and about how these skills are assessed. In a final comment, McWalters said it would be valuable to think about how new approaches to teaching and learning in the humanities, as well as in science and mathematics, could be used to develop communication, problem-solving, and other broad skills.

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8

Final Reflections

In the final workshop session, several members of the planning committee reflected on what they had learned from the workshop and what questions remain to be addressed.

Richard Murnane opened his remarks by asking what problem led researchers and policy makers to be concerned about changing skill demands. He noted that trends in workplace skill demands have implications both for the nation's economic growth and for social equity. Referring to the earlier debate between Harry Holzer and Peter Cappelli, he said that the implications of skills for economic growth are "complicated," but the implications for equity are clear. Murnane reminded the audience that the real earnings of high school dropouts have fallen (Levy and Murnane, 2004) and said that the lack of labor market opportunities for dropouts help to explain high unemployment among young black men. However, he said, because the national constituency concerned about inequality is much smaller than the constituency concerned about competitiveness and economic growth, it would be useful to tie public discussions of workforce skills to the concerns about competitiveness.

Focusing on the key problem of inequality, Murnane reflected on the trend of rapid growth at the high and low ends of the labor market, asking "What is the stability of a democracy in which you have . . . two classes with very little mobility between them?"

Murnane said that interpersonal skills appear to be important across a wide variety of jobs, from the low-wage service occupations to the biotechnology and information technology occupations. He suggested that written communication skills, knowing how to work well with people of

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various races and cultures, and knowing how to give and receive advice constructively are essential to successful performance of jobs, because no single individual has all of the required knowledge and therefore "we rely on others."

Murnane then addressed what educators and policy makers have learned about teaching these broad skills since they were identified in the SCANS report (U.S. Department of Labor, 1991). Many school districts, he said, use curricula designed to teach not only the basic skills of reading, writing, and arithmetic, but also communication, analytical reasoning, and teamwork skills. He cited the Writers Workshop (Network for Instructional TV, Inc., 2003) and "hands-on" approaches to science learning as examples of such curricula. He asserted that schools have made more progress in teaching the broad competencies through innovative approaches to writing than through hands-on science, mentioning Massachusetts as an example of a state that requires students to write as part of high-stakes state tests.

Murnane argued that test-based accountability tends to discourage teaching the broad skills, because they are not measured by most current state tests. More affluent suburban schools use innovative curricula to develop problem-solving, communication, and teamwork skills, he said, but poor schools often focus on attaining basic content standards, using a "drill and kill pedagogy." Murnane asked whether state science assessments mandated by the No Child Left Behind Act would slow the possibilities for developing the broad skills through hand-on science approaches. Noting that science education is potentially a "powerful method" for teaching problem-solving and communication skills (National Research Council, 2007c), he suggested further research on how to assess the broad skills (e.g., National Research Council, 2001). He noted that, although performance-based assessments are expensive, they could provide a powerful policy lever to encourage the teaching of these skills.

He went on to mention that career-technical education, or CTE, has "promise" although it has not been a focus of education policy—in part because of the pressure on urban school districts to improve test scores and in part because vocational education has a "bad reputation." Murnane noted that rigorous research using random assignment methods provides evidence of the value of career academies, a form of CTE (Kemple, 2004). He suggested thinking about CTE, not as "training people for particular narrow vocations," but rather as a way to effectively teach teamwork and communication skills as well as content skills in algebra, writing, and other subjects. Murnane noted that, at least in principle, CTE also offers a path to community college, suggesting further examination of this educational approach.

Reflecting on concerns about the cost of higher education raised by earlier speakers, Murnane said that researchers have demonstrated that

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demand for higher education is "strikingly sensitive to college costs" (Dynarski, 2005; Long, 2004). Murnane suggested further study of this topic, particularly because high costs have a much bigger impact in deterring college attendance among low-income students.

Murnane said that he had learned from several speakers that efforts to first examine demand for skill and then think about how education and training could increase the supply of skills (the approach followed in the workshop agenda) does not work well. Stating that examining skill supply and demand is not a "modular problem," he echoed Arne Kalleberg's earlier point that social choices affect not only the supply of skills, but also the demand for skills. He said that Peter Kemper had explained that social choices about the level of Medicaid reimbursement affect how care workers are paid, which in turn affects recruitment and retention.

Reflecting on the discussions of service work, Murnane observed that the speakers had proposed two rather different arguments about the need to improve the quality and skill demands of service jobs. First, because the populations served (young children, elderly people) are weak and vulnerable, an argument can be made that "we as a society ought to care about the quality of care" that they receive. He said that, because interpersonal skills are critical to the work, it would not be possible to improve the quality of care simply by making the jobs routine and increasing the monitoring of workers in a "Taylorist"[1] approach. For example, he said, the O*NET database indicates that one of the most important skills for a nursing aide is "social perceptiveness—being aware of others' reactions and understanding why they react as they do" (O*NET Online, 2007). Improving the quality of care might require changes in policy and practice, such as providing higher wages and better training to increase the supply of skills and create better jobs that would attract more educated, skilled workers.

Murnane then reflected on another "quite different argument" about low-wage care work that had emerged at the workshop. This argument, he said, is that service jobs are of low quality with few or no benefits and that our wealthy U.S. society could afford to provide better wages and employment opportunities. He said various policies had been proposed to address this problem, such as increasing the minimum wage or the earned income tax credit (Wellin, 2007b; Appelbaum, Bernhardt, and Murnane, 2003). He noted Paul Osterman's earlier argument that, if the national government had enforced its existing labor laws over the past several decades, employees in these occupations would be able to bargain for higher wages.

Finally, Murnane said that it is not possible to discuss skill supply and

[1] "Taylorism" refers to the management approach advocated by Frederick W. Taylor (1911), which calls for specifying job tasks, routines, and tools in detail.

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demand in any detail without considering immigration—a factor that affects both low-end and high-end jobs.

REFLECTIONS OF PLANNING COMMITTEE MEMBERS

Cappelli agreed with Murnane that it is not useful to try to predict skill demand "with any great certainty," but said that the workshop participants had learned a great deal about factors influencing skill demands, including employer choices about how to organize work. Given the uncertainties about future skill demands, Cappelli called for policies to create tighter linkages between education and the workplace. He noted that such policies had been discussed a decade earlier[2] and are still relevant now. One key question, he said, is whether and to what extent policies should encourage the education and training system to respond to employer demands and what such policies should "ask of employers in return."

Christopher Sager said that, as an expert in measurement and the analysis of jobs, he sees two quite different problems related to future skills. First, for jobs at the upper end of the labor market, there are some technical measurement problems related to more specifically identifying skills needed in various occupations and communicating them more clearly to students and workers in other occupations. Generally, however, "that system works pretty well in our economy." The second problem, he said, is to develop the skills required to enter the workforce, including adequate levels of oral and written communication skills, interpersonal skills, and conscientiousness. Sager argued that, because many people lack these skills and opportunities to develop them, they have trouble obtaining work and may become dependent on welfare. He said it is "abundantly clear" that society needs to address this second skill demand problem.

David Finegold said that, in thinking about concerns about the nation's skill supply, an argument could be made for improving the quality of child care jobs as a strategic approach to increasing the future skill supply, in addition to the other arguments for improving the quality of service jobs that had already been advanced. He described this as a "win-win" area. Finegold said that the discussions of globalization had identified critical information gaps. Flagging a "disconnect" between data Martin Kenney had presented on the large numbers of jobs being created abroad by only a few companies and other studies suggesting that globalization would have only marginal effects on national employment, he called for close monitoring of developments and further research.

Finegold agreed with Cappelli that one of the most important changes

[2]For example, the School to Work Opportunities Act of 1994 was designed to increase links between high schools and workplaces.

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in employment patterns over the past three decades has been the tendency of companies, including large corporations, to reduce or dismantle internal career ladders. Given this change and the trend toward a bifurcated distribution of employment into low-level and high-level jobs, he asked how society could prepare people for corporate leadership roles. In addition, Finegold argued that companies increasingly want demonstrated experience, raising questions about how young people can obtain the experience needed to be hired. He suggested examining how to create integrated systems linking education and training providers with employers that would provide young people with the experiences needed to perform at higher levels once hired.

Finally, Finegold commented that other panelists had not mentioned Stuart Elliott's analysis, perhaps because its proposition that computers would take over much human work raised "scary" implications, particularly given the current trend toward growing income inequality. He suggested studying the possibilities for using computers as a tool to reduce social inequality, such as by providing online education and training to low-skilled workers and the unemployed.

FINAL COMMENTS AND QUESTIONS

Ken Kay suggested telling one's children that they will need creativity, problem-solving, communications and other broad skills to negotiate "multiple careers and multiple jobs." On the negative side, he said, noting the trends toward elimination of jobs through computerization and globalization, it may be important to tell one's children that they will need the broad competencies as a "self-defense mechanism" in case of displacement or layoffs. Whether to accommodate voluntary job changes or survive displacement, he said, the broad competencies would be valuable. Finegold responded that the possibility of many dislocations and career changes over an increasingly long human life span could be viewed negatively or from a more positive perspective, as opening up different possibilities at different stages of life. He said he believed that the available data on job tenure indicated that, although young people in their twenties change jobs frequently, average job tenure has not greatly declined over the past several decades.

Cappelli responded that average job tenure is "a confusing measure" because it includes both voluntary job changing and involuntary layoffs. He said that the average job tenure of women has increased compared with a generation ago, because women today are less likely to quit their jobs when they have families, but that this trend does not reflect an important change. In contrast, he said, "tenure for men is down . . . particularly for men over age 55," primarily due to layoffs (Cappelli, 2007). He argued that the most important point is that employees today must manage their own careers, in

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contrast to the "organization man" of the 1950s (Whyte, 1956) who tried to fit into roles created for him by the company. Today, Cappelli argued, the situation is "completely reversed." Employees must learn to market themselves, and one who tries to simply fit in will have little chance of promotion. Cappelli cautioned against telling one's children things about future skill demand that might be incorrect, suggesting it would be better to admit that "we don't know." But, he said, "the skills of managing uncertainty are probably going to be really important."

Recent college graduate and author Marcos Salazar (2006) said that the hundreds of college graduates he had interviewed for his book often reported feeling unprepared for the working world and unable to apply what they had learned in college. Based on these interviews, Salazar asserted that the transition from college to work is psychologically difficult, as the graduate moves away from friends and faces the challenge of forging a new identity as an employee. Salazar said those he interviewed reported feeling helpless and entering a phase of what he termed "post college depression." Sager responded that, in contrast to his time in college, when most students worked, he had the impression that many current college students do not work.

Finegold said that the college population is segmented, and students enrolled in two-year colleges are more likely to work, and to work a greater number of hours, than their counterparts in four-year colleges.[3] He said he was curious about Salazar's question, because "the data tell us" that most students have been working for several years by the time they graduate. Cappelli cautioned that the feeling of not being prepared for work after college graduation is not a new phenomenon, as he and another workshop participant who had been his college classmate agreed that they had both felt that way 25 years earlier.

Labor economist Robert Lerman (American University) introduced a new topic, asking why no one had mentioned the National Skill Standards Board[4] throughout the workshop. He suggested this is because the board developed few standards and its work was not embedded in "real recruitment and training practices." Lerman said that the workshop speakers addressed the demand for broad skills and also discussed the role of com-

[3]Between 1970 and 2005, the percentage of full-time college students who were employed grew from 34 to 49 percent. In 2005, 54 percent of full-time students enrolled in two-year colleges were employed, compared with 48 percent of full-time students enrolled in four-year colleges (National Center for Education Statistics, 2007a).

[4]The National Skill Standards Board was created under the School to Work Opportunities Act of 1994 to engage industry, labor, and education in development of a voluntary, national system of skill standards, assessments, and certifications. Standards were created for only a few sectors (manufacturing, sales), Congress withdrew funding in 2002, and the Board ceased operations in 2003 (Allum, 2007).

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panies in developing skills. What is missing, he argued, is attention to the role of industry and occupational groups in organizing pathways to develop needed skills (Lerman, 2007). Lerman mentioned the example of nursing education discussed earlier, criticizing the current situation, in which hospitals are paying to recruit trained foreign nurses, while community colleges are reluctant to expand their nursing education programs.

Lerman said that creation of industry or occupational structures to support skill development would help to address the problem of growing income inequality. He also called for more research on the growth of income inequality within groups of equal educational attainment, noting that this "within-group" inequality is almost as high as overall inequality (Autor, Katz, and Kearney, 2006). Lerman said that one possible explanation for these wage differentials might be workers' varying levels of the broad social, interpersonal, and analytical skills discussed at the workshop, but "we don't really understand it very well."

Cappelli agreed with Lerman that within-group inequality is growing, noting that another part of the explanation might be the wide variation in the quality of college education in the United States. Agreeing with Lerman that the infrastructure supporting skill development pathways has weakened, he asked about the extent of apprenticeship. Responding that there are few good measures of apprenticeship, Lerman said that estimates of the number of young people involved vary from about 500,000 to 1.5 million (Lerman, 2007). He asserted that the national apprenticeship system had been "starved over time," and that the current Department of Labor budget includes only $20 million annually to support apprenticeship. He noted that the federal government provides no subsidy for this training, which is supported entirely by employers and other partners, including community colleges and labor unions.

Mary Gatta noted that mentoring is a valuable way help college students develop broad interpersonal and adaptability skills, calling for linking students with mentors in companies, in order to help prepare them for the transition to work. Helen Ladd then raised a question about whether policies may be needed to increase engagement in education among boys and young men, referring to national data showing that more boys than girls are dropping out of high school and that most colleges and universities enroll many more women than men (National Center for Education Statistics, 2007b). Murnane agreed that this issue is of great concern across all ethnic groups, and particularly among blacks, as a much higher percentage of black women than men enroll in higher education. Sager responded that, because research has identified very few differences between the genders in intellectual abilities, the differential enrollment patterns between the genders must reflect social and cultural factors, not differences in abilities.

Finegold said that, in the field of biological sciences he studies, equal

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numbers of men and women receive doctoral degrees, but the senior leadership in both academia and the biotechnology industry is male-dominated. Eileen Collins, formerly employed by the National Science Foundation, said that internships are valuable, but cautioned that, if internships are not paid, they may be an option only for young people from wealthy families. She mentioned that there are many practical programs under way across the nation designed to address the problem of inequality, citing the example of summer camps and internships in Texas that engage young women and minorities in preparation for science and engineering careers. She suggested an effort to assemble existing databases about such programs. A District of Columbia public schools official involved in technical education said that she believes that employers do want to help young people develop high levels of skills, describing partnerships with companies that provide mentoring, student field trips, and guest speakers in schools. Stating that her greatest challenge is to develop interpersonal and cognitive skills among the teachers, many of whom lack work experience outside the classroom, she called for enhanced training of teachers.

Noting that one of the broad skills important for the future workplace is time management, Finegold then adjourned the workshop.

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References

Abel, E.K. (1990). Daughters caring for elderly parents. In J.F. Gubrium and A. Sankar (Eds.), *The home care experience*. Newbury Park, CA: Sage.

Abraham, K., and Houseman, S. (2007). *Removing barriers to work for older Americans*. Presentation at the W.E. Upjohn Institute for Employment Studies Conference, A Future of Good Jobs? America's Challenge in the Global Economy. Available: http://www.upjohninst.org/jobs-conference/abraham-houseman.html [accessed August 6, 2007].

Acemoglu, D. (2003). Patterns of skill premia. *Review of Economic Studies, 70*, 199-230.

Adler, P.S., and Borys, B. (1989). Automation and skill: Three generations of research on the NC case. *Politics and Society, 17*, 377-402.

Allum, J.R. (2007). *Message in a bottle: A case study of the National Skill Standards Board*. Dissertation, George Washington University Graduate School of Education and Human Development (May 20).

Appelbaum, E., and Batt, R. (1993). *High-performance work systems: American models of workplace transformation*. Washington, DC: Economic Policy Institute.

Appelbaum, E., Bailey, T., Berg, P., and Kalleberg, A. (2000). *Manufacturing advantage: Why high-performance work systems pay off*. Ithaca, NY: ILR Press.

Appelbaum, E., Bernhardt, A.D., and Murnane, R.J. (Eds.). (2003). *Low-wage America: How employers are reshaping opportunity in the workplace*. New York: Russell Sage Foundation.

Attewell, P. (1990). What is skill? *Work and Occupations, 17*(4), 422-448.

Autor, D. (2007a). *Technological change and job polarization: Implications for skill demand and wage inequality*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 23, 2007].

Autor, D. (2007b). *Discussion of "High-touch and here-to-stay: Skill demands in low-wage service occupations."* Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 23, 2007].

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Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Autor, D.H., Katz, L., and Kearney, M. (2006). The polarization of the United States labor market. *AEA Papers and Proceedings, 96*(2). Also available: http://econ-www.mit.edu/faculty/download_pdf.php?id=1408 [accessed July 3, 2007].

Autor, D.H., Levy, F., and Murnane, R.J. (2003a). Computer-based technological change and skill demands: Reconciling the perspectives of economists and sociologists. In E. Appelbaum, A.D. Bernhardt, and R.J. Murnane (Eds.), *Low-wage America: How employers are reshaping opportunity in the workplace*. New York: Russell Sage Foundation.

Autor, D.H., Levy, F. and Murnane, R.J. (2003b). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics, 118*(4), 1279-1333.

Barbuceanu, M., Fox, M.S., Hong, L., Lallement, Y., and Zhongdong, Z. (2004). Building agents to serve customers. *Artificial Intelligence, 25*(3), 47-60.

Barley, S., and Bechky, B. (1994). In the backrooms of science: The work of technicians in science labs. *Work and Occupations, 21*(1), 85-126.

Barton, P.E. (2000). *What jobs require: Literacy, education, and training, 1940-2006*. Princeton, NJ: Educational Testing Service. Also available: http://www.ets.org/research/researcher/PIC-JOBS.html [accessed September 26, 2007].

Battelle Memorial Institute and SSTI. (2006). *Growing the nation's bioscience sector: State bioscience initiatives*. Washington, DC: Biotechnology Industry Organization. Also available: http://bio.org/local/battelle2006/executive_summary.pdf [accessed July 19, 2007].

Becker, G.S. (1964). *Human capital*. New York: Columbia University Press.

Berman, E., Bound, J., and Machin, S. (1998). Implications of skill-biased technological change: International evidence. *Quarterly Journal of Economics, 113*(4), 1245-1280.

Berryman, S., and Bailey, T. (1992). *The double helix of education and the economy*. New York: Columbia University, Teachers College.

Black, B. (1999). *Corporate law and residual claimants*. (Berkeley Program in Law and Economics, Working Paper Series, Paper #27). Berkeley: University of California. Also available: http://repositories.cdlib.org/blewp/27 [accessed August 2, 2007].

Blinder, A. (2007). *How many United States jobs might be offshoreable?* (CEPS Working Paper #142). Princeton, NJ: Princeton University Center for Economic and Policy Studies. Also available: http://www.princeton.edu/~ceps/publications.shtml [accessed July 20, 2007].

Business–Higher Education Forum. (2003). *Building a nation of learners: The need for changes in teaching and learning to meet global challenges*. Washington, DC: Author. Also available: http://www.bhef.com/publications/2003_build_nation.pdf [accessed September 26, 2007].

Business Roundtable. (2005). *Tapping America's potential: The education for innovation initiative*. Washington, DC: Author. Also available: http://www.businessroundtable.org//publications/index.aspx [accessed May 9, 2006].

Cain, P.S., and Treiman, D.J. (1981). The dictionary of occupational titles as a source of occupational data. *American Sociological Review, 46*, 253-278.

Cappelli, P. (2003). Will there *really* be a labor shortage? *Organizational Dynamics, 32*(3), 221-253.

Cappelli, P. (2007). *Talent on demand*. Cambridge, MA: Harvard Business School Press.

Casner-Lotto, J., and Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century United States workforce*. New York: The Conference Board. Also available: http://www.21stcenturyskills.org/documents/FINAL_REPORT_PDF09-29-06.pdf [accessed July 18, 2007].

Casper, S., and Murray, F. (2004). Examining the marketplace for ideas: How local are Europe's biotechnology clusters? In M. McKelvey, A. Rickne, and J. Laage-Hellman (Eds.), *The economic dynamics of modern biotechnology*. Cheltenham, England: Elgar.

Copyright © National Academy of Sciences. All rights reserved.

Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Center on Wisconsin Strategy. (2007). *Choosing the high road*. Available: http://www.cows.org/hr_index.asp [accessed August 8, 2007].

Commission on the Skills of the American Workforce. (1990). *America's choice: High skills or low wages*. Washington, DC: National Center on Education and the Economy.

Cyert, R.M., and Mowery, D.C. (1988). *The impact of technological change on employment and economic growth*. Cambridge, MA: Ballinger.

Darr, A. (2007a). *The knowledge worker and the future skill demands of the United States workforce*. Presentation at the the National Academies Workshop on Research Evidence Related to Future Skill Demands, Washington, DC, May 31-June 1. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 16, 2007].

Darr, A. (2007b). *The knowledge worker and the future skill demands of the United States workforce*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands, Washington, DC, May 31-June 1. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Commissioned_Papers.html [accessed July 11, 2007].

Dustmann, C., Ludsteck, J., and Schoenberg, U. (2007). *Revisiting the German wage structure*. (University of Rochester Working Paper). Available: http://www.econ.rochester.edu/Faculty/Schoenberg/papers/inquality.pdf [accessed July 11, 2007].

Dynarski, S. (2005). *Building the stock of college-educated labor*. (NBER Working Paper #11604). Cambridge, MA: National Bureau of Economic Research.

Eaton, S.C. (1999). Changing labor-management relations in nursing homes. In *Proceedings of the 51st annual meeting of the Industrial Relations Research Association* (vol. 1, pp. 75-86). Madison, WI: Industrial Relations Research Association.

Edwards, M.G., Murray, F., and Yu, R. (2006). Gold in the ivory tower: Equity rewards of outlicensing. *Nature Biotechnology, 24*(5), 509-515. Also available: http://web.mit.edu/fmurray/www/ [accessed July 19, 2007].

Elliott, S. (2007a). *Projecting the impact of computers on work in 2030*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 11, 2007].

Elliott, S. (2007b). *Projecting the impact of computers on work in 2030*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 11, 2007].

Ellis, R. (2000). The IT labor shortage: Fact or fiction? *Dr. Dobb's Journal*. Available: http://www.ddj.com/architect/184404070 [accessed September 26, 2007].

England, P., Budig, M., and Folbe, N. (2002). Wages of virtue: The relative pay of care work. *Social Problems, 49,* 455-473.

Ernst and Young Global Biotechnology Center. (2006). *Beyond borders: The Ernst and Young global biotechnology report*. Available: http://www.ey.com/beyondborders [accessed August 2007].

Felicelli, M., and Allen, K. (2006). *Leading CEOs: A snapshot of Fortune 500 leaders*. Available: http://www.spencerstuart.com/research/articles/975/ [accessed August 8, 2007].

Finegold, D. (2007). *Is education the answer? A quick history of debates about skills and United States competitiveness*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands, Washington, DC, May 31-June 1. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 11, 2007].

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Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Ford, R.C., and Randolph, W.A. (1992). Cross-functional structures: A review and integration of matrix organization and project management. *Journal of Management, 18*(2), 267-294.

Freeman, R. (2007). Is a great labor shortage coming? Replacement demand in the global economy. In H.J. Holzer and D.S. Nightingale (Eds.), *Reshaping the American workforce in a changing economy.* Washington, DC: Urban Institute Press.

Friedman, T.L. (2005). *The world is flat: A brief history of the 21st century.* New York: Farrar, Straus & Giroux.

Gatta, M. (2002). *Juggling food and feelings: Emotional balance in the workplace*. Lanham, MD: Lexington Books.

Gatta, M., Boushey, H., and Appelbaum, E. (2007a). *High-touch and here-to-stay: Future skill demands in low-wage service occupations*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed October 10, 2007].

Gatta, M., Boushey, H., and Appelbaum, E. (2007b). *High-touch and here-to-stay: Future skill demands in low-wage service occupations*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Mary_Gatta_Paper.pdf [accessed September 26, 2007].

Ginsburg, R., and Robinson, D. (2006). *Illinois' future workforce: Will there be enough workers with the right skills?* Dekalb, IL: Northern Illinois University and the Center for Tax and Budget Accountability. Also available: http://www.stateofworkingillinois.niu.edu/swil/pubs/2006_Future_Workforce_PolicyBrief.pdf [accessed September 26, 2007].

Gittelman, M., and Kogut, B. (2003). Does good science lead to valuable knowledge? Biotechnology firms and the evolutionary logic of citation patterns. *Management Science, 49*(4), 366-382 (Special Issue: Managing Knowledge in Organizations).

Glomb, T., Kammeyer-Mueller, J., and Rotundo, M. (2004). Emotional labor demands and compensating wage differentials. *Journal of Applied Psychology, 89*, 700-714.

Goos, M., and Manning, A. (2007). Lousy and lovely jobs: The rising polarization of work in Britain. *Review of Economics and Statistics, 89*(1), 118-133.

Granovetter, M., and McGuire, P. (1998). The making of an industry: Electricity in the United States. In M. Callon (Ed.), *The laws of the markets*. Oxford, England: Blackwell.

Groshen, E. (1991). Sources of intra-industry wage dispersion: How much do employers matter? *Quarterly Journal of Economics, 106*(3), 869-884.

Hampson, I., and Junor, A. (2005). Invisible work, invisible skills: Interactive customer service as articulation work. *New Technology, Work and Employment, 20*, 166-181.

Handel, M.J. (2003). Skills mismatch in the labor market. *Annual Review of Sociology, 29*, 135-165.

Handel, M.J. (2007a). *A new survey of workplace skills, technology, and management practices (STAMP): Background and descriptive statistics*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed August 2, 2007].

Handel, M.J. (2007b). *A new survey of workplace skills, technology, and management practices (STAMP): Background and descriptive statistics*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed August 2, 2007].

Hecker, D.E. (2004). Occupational employment projections to 2012. *Monthly Labor Review, 127*(2), 80-105.

Copyright © National Academy of Sciences. All rights reserved.

Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Hecker, D.E. (2005). Occupational employment projections to 2014. *Monthly Labor Review Online, 128*(11). Available: http://www.bls.gov/opub/mlr/2005/11/art5exc.htm [accessed November 2007].

Henderson, R., and Cockburn, I. (1994). Measuring competence: Exploring firm effects in pharmaceutical research. *Strategic Management Journal, 15*, 63-84.

Hochschild, A.R. (1983). *The managed heart: The commercialization of human feeling*. Berkeley: University of California Press.

Holzer, H., Edelman, P., and Offner, P. (2006). *Reconnecting disadvantaged young men*. Washington, DC: Urban Institute Press.

Holzer, H., and Nightingale, D.S. (Eds.) (2007). *Reshaping the American workforce in a changing economy*. Washington, DC: Urban Institute Press.

Houston, J. (2007). *Future skill demands, from a corporate consultant perspective*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 3, 2007].

Institute for the Future of Aging Services. (2007). *Better jobs, better care: Building a strong long-term care workforce*. Washington, DC: American Association of Homes and Services for the Aging. Also available: http://www.bjbc.org/ [accessed July 24, 2007].

Johnstone, W.B., and Packer, A.E. (1987). *Workforce 2000: Work and workers for the twenty-first century*. Indianapolis, IN: Hudson Institute.

Kemple, J. (2004). *Career academies: Impacts on labor market outcomes and educational attainment*. New York: MDRC.

Kenney, M., and Dossani, R. (2007). *The knowledge workforce in the global economy: Some thoughts*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 3, 2007].

Kleiner, M.M. (2006). *Licensing occupations: Ensuring quality or restricting competition*. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Kutner, M., Greenberg, E., and Baer, I. (2006). *A first look at the literacy of America's adults in the 21st century*. (National Center for Education Statistics, Report #2006 470). Washington, DC: U.S. Department of Education. Also available: http://nces.ed.gov/NAAL/PDF/2006470.PDF [accessed July 24, 2007].

Leamer, E.E. (2007). A flat world, a level playing field, a small world after all, or none of the above? A review of Thomas L. Friedman's *The world is flat*. *Journal of Economic Literature, 45*(1), 83-126.

Leidner, R. (1993). *Fast food, fast talk: Service work and the routinization of everyday life*. Berkeley: University of California Press.

Lerman, R. (2007). *Are skills the problem? Reforming the education and training system in the United States*. Presentation at the W.E. Upjohn Institute Conference, A Future of Good Jobs? America's Challenge in the Global Economy. Available: http://www.upjohninst.org/jobs-conference/lerman.html [accessed August 6, 2007].

Levy, F., and Goelman, A. (2005). Offshoring and radiology. In S. Collins and L. Brainard (Eds.), *Offshoring white-collar work: The issues and the implications* (pp. 411-423). Washington, DC: Brookings Trade Forum. Also available: http://www.brookings.edu/es/commentary/journals/tradeforum/agenda2005.htm [accessed July 18, 2007].

Levy, F., and Murnane, R.J. (2004). *The new division of labor: How computers are creating the next job market*. Princeton, NJ: Princeton University Press.

Lloyd, C., Mason, G., and Mayhew, K. (2008). *Low-paid work in the U.K.* New York: Russell Sage Foundation.

Copyright © National Academy of Sciences. All rights reserved.

Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Loffler, A., and Stern, S. (2006). *The future of the biomedical industry in the era of globalization*. Northwestern University, Kellogg School of Business. Available: http://www.kellogg.northwestern.edu/academic/biotech/articles/index.htm [accessed July 18, 2007].

Long, B.T. (2004). The impact of federal tax credits for higher education expenses. In C.M. Hoxby (Ed.), *College choices: The economics of where to go, when to go, and how to pay for it*. Chicago, IL: University of Chicago Press.

Lowell, B.L. (2006). *Projected number of foreign computer and engineering workers under the Senate's Comprehensive Immigration Reform Act (S. 2611)*. Paper prepared for the Institute of Electrical and Electronic Engineers. Washington, DC: Georgetown University, Institute for the Study of International Migration. Also available: http://isim.georgetown.edu/Publications/LindsayPubs/Lowell,%20C&E%20S2611%20projections%208-31-06.pdf [accessed August 7, 2007].

Lowell, B.L. (2007). *Panel discussion of skill supply and demand: Immigrants*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed August 7, 2007].

Lynn, L., and Salzman, H. (2007). *Innovation shift to the emerging economies: Cases from IT and heavy industries (draft)*. Presentation at the Sloan Industry Studies Conference. Available: http://web.mit.edu/sis07/www/lynn.pdf [accessed July 18, 2007].

Marrelli, A.F., Tondora, J. and Hoge, M.A. (2005). Strategies for developing competency models. *Administration and Policy in Mental Health Services and Mental Health Research, 32*(5-6), 533-561.

McKinsey Global Institute. (2005). *The emerging global labor market: Part 1-The demand for offshore talent in services*. Washington, DC: Author. Also available: http://www.mckinsey.com/mgi/publications/emerginggloballabormarket/ [accessed July 18, 2007].

Moravec, H. (1999). *Robot: Mere machine to transcendent mind*. New York: Oxford University Press.

Mosisa, A. and Hipple, S. (2006). Trends in labor force participation in the United States. *Monthly Labor Review, 129*(10), 35-57.

Murray, F., and Hsi, H. (2007a). *Knowledge workers in biotechnology: Occupational structures, careers, and skill demands*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed October 10, 2007].

Murray, F., and Hsi, H. (2007b). *Knowledge workers in biotechnology: Occupational structures, careers, and skill demands*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Fiona_Murray_Paper.pdf [accessed September 26, 2007].

Nagel, H. (2004). Steps toward a cognitive vision system. *Artificial Intelligence, 25*(2), 31-50.

National Academy of Engineering. (2004). *The engineer of 2020: Visions of engineering in the new century*. Washington, DC: The National Academies Press.

National Academy of Engineering. (2005). *Educating the engineer of 2020: Adapting engineering education to the new century*. Committee on Engineering Education. Washington, DC: The National Academies Press.

National Center for Education Statistics. (2007a). Employment of college students. In *The condition of education 2006*. Available: http://nces.ed.gov/programs/coe/2007/section5/indicator45.asp [accessed August 6, 2007].

Copyright © National Academy of Sciences. All rights reserved.

Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

National Center for Education Statistics. (2007b). Participation in education: Undergraduate education. In *The condition of education 2006*. Available: http://nces.ed.gov/programs/coe/2007/section1/indicator08.asp [accessed August 8, 2007].

National Center for O*NET Development. (2007). *O*NET Online*. Available: http://online.onetcenter.org/ [accessed July 26, 2007].

National Center on Education and the Economy. (2006). *Tough choices or tough times: The report of the new Commission on the Skills of the American Workforce*. Washington, DC: Author. Also available: http://www.skillscommission.org/executive.htm [accessed July 23, 2007].

National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Department of Education. Also available: http://www.ed.gov/pubs/NatAtRisk/index.html [accessed June 29, 2007].

National Research Council. (1980). *Work, jobs and occupations: A critical review of the Dictionary of Occupational Titles*. Committee on Occupational Classification and Analysis. Washington, DC: National Academy Press.

National Research Council. (1999). *The changing nature of work: Implications for occupational analysis*. Committee on Techniques for the Enhancement of Human Performance: Occupational Analysis. Washington, DC: National Academy Press.

National Research Council (2000). *Forecasting demand and supply of doctoral scientists and engineers: Report of a workshop on methodology*. Office of Scientific and Engineering Personnel and Policy and Global Affairs. Washington, DC: National Academy Press.

National Research Council. (2001). *Building a workforce for the information economy*. Committee on Workforce Needs in Information Technology, Board on Testing and Assessment, Board on Science, Technology, and Economic Policy, and Office of Scientific and Engineering Personnel. Washington, DC: National Academy Press.

National Research Council. (2005). *How students learn: History, mathematics, and science in the classroom*. Committee on How People Learn, A Targeted Report for Teachers. Washington, DC: The National Academies Press.

National Research Council. (2007a). *Rising above the gathering storm: Energizing and employing America for a brighter future*. Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology. Washington, DC: The National Academies Press.

National Research Council. (2007b). *Workshop on the globalization of innovation: Emerging trends in information technology, biopharmaceuticals, and financial services*. Board on Science, Technology, and Economic Policy. Washington, DC: The National Academies Press. Available: http://www7.nationalacademies.org/step/The%20Conference%20on%20Globalization%20of%20Industry.%20April%2007.%20Chapter%20list.html [accessed July 18, 2007].

National Research Council. (2007c). *Taking science to school: Learning and teaching science in grades K-8*. Committee on Science Learning, Kindergarten Through Eighth Grade, R.A. Duschl, H.A. Schweingruber, and A.W. Shouse, Eds. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Network for Instructional TV, Inc. (2003). *Writer's workshop: Making writing a lifelong habit for elementary school students*. Available: http://www.teachersfirst.com/lessons/writers/index.html [accessed August 2, 2007].

Newman, K. (1999). *No shame in my game: The working poor in the inner city*. New York: Russell Sage Foundation.

O*NET Online. (2007). *Details report for 31-1012.00—Nursing aides, orderlies, and attendants*. Available: http://online.onetcenter.org/link/details/31-1012.00 [accessed August 3, 2007].

Osterman, P. (Ed.). (1984). *Internal labor markets*. Cambridge, MA: MIT Press.

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Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Osterman, P. (2000). Work reorganization in an era of restructuring: Trends in diffusion and effect on employee welfare. *Industrial and Labor Relations Review, 53*(2), 179-196.

Osterman, P. (2006). *Improving job quality: Policies aimed at the demand side of the labor market*. Presentation at the W.E. Upjohn Institute for Employment Policy Conference, A Future of Good Jobs? America's Challenge in the Global Economy. Available: http://www.upjohninst.org/jobs-conference/osterman.html [accessed August 8, 2007].

Osterman, P., Kochan, T., Locke, R., and Piore, M. (2001). *Working in America: A blueprint for a new labor market*. Cambridge, MA: MIT Press.

Owen-Smith, J. (2001). Managing laboratory work through skepticism: processes of evaluation and control. *American Sociological Review, 66*, 427-452.

Partnership for 21st Century Skills. (2005). *The road to 21st century learning: A policymaker's guide to 21st century skills*. Washington, DC: Author. Also available: http://www.21stcenturyskills.org [accessed November 14, 2005].

Passel, J. (2003). *Projections of the U.S. labor force by generation and educational attainment: 2000-2050*. Washington, DC: Urban Institute.

Peterson, N., Mumford, M., Borman, W., Jeanneret, P., and Fleishman, E. (1999). *An occupational information system for the 21st century: The development of O*NET*. Washington, DC: American Psychological Association.

Potter, S.J., Churilla, A., and Smith, K. (2006). An examination of full-time employment in the direct care workforce. *Journal of Applied Gerontology, 25*(5), 356-374.

Powell, W.W., Koput, K.W., and Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly, 41*, 116-145.

Pulakos, E.D., Arad, S., Donovan, M.A., and Plamondon, K.E. (2000). Adaptability in the workplace: Development of a taxonomy of adaptive performance. *Journal of Applied Psychology, 85*, 612-624.

Quinn, R.P., and Staines, G.L. (1979). *The 1977 quality of employment survey*. Ann Arbor: University of Michigan, Institute for Social Research, Survey Research Center.

Ritzer, G. (1996). *The McDonaldization of society.* Thousand Oaks, CA: Pine Forge Press.

Rosenthal, N.H. (1997). Evaluating the 1995 BLS projections. *Monthly Labor Review Online, 120*(9). Available: http://www.bls.gov/opub/mlr/1997/09/contents.htm [accessed November 2007].

Salazar, M. (2006). *The turbulent twenties survival guide: Figuring out who you are, what you want, and where you're going after college*. Oakland, CA: New Harbinger.

Sandelowski, M. (1995). Sample size in qualitative research. *Research in Nursing and Health, 18*, 179-183.

Saunders, N.C. (2005). *A summary of BLS projections to 2014*. Washington, DC: U.S. Department of Labor. Also available: http://www.bls.gov/opub/mlr/2005/11/art1exc.htm [accessed July 2, 2007].

Shaiken, H. (1986). *Work transformed: Automation and labor in the computer age*. Lexington, MA: Lexington Books.

Sommers, D. (2007). *Overview of occupational projections to 2014*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 11, 2007].

Spenner, K. (1983). Deciphering Prometheus: Temporal change in the skill level of work. *American Sociological Review, 48*(6), 824-837.

Taylor, F. (1911). *The principles of scientific management*. New York: Harper and Brothers.

Toossi, M. (2005). Labor force projections to 2014: Retiring boomers. *Monthly Labor Review, 128*(11), 25-44.

Copyright © National Academy of Sciences. All rights reserved.

Research on Future Skill Demands: A Workshop Summary
http://www.nap.edu/catalog/12066.html

Tsacoumis, S. (2007a). *The feasibility of using O*NET to study skill changes*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed July 11, 2007].

Tsacoumis, S. (2007b). *The feasibility of using O*NET to study skill changes*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Commissioned_Papers.html [accessed July 11, 2007]

United Kingdom HM Treasury. (2006). *Prosperity for all in the global economy: World-class skills*. London, England: Author. Available: http://www.hm-treasury.gov.uk/independent_reviews/leitch_review/review_leitch_index.cfm [accessed July 2, 2007].

University of Tennessee. (2004). *Equipped for the future*. Knoxville: Author. Also available: http://eff.cls.utk.edu/default.htm [accessed August 9, 2007].

U.S. Bureau of Economic Analysis. (2007). *News release, gross domestic product: Second quarter 2007 (preliminary)*. Washington, DC: U.S. Department of Commerce. Also available: http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm [accessed September 5, 2007].

U.S. Census Bureau. (2007). *International database: Population pyramids*. Available: http://www.census.gov/ipc/www/idb/pyramids.html [accessed August 6, 2007].

U.S. Department of Education. (1998). *Access to postsecondary education for the 1992 high school graduates*. Washington, DC: Author. Also available: http://nces.ed.gov/pubs98/access/98105-9.asp [accessed October 26, 2007].

U.S. Department of Education. (2004). *Program for international student assessment: U.S. performance in mathematics literacy and problem-solving*. Washington, DC: Author. Also available: http://nces.ed.gov/surveys/pisa/pisa2003highlights_2.asp [accessed July 2, 2007].

U.S. Department of Health and Human Services. (2002). *The changing organization of work and the safety and health of working people: Knowledge gaps and research directions*. (National Institute for Occupational Safety and Health, NIOSH Publication No. 2002–116). Cincinnati, OH: Author.

U.S. Department of Labor. (1991). *Secretary's commission on achieving necessary skills*. Available: http://wdr.doleta.gov/SCANS/ [accessed July 31, 2007].

Weizenbaum, J. (1966). Eliza: A computer program for the study of natural language communication between man and machine. *Communications of the ACM, 9*(1). Available: http://i5.nyu.edu/~mm64/x52.9265/january1966.html [accessed August 1, 2007].

Wellin, C. (2007a). *Paid care-giving for older adults with serious or chronic illness: Ethnographic perspectives, evidence, and implications for training*. Presentation at the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Presentations.html [accessed October 10, 2007].

Wellin, C. (2007b). *Paid care-giving for older adults with serious or chronic illness: Ethnographic perspectives, evidence, and implications for training*. Paper prepared for the National Academies Workshop on Research Evidence Related to Future Skill Demands. Available: http://www7.nationalacademies.org/cfe/Future_Skill_Demands_Christopher_Wellin_Paper.pdf [accessed September 26, 2007].

Whyte, W. (1956). *The organization man: Molding team players for free enterprise*. New York: Simon and Schuster.

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Appendix A

Workshop Agenda

Workshop on Research Evidence Related to Future Skill Demands
May 31–June 1, 2007

Thursday, May 31

8:00 a.m. ***Working Breakfast and Welcome***

8:30 **Michael Feuer,** DBASSE
Martin Orland, Center for Education
Bruce Fuchs, National Institutes of Health
Eric Wanner, Russell Sage Foundation

Workshop Goals and Context
Richard Murnane, Harvard Graduate School of Education, moderator

8:45 ***Debates About United States Workforce Skills and Competitiveness***
David Finegold, Rutgers University

Questions and discussion

9:10 ***The Current Labor Market***
Peter Cappelli, University of Pennsylvania, moderator

9:15 ***Overview of Occupational Projections to 2014***
Dixie Sommers, Bureau of Labor Statistics

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9:30 **Response: Sam Leiken,** Council on Competitiveness

9:35 ***Presentation on Polarization in the U.S. Labor Market***
David Autor, Massachusetts Institute of Technology

9:50 **Response: Janis Houston,** Personnel Decisions Research Institutes

9:55 Discussion among presenters and discussants

10:10 Questions from the steering committee and audience

10:25 Moderator reflections
Peter Cappelli, University of Pennsylvania, moderator

10:35 ***Break***

10:50 ***Skill Demands of Knowledge Work***
Beth Bechky, University of California-Davis, moderator

Guiding Questions for Session

- What are "knowledge workers"? How many people are employed in these occupations and how are these occupations projected to grow over the next decade?
- What are the strengths and weaknesses of the available research on skill demands among knowledge workers?
- What does the available research tell us about factors that may affect the future skill demands of knowledge occupations generally, and biotechnology occupations in particular?
- What does the available research tell us about current and projected future skill demands among knowledge workers?
- What types of broad skills, such as technical/scientific, cognitive, and communications skills—if any—appear to be most in demand?
- What are the implications for education, including continuing education, of knowledge workers?

11:00 ***The Knowledge Worker and the Future Skill Demands of the U.S. Workforce***
Asaf Darr, University of Haifa

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11:05 **Response: Ken Kay,** Partnership for 21st Century Skills

11:10 ***Future Skill Demands in Biotechnology***
Fiona Murray, MIT

11:25 **Response: David Finegold,** Rutgers University

11:30 Discussion among presenters and discussants

11:45 Questions from the steering committee and audience

12:00 p.m. Moderator reflections
Beth Bechky, University of California-Davis

12:10 ***Working Lunch***
The Globalization of Knowledge Work
Martin Kenney, University of California-Davis

Questions and discussion

1:20 ***Skill Demands in Growing Service Sector Jobs***
Peter Cappelli, University of Pennsylvania, moderator

Guiding Questions for Session

- How many people are employed in nonprofessional service sector occupations and how are these occupations projected to grow over the next decade?
- What are the strengths and weaknesses of the available research on skill demands of nonprofessional service-sector workers?
- What does qualitative research tell us about the skill demands of elder care occupations?
- What does the available research tell us about factors that may affect the future skill demands of service sector jobs generally, and elder care jobs in particular?
- In those settings where skill demands have increased, what types of skills are most in demand, including both technical and general/transferable skills?
- What are the implications for continuing education of current service sector workers, including elder care workers? What opportunities do they have to develop new skills, through internal job ladders and training systems or access to external education providers, such as community colleges?

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- What are the implications for K-12 education of future service workers?
- What are the implications for education of managers of service workers?

1:25 *Future Skill Demands of Service Work*
Mary Gatta, Rutgers University

1:40 **Response: David Autor,** MIT

1:45 *Future Skill Demands in Elder Care*
Chris Wellin, Miami University

2:00 **Response: Peter Kemper,** Pennsylvania State University

2:05 Discussion among presenters and discussants

2:25 Questions from steering committee and audience and general discussion

2:45 Moderator reflections
Peter Cappelli, University of Pennsylvania

2:55 *Break*

3:10 *Promising Methods for Studying Future Skills*

Guiding Questions for Session
- What questions about possible future skill demands can we answer now?
- What questions remain unanswered?
- What kinds of data and resources do we need to help answer questions about future skill demands?

Christopher Sager, University of Central Florida, moderator

3:15 *The Feasibility of Using O*NET Data to Study Changes Over Time in Workforce Skill Demands*
Suzanne Tsacoumis, Human Resources Research Organization

3:30 *Projecting the Impact of Computers on Work in 2030*
Stuart Elliott, Center for Education

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3:45	**Response: Kenneth Spenner,** Duke University
3:55	***Survey of Skills, Technology, and Management Practices*** **Michael Handel,** Northeastern University
4:10	**Response: Arne Kalleberg,** University of North Carolina-Chapel Hill
4:15	Discussion among presenters and respondents
4:30	Questions from steering committee and audience
4:45	Moderator reflections **Christopher Sager,** University of Central Florida, moderator
5:00	***Adjourn Day 1***

Friday, June 1

8:00 a.m.	***Working Breakfast: Discussion of Future Skill Demand***
	Arne Kalleberg, University of North Carolina, moderator
8:25	**Reflections on Emerging Skill Demand (from Day 1), Arne Kalleberg**
8:45	Panel discussion of skill supply and demand

Guiding Questions for Panel Discussion

- What is known about the future supply of skills in the United States (including demographic trends, trends in educational attainment, and immigration trends) and what remains unknown?
- Are there possible gaps or mismatches between projected future skill demands and the future skill supply, based on what is known?
- What is known about the dynamics of the labor market and the economy, including possible responses to any skill shortfalls and/or to any increases in the supply of skills?
- Are policy interventions (e.g., improvements in education, changes in immigration law) needed to balance skill supply and demand?

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Panelists

- **Peter Cappelli,** University of Pennsylvania
- **Harry Holzer,** Georgetown University and the Urban Institute
- **B. Lindsay Lowell,** Georgetown University

9:30 Questions from steering committee and audience

9:45 Moderator reflections
Arne Kalleberg, University of North Carolina

9:55 *Break*

10:10 *Implications for Education and Training*
David Finegold, Rutgers University, moderator

Guiding Questions for Panel Discussion

- What forms of education and/or workplace training are likely to be most effective in addressing future skills gaps or mismatches?
- Can we distinguish between skills that are best developed in education and those that are best developed on the job?
- How can research on future skill demands/skills gaps be used to inform curriculum development?
- If the supply of skills changes, independent of demand, will this affect the future design of jobs and the skills jobs require? (For example, will improving the science and math skills of the workforce lead to creation of more high-skill jobs?)

Panelists

- **Susan Traiman,** Business Roundtable
- **Peter McWalters,** Rhode Island Commissioner of Education
- **Paul Osterman,** MIT Sloan School of Management
- **Tom Bailey,** Columbia University

10:15 Opening comments from panelists (5 minutes)

10:35 Panel discussion

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11:00 Questions from steering committee and audience

11:15 Moderator reflections
David Finegold, Rutgers University

11:25 ***Lessons Learned and Next Steps***
Richard Murnane, Harvard Graduate School of Education, moderator

Guiding Questions for Session

- What have we learned over the past day and a half about the strengths and weaknesses of the available research on future skill demands?
- What support does the research provide for the proposition that future skill demands will be significantly higher than at present, either generally or within groups of jobs, such as knowledge workers and service workers?
- What support does the research provide for the proposition that major changes in education and training are required to meet future skill demands? What types of changes may be required?
- What questions remain unanswered, both about future skill demands and education and training required to meet those demands?
- What further research or studies are needed to answer these unanswered questions?

Moderator reflections
Richard Murnane, Harvard Graduate School of Education

11:40 ***Working Lunch and Steering Committee Reflections***

12:30 p.m. Audience questions, comments, and final observations

12:45 ***Adjourn***

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Appendix B

Professional and Service Occupational Clusters

TABLE B-1 Professional and Related Occupations Cluster

Standard Occupational Classification Code	Occupational Groups
15-0000	Computer and mathematical science occupations
17-0000	Architectural and engineering occupations
19-0000	Life, physical, and social science occupations
21-0000	Community and social services occupations
23-0000	Legal occupations
25-0000	Education, training, and library occupations
27-1000	Arts, design, entertainment, sports, and media occupations
29-0000	Health care practitioner and technical occupations

SOURCE: Hecker (2005).

TABLE B-2 Service Occupations Cluster

Standard Occupational Classification Code	Occupational Groups
31-0000	Health care support occupations
33-0000	Protective service occupations
35-0000	Food preparation and serving-related occupations
37-0000	Building and grounds cleaning and maintenance occupations
39-0000	Personal care and service occupations

SOURCE: Hecker (2005).

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Appendix C

Biographical Sketches of Planning Committee Members and Staff

Richard J. Murnane (*Chair*) is Juliana W. and William Foss Thompson Professor of Education and Society in the Graduate School of Education at Harvard University. He is an economist whose research focuses on the relationships between education and the economy, teacher labor markets, the determinants of children's achievement, and strategies for making schools more effective. His 1996 book, *Teaching the New Basic Skills*, coauthored with Frank Levy, explains how changes in the U.S. economy have increased the skills that high school graduates need to earn a middle-class living and shows how schools need to change to provide all students with the requisite skills. The 2004 book, *The New Division of Labor: How Computers Are Creating the Next Job Market,* by Murnane and Levy, explains how advances in computer technology are altering the distribution of jobs in the United States and the skills that are rewarded in the labor market. Murnane was appointed to the National Research Council's (NRC) Division of Behavioral and Social Sciences and Education in 1999 and was chair of the Center for Education Advisory Board from 2001 to 2006. He was elected to the National Academy of Education in 1990. He has a Ph.D. in economics from Yale University.

David Autor is associate professor of economics at the Massachusetts Institute of Technology and a faculty research fellow in the Program on Labor Studies and Education of the National Bureau of Economic Research. He is currently engaged in two research programs, one on the growth of labor market intermediation, and the other on job skill demands, technological change, and earnings inequality. He received a National Science Foundation

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CAREER award for his research on labor market intermediation and an Alfred P. Sloan Foundation fellowship. He has a B.A. in psychology with a minor in computer science from Tufts University (1989) and a Ph.D. in public policy from Harvard University's Kennedy School of Government (1999). Prior to obtaining his Ph.D., Autor spent three years directing efforts in San Francisco and South Africa to teach computer skills to economically disadvantaged children and adults.

Beth A. Bechky is assistant professor of management in the Graduate School of Management at the University of California, Davis. An ethnographer of work and occupations, she studies the work activities of professional, technical, and knowledge workers in order to understand the changing nature of postindustrial work and its theoretical and practical implications for how organizations are managed. Her recent studies have examined how workers in manufacturing use engineering drawings and prototype machines to solve problems, how film crew members learn and coordinate their work in temporary organizations, and how contract workers acquire jobs that stretch their skills in order to advance their careers. Her research is published in leading journals of management and sociology, including *Academy of Management Journal, Organization Science,* and *American Journal of Sociology*. She has a B.S. in industrial and labor relations from Cornell University and an M.A. in sociology and a Ph.D. in organizational behavior from Stanford University.

Peter Cappelli is the George W. Taylor professor of management at the University of Pennsylvania Wharton School and director of Wharton's Center for Human Resources. He is also a research associate at the National Bureau of Economic Research. He has been a guest scholar at the Brookings Institution, a German Marshall Fund fellow, and a faculty member at the Massachusetts Institute of Technology, the University of Illinois, and the University of California, Berkeley. He was a staff member on the secretary of labor's Commission on Workforce Quality and Labor Market Efficiency in 1988-1990 and codirector of the National Center on the Educational Quality of the Workforce of the U.S. Department of Education. At the NRC, he was a member of the Committee on Techniques for the Enhancement of Human Performance—Occupational Analysis and the steering committee of the Workshop on the Impact of the Changing Economy on the Education System. He was recently named by Vault.com as one the 25 most important people working in the area of human capital. He is a fellow of the National Academy of Human Resources, serves on the advisory boards of several companies, and is the founding editor of the *Academy of Management Perspectives*. He has a Ph.D. in labor economics from Oxford University, where he was a Fulbright scholar.

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David Finegold is dean of the School of Management and Labor Relations at Rutgers, the State University of New Jersey. Prior to joining Rutgers, he was a professor at the Keck Graduate Institute in Claremont, California, and at the Marshall School of Business of the University of Southern California. At the Keck Institute, he worked with biotechnology firms to identify skill demands and investigated the skills required in the temporary staffing industry. He is the author of numerous publications, including *Bioindustry Ethics* (2005) and *Are Skills the Answer? A Comparison of Education, Training and Employment Systems in Seven Industrial Countries* (1999). In summer 2006, he served as a special adviser to the Leitch review of skills, a government-mandated study of long-term skill needs in the United Kingdom. He has a Ph.D. in political science from Oxford University, where he was a Rhodes scholar.

Margaret Hilton (*Study Director*) is a senior program officer at the Center for Education. She has directed and contributed to several National Academies studies and workshops on K-12 and higher education, workforce skill demands, and continuing education. In 2003, she was guest editor of a special issue of *Comparative Labor Law and Policy*. Prior to joining the National Academies in 1999, she was a consultant to the National Skill Standards Board. Earlier, she directed projects on workforce training, employee involvement, and competitiveness at the congressional Office of Technology Assessment. She has a bachelor's degree in geography (with high honors) from the University of Michigan and a master of regional planning degree from the University of North Carolina, Chapel Hill, and she is currently studying for a master's degree in human resource development at George Washington University.

Arne L. Kalleberg is the Kenan distinguished professor of sociology and the senior associate dean for social sciences and international programs in the College of Arts and Sciences at the University of North Carolina, Chapel Hill. He also serves on the advisory board of the university's Center on Poverty, Work and Opportunity. Previously he was a professor of sociology at Indiana University, Bloomington. He is the author of numerous publications on topics related to the sociology of work, organizations, occupations and industries, labor markets, and social stratification. At the NRC, he was a member of the Committee on Techniques for the Enhancement of Human Performance—Occupational Analysis. He is the 2007-2008 president of the American Sociological Association. He has a B.A. from Brooklyn College and M.S. and Ph.D. degrees from the University of Wisconsin, Madison.

Christopher E. Sager is lecturer, Department of Psychology, the University of Central Florida. As an assistant professor of psychology at George Wash-

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ington University, he taught undergraduate classes in social psychology and industrial/organizational psychology and graduate classes in psychometrics and job performance modeling. At the American Institutes for Research, he worked on the development of the Occupational Information Network (O*NET), the occupational classification system that replaced the Dictionary of Occupational Titles and conducted a project for the Florida Department of Education to identify the skills that the state's youth need to succeed in Florida's changing economy. At the Human Resources Research Organization, he designed data collection and analysis procedures for elements of the ongoing O*NET occupational analysis effort, and led a future-oriented job analysis project for the U.S. Army designed to identify the characteristics that entry-level personnel will need to succeed in the 21st century. He has a Ph.D. in industrial/organizational psychology from the University of Minnesota.

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