Building America's Skilled Technical Workforce

DETAILS

258 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-44006-6 | DOI: 10.17226/23472

CONTRIBUTORS

Committee on the Supply Chain for Middle-Skill Jobs: Education, Training, and Certification Pathways; Board on Science, Technology, and Economic Policy; Board on Higher Education and Workforce; Policy and Global Affairs; Board on Science Education; Division of Behavioral and Social Sciences and Education; National Academy of Engineering; National Academies of Sciences, Engineering, and Medicine

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Committee on the Supply Chain for Middle-Skill Jobs:
Education, Training, and Certification Pathways

Board on Science, Technology, and Economic Policy
Board on Higher Education and Workforce
Policy and Global Affairs

Board on Science Education
Division on Behavioral and Social Sciences

National Academy of Engineering

A Report of
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported in part by the National Science Foundation under Grant No. DUE-1406910; Contract No. HHSH250200976014I/ HHSH25034024T with the Health Resources & Services Administration of the U.S. Department of Health and Human Services; Contract No. HHSP233201400020B/HHSP23337006 with the Administration for Children and Families of the U.S. Department of Health and Human Services; Contract No. DOL-OPS-15-P-00071 with the U.S. Department of Labor; and a grant from the Spencer Foundation; with additional support from the National Academy of Sciences W. K. Kellogg Foundation Fund. This study was also funded in part by a grant from JPMorgan Chase.

Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-44006-6
International Standard Book Number-10: 0-309-44006-8
Digital Object Identifier: https://doi.org/10.17226/23472
Library of Congress Control Number: 2017939638

Additional copies of this publication are available for sale from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Printed in the United States of America

Suggested citation: National Academies of Sciences, Engineering, and Medicine. 2017. *Building America's Skilled Technical Workforce*. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/23472.

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Fred Lestina, Senior Program Assistant
Erik Saari, Senior Program Assistant
Sujai Shivakumar, Senior Program Officer and Study Director

Preface

Skilled technical occupations—defined as occupations that require a high level of knowledge in a technical domain but do not require a bachelor's degree for entry—are a key component of the U.S. economy. The United States needs a workforce with the right mix of skills to remain competitive while fostering greater innovation and boosting shared prosperity.

In response to globalization and advances in science and technology, American firms are demanding workers with greater proficiency in literacy and numeracy, as well as strong interpersonal, technical, and problem-solving skills. However, employer surveys and industry and government reports have raised concerns that the nation may not have an adequate supply of skilled technical workers to achieve its competitiveness and economic growth objectives. American policy makers therefore need to consider whether they are creating the conditions that will encourage citizens to prepare for technically oriented, skilled jobs. The implementation of the recently reauthorized Workforce Innovation and Opportunity Act of 2014 represents an opportunity for federal, state, and local policy makers to make the U.S. system for workforce development more demand-driven and accountable.

In response to the broader need for policy information and advice, the National Academies of Sciences, Engineering, and Medicine convened the Committee on the Supply Chain for Middle Skilled Jobs to examine the coverage, effectiveness, flexibility, and coordination of the policies and various programs that prepare Americans for skilled technical jobs.[1] To carry out this charge, the committee undertook a review of the salient academic and evaluation literature, commissioned a series of papers on key topics, convened a national symposium, and consulted numerous experts to gather evidence and incorporate diverse viewpoints to inform its deliberations.

This consensus report, which provides the committee's conclusions and action-oriented recommendations for improving the American system of

[1]Although the committee's name includes the phrase "middle-skill," this report describes this workforce as "technically skilled," a term the committee determined to be a more appropriate designation (see Chapter 1).

technical education, training, and certification, is a result of this broad-based effort. It is the committee's hope that this report will guide policy makers and administrators, educators, employers, labor organizations, and other stakeholders in preparing Americans for well-paid technically skilled jobs that meet local and national needs to support a robust economy.

This study reflects a collaborative effort across several boards and program offices of the National Academies: the Board on Higher Education and Workforce, the Board on Science Education, and National Academy of Engineering Program Office. The study was led by the Board on Science, Technology, and Economic Policy (STEP).

ACKNOWLEDGMENTS

On behalf of the National Academies, the committee expresses its appreciation for the insights, experiences, and perspectives made available by the authors of the papers we commissioned and to the participants in the symposium and meetings we convened over the course of this study. We particularly recognize Margaret Polski for her assistance in preparing a draft of this report and in responding to the comments of reviewers. In addition, we thank Alicia Sasser Modestino for her valuable contributions to Chapter 2 of this report. We also recognize David Dierksheide, Fredric Lestina, and Erik Saari of the STEP staff, along with Rita Johnson, for their contributions to the report's preparation.

ACKNOWLEDGMENT OF REVIEWERS

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. 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 study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

We wish to thank the following individuals for their review of this report: Marilyn Barger, Hillsborough Community College; Crystal Bridgeman, Siemens Foundation; Ellis Cowling, North Carolina State University; Alicia Dowd, Pennsylvania State University; Miles Free, Precision Machined Products Association; Kevin Hollenbeck, W.E. Upjohn Institute for Employment Research; Melissa Kearney, University of Maryland; Livia Lam, Learning Policy Institute; Robert Lerman, American University; Daniel Marschall, AFL-CIO; Mary Alice McCarthy, New America Foundation; Darlene Miller, Permac Industries; Sanjay Rai, Montgomery College; Ursula Renolds, ETH Zürich;

James Stone, National Research Center for Career and Technical Education; Michelle Van Noy, Rutgers University; and Michael Wolf, Bureau of Labor Statistics.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Cora Marrett, University of Wisconsin, and Robert Sproull, University of Massachusetts. Appointed by the National Academies, they were 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 authoring committee and the institution.

Jeff Bingaman Sujai Shivakumar

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Abbreviations and Acronyms

AACC	American Association of Community Colleges
ACTE	Association for Career and Technical Education
ASAP	Accelerated Study in Associate Programs
ATD	Association for Talent Development
ATE	advanced technical education
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CBO	Congressional Budget Office
CPI	Career Pathways Initiative
CPS	Current Population Survey
CSW	Corporation for a Skilled Workforce
CTE	career and technical education
CUNY	City University of New York
CWS	Credentials for Work Survey
DoD	U.S. Department of Defense
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
ED	U.S. Department of Education
ESSA	Every Student Succeeds Act
FAFSA	Free Application for Federal Student Aid
FTE	full-time equivalent
FY	fiscal year
GAO	Government Accountability Office

HEA	Higher Education Act
HHS	U.S. Department of Health and Human Services
IT	information technology
JATC	Joint Apprenticeship and Training Committee
MIT	Massachusetts Institute of Technology
MOOC	massive open online course
NAEP	National Assessment of Educational Progress
NAF	National Academy Foundation
NASDCTEc	National Association of State Directors of Career Technical Education Consortium
NCES	National Center for Education Statistics
NGA	National Governors Association
NMI	National Manufacturing Institute
NSB	National Science Board
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
PCAST	President's Council of Advisors on Science and Technology
PIACC	Programme for the International Assessment of Adult Competencies
SHRM	Society for Human Resource Management
SOC	Standard Occupational Classification (System)
STEM	science, technology, engineering, and mathematics
TAA	Trade Adjustment Assistance Act
UCX	Unemployment Compensation for Ex-servicemembers
USCM	U.S. Conference of Mayors
USMAP	United States Military Apprenticeship Program
VET	vocational education and training
WIA	Workforce Investment Act
WIOA	Workforce Innovation and Opportunity Act
WLMIS	workforce labor market information system

Summary

The United States needs a skilled technical workforce to remain competitive in the global economy and to ensure that its workers participate in the nation's economic growth. There are significant opportunities as well as major challenges in this regard. Notably, rigorous evidence indicates that the returns to investments in technical skills in the labor market are strong when students successfully complete their training and gain credentials sought by employers. At the same time, the committee found that in many instances, workers either are not taking advantage of these opportunities or are failing to complete their training programs.

To understand why, it is necessary to recognize that in the United States, the responsibility for developing and sustaining a skilled technical workforce is fragmented across many groups, including educators; students; workers; employers; the federal, state, and local governments; labor organizations; and civic associations. For the system to work well, these groups need to be able to coordinate and cooperate successfully with each other.

Unlike most other advanced economies, the United States lacks formal mechanisms that require governments, educators, labor representatives, and employers to coordinate on workforce development policies and practices at the national level. In fact, workforce development in the United States is polycentric in nature, driven by a variety of private and public investments in workforce education and training. Workers often pay for on-the-job training through lower wages. Although employers and governments share an interest in developing and maintaining a robust skilled technical workforce, their respective investments often are uncoordinated. At the same time, public investments are guided by a complex and similarly uncoordinated set of policies associated with achieving similarly divergent goals related to economic development, education, employment, health and human services, and veterans' affairs. In this polycentric system, making better use of available resources and generating better outcomes requires improving coordination between students and educational or training institutions, between secondary and postsecondary institutions, and especially between training institutions and employers through a variety of public, private, and hybrid mechanisms.

The good news is that promising experiments currently under way across the United States can provide guidance for innovation and reform, although the scalability of some of these experiments has not yet been tested. As detailed in Chapter 6, evidence suggests that integration of academic education, technical training, and hands-on work experience improves outcomes and return on investment for students in secondary and postsecondary education and for skilled technical workers in different career stages.

The findings and recommendations presented below are designed to help overcome some of the barriers identified within the current framework of federal governance, state implementation, and market incentives. They address the key elements of the statement of task for this study. To the extent possible, the recommendations call for specific actions by Congress, federal agencies, state governments, employers, and civic organizations to improve the American system of workforce development.

FINDINGS

1. The skilled technical workforce includes a range of occupations that require a high level of knowledge in a technical domain, but many of these occupations do not require a bachelor's degree for entry.
2. Although widely used to describe this segment of the workforce, the term "middle skills" fails to capture the high value and dynamism of this segment of the U.S. workforce and is seen by some as having pejorative connotations. This label can deter students and workers from these occupations at every stage of their career.
3. To remain competitive in the global economy, foster greater innovation, and provide a foundation for shared prosperity, the United States needs a workforce with the right mix of skills to meet the diverse needs of the economy. Conversely, an insufficiently skilled workforce imposes significant burdens on the U.S. economy, including higher costs to workers and employers and lower economic productivity.
4. The evidence suggests that as a nation, the United States is not adequately developing and sustaining a workforce with the skills needed to compete in the 21st century.
5. It is difficult to find rigorous evidence on how well skilled technical labor markets are functioning at aggregate levels of analysis across the nation.
6. The nation is experiencing, and will continue to experience, imbalances in the supply of and demand for skilled technical workers in certain occupations, industry sectors, and locations. The nature of the problem differs across sectors and locations. These imbalances arise from multiple sources.
7. In the United States, educators, students, workers, employers, the federal government, state and local governments, labor unions, industry and trade

associations, and other civic associations all play a role in skilled technical workforce development.

8. Skilled technical workforce development in the United States is guided and supported by a complex and often uncoordinated set of policies and funds at the local, state, and federal government levels associated with achieving goals related to economic development, education, labor and employment, health and human services, and veterans' affairs. Most resources are allocated by formulas based on demographic factors, which serve as a proxy for need, rather than on performance, outcomes, or evidence of what works best in workforce development.
9. The incentives for students and employers to invest in skill development depend on the return on these investments.
10. Policy makers and participants in workforce development lack the information they need to adjust policies and make choices. User-friendly tools that provide direct access to information about options and performance can assist labor market participants in their decision-making processes.
11. Several strategies and initiatives show promising results by improving rates of successful completion of education and training and by coordinating education and training opportunities with employer needs. These experiments, which link the different parts of the ecosystem for workforce education and training, could be instructive for designing and enforcing policy and allocating resources within appropriate contexts.
12. The Armed Services, one of the largest employers in the United States, could do a better job of assessing employment transition risks for military personnel, and designing and delivering services to mitigate these risks. They could also coordinate better with civilian policy makers, regulators, and educators to improve the transferability of military education, training, and certification.
13. Policies and governmental structures used to support education and training in such countries as Germany and Switzerland may not be directly applicable in the United States because of differences in political and economic structures. However, applicable lessons can be learned from specific programs or innovative educational techniques, and policy makers in the United States can benefit from more rigorous cross-country comparisons.

RECOMMENDATIONS

1. State and federal policy makers should support and enhance strategies that help students successfully complete their training for the skilled technical workforce. In addition, public policies should ensure that stakeholders, including students, workers, employers, and educational organizations, have

the right incentives to improve the quality of technical education and training, encourage experimentation and collaboration, and improve the collection and use of relevant information.

2. An alliance of industry, trade, academic, and civic associations and labor unions, in cooperation with the U.S. Departments of Labor and Education, should organize a nationwide public–private communication campaign to raise awareness of the value of and demand for skilled technical workers and the return on investment for individuals preparing for these careers. This campaign should be customized to recognize local variations in skilled technical workforce education, training, and labor market requirements.
3. Congress and state legislatures should improve oversight of public policies and resources, highlighting the implementation of reforms such as those called for in the Workforce Innovation and Opportunity Act (WIOA). Reforms should be accelerated through targeted incentives.
4. Congress, state legislatures, and agencies of the federal and state governments should improve the workforce labor market information system (WLMIS), labor market data, and research tools and methods, including by providing funding for such activities.
5. Federal and state agencies should remove barriers to worker mobility, such as licensing and certification requirements that are not related to public safety. They also should improve labor market information on the changing requirements for skilled technical workers to help reduce imbalances in labor markets and to align workforce development with advances in science and technology.
6. The Department of Defense should further integrate skills transition into military training rather than treating it as a separate component at the end of the service member's career.
7. While selected programs and policies from other countries have been adapted in the United States, federal agencies should further study the conditions under which particular attributes of apprenticeships or other programs can be effectively applied more broadly.

1

The Skilled Technical Workforce Development Challenge

The United States needs a skilled technical workforce to compete in the global economy and to sustain a high standard of living for its citizens. If the nation does not adequately develop and sustain this skilled workforce relative to what is needed, the consequences will be seen in lower productivity, falling revenues, and fewer job opportunities for Americans. Addressing this workforce development challenge requires understanding the scale and dynamics of the skilled technical workforce, as well as the complex and rapidly changing environments within which Americans provide and acquire skills and training for the jobs of the future.

1.1 KEY CHALLENGES FOR DEVELOPING A SKILLED TECHNICAL WORKFORCE

Globalization and scientific and technological change are affecting nearly every aspect of modern life, from how people communicate with each other to how they shop, how they make things, and how and where they work. As artificial intelligence and advanced robotics become ubiquitous, substantial changes are likely in the nature and character of work as humans find new ways to work symbiotically with the machines they have created and as machines increasingly work autonomously (see, for example, Brynjolfsson and McAfee [2014] and Frey and Osborne [2013]). As a 2017 report by McKinsey & Company (2017, p. 3) concludes, "Individuals in the workplace will need to engage more comprehensively with machines as part of their everyday activities, and acquire new skills that will be in demand in the new automation age." Adapting to this new world, American employers are demanding workers with greater proficiency in literacy and numeracy and strong interpersonal, technical, and problem-solving skills.

Many employers report experiencing difficulty finding skilled workers, although some employers may be using inappropriate screening criteria, such as requiring a 4-year degree for jobs that do not require this credential. At the same time, many students either are unaware of well-paying jobs available for skilled workers or shy away from training opportunities because of a lack of basic math or science skills. This reported shortage of skilled workers raises questions about the role of postsecondary credentials, the value of technical skills, and whether the U.S. education and workforce development systems are meeting the skills development challenge. It also raises questions about whether labor markets have the incentives and information to function properly.

While this report examines these challenges in depth, it also presents evidence in Chapter 6 that integrating academic education, technical training, and hands-on work experience produces better outcomes and return on investment for all students in elementary, high school, postsecondary, and continuing education. Moreover, a growing body of research on promising initiatives under way across the United States can be instructive for designing and implementing supportive policies and for allocating resources across organizations and programs.

1.2 THE IMPORTANCE OF SKILLS

Over the past decade, policy makers and employers have been concerned that advances in science and technology, slower population growth, and the retirement of the baby boom generation would lead to a shortage of skilled labor. These developments have important implications for the economy, society, workers, and employers.

For the economy, a skilled workforce is necessary to grow employment, output, and productivity (Lerman, 2015). If employers cannot hire workers with the right skills, they cannot produce enough of the higher-value products and services in the United States that are associated with sustained innovation and growth. Employers may then relocate or cease to operate.

For society, a skilled workforce is linked with better public and fiscal outcomes. As Figure 1-1 shows for the example of literacy skills, inequality in skills is associated with inequality in income, which creates pressure on public order and public programs. For instance, if a low-skilled workforce leads to slow economic growth and declining tax revenues, government budgets will be strained as a larger share of the population retires and draws on public programs such as Social Security and Medicare. Figure 1-1 also shows that citizens with low skill levels tend to report poorer health, lower levels of civic engagement, and less trust relative to those with higher skill levels (OECD, 2013).

For individual workers, higher skill levels are necessary to compete for increasingly skill-intensive jobs and higher wages, and are associated with a

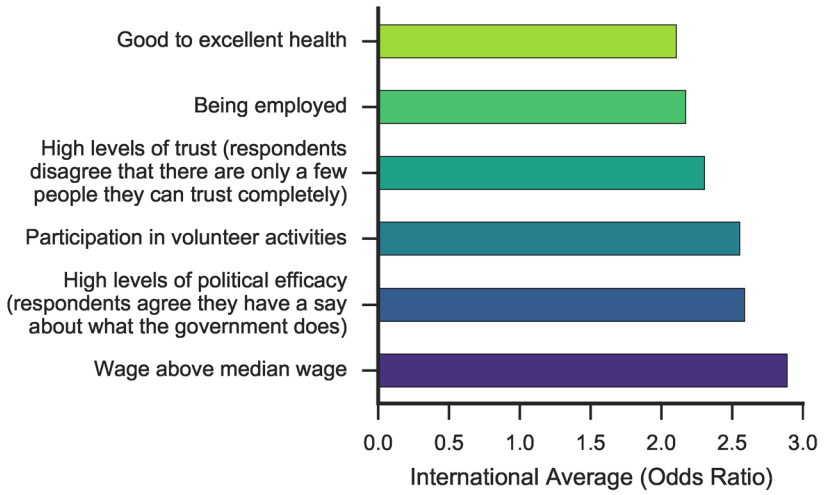

FIGURE 1-1 Likelihood of positive social and economic outcomes among highly literate adults.
NOTE: The figure shows the increased likelihood (odds ratio) of adults scoring at level 4/5 in literacy reporting high wages, high levels of political efficacy, participation in volunteer activities, high levels of trust, being employed, and having good to excellent health relative to those scoring at or below level 1 in literacy (adjusted). Odds ratios are adjusted for age, gender, educational attainment, and immigrant and language background. High wages are defined as workers' hourly earnings above the country's median.
SOURCE: OECD, 2012b, Graph II.1.1.

wide range of better outcomes. A recent cross-country survey of adult skills by the Organisation for Economic Co-operation and Development (OECD) Programme for the International Assessment of Adult Competencies found that skills have a major influence on life choices and outcomes: lower-skilled workers have fewer opportunities in many areas of life and are increasingly likely to be left behind. In an innovative economy, workers must continually upgrade their skills. Those with technical skills need to determine how best to maintain their employability, pursue career advancement, and respond to unexpected changes in demand for their current skill set. Low skill levels make it more difficult for workers to attain additional education or training when structural changes require adaptation to new methods and processes (OECD, 2013).

For employers and firms, a skilled workforce is needed to adapt to rapid technological changes. Assessment, analysis, and communication of information and action are now conducted with a wide range of software applications using personal computers, smartphones, and the Internet. As employers increasingly automate tasks and incorporate artificial intelligence in standard operating

procedures and decision-making processes, the capacity of workers to use these tools to manage tasks is becoming essential in most occupations and jobs.

The demand for a skilled technical workforce is changing so rapidly that workers, employers, educators, policy makers, and civic organizations need to be highly flexible and forward looking. Likewise, the nation's approach to workforce development and skills acquisition must also adapt to changing realities at the federal, state, and local levels. Although some skilled technical jobs in such occupations as production and transportation are being eliminated through automation and outsourcing, others are in high demand. These latter jobs, which require the ability to use new technologies, can be found in growing industries associated with health care, advanced manufacturing, and information technology. Many skilled technical jobs require postsecondary credentials below the 4-year degree, yet they provide competitive salaries and benefits, as well as the opportunity to advance to even better positions. With sufficient information and resources, these jobs could be filled by people with high-quality education and training provided by community colleges, career and technical education programs, apprenticeships, and a growing number of web-based educational programs.

As American policy makers work to tackle the challenges of social and economic development, then, they must consider whether they are creating the conditions that will prepare citizens for skilled technical jobs. These jobs require problem solving and a broad range of competencies in addition to occupation-specific technical competencies. Box 1-1 lists the general set of worker competencies identified by the U.S. Department of Labor.[1]

With the implementation of the recently reauthorized Workforce Innovation and Opportunity Act of 2014, policy makers at all levels are expected to make the U.S. workforce development system more demand-driven and accountable. Tackling these challenges requires that policy makers

- understand current trends in the level and distribution of skills in the adult working-age population;
- determine the adequacy of the supply of skilled workers to meet the changing demand for skills driven by social, technological, and economic requirements;
- ensure that individuals can develop and maintain the necessary skills and adapt positively to social and economic change; and
- create the conditions that forge strong, positive linkages between skill acquisition and social and economic outcomes.

[1]A recent report of the National Academies of Sciences, Engineering, and Medicine (NRC, 2012) elaborates on the types of skills and learning required to be successful in the 21st century.

BOX 1-1
An Array of Skills and Competencies

The following is the general set of worker competencies identified by the U.S. Department of Labor's Competency Model Clearing House:

- **Personal skills.** These include interpersonal skills, integrity, initiative, dependability, reliability, adaptability, flexibility, and lifelong learning.
- **Academic competencies.** These include basic academic skills such as reading, writing, and mathematics; advanced knowledge and skills in science and technology relevant to the occupation; and critical and analytical thinking.
- **Workplace competencies.** These include understanding the big picture of the organization, such as inputs, throughputs, and outputs; teamwork and collaboration; customer focus; planning and organizing; problem solving and decision making; working with tools and technologies; scheduling and coordination; and checking, examining, and recording.
- **Industry-wide technical competencies.** These are the knowledge, skills, and abilities associated with a particular industry, such as health care or manufacturing. They are cross-cutting competencies common to most occupations within the industry. These competencies typically relate to comprehension, awareness, or analysis.
- **Occupation-specific technical competencies.** These are the knowledge, skills, and abilities associated with particular occupations, such as emergency medicine or automotive manufacturing technicians.

SOURCE: Competency Model Clearing House, 2015.

1.3 STUDY CHARGE, SCOPE, AND APPROACH

Recognizing the challenges outlined above, the National Academies of Sciences, Engineering, and Medicine convened the Committee on the Supply Chain for Middle-Skill Jobs to examine the coverage, effectiveness, flexibility, and coordination of programs that prepare Americans for skilled technical jobs. In carrying out its charge, the committee considered such topics as gaps in coverage and fluctuations in the labor market, the current and preferred public- and private-sector roles in financing and providing employment training and skills certification, and the incentives and information resources available for individuals to improve their work skills (see Box 1-2).

BOX 1-2
Statement of Task

An ad hoc committee will examine the coverage, effectiveness, flexibility, and coordination among the nation's programs to prepare Americans for technically oriented, skilled positions in the workforce demanding non-routine problem solving but not requiring a baccalaureate or higher degree. This system includes apprenticeship programs of schools, unions, and employers; high school Career Technical Education programs; advanced technical education and training in community colleges and for-profit colleges; employer-financed and -provided training; federal education and training programs; state learning exchanges; public-private employment training partnerships; and licensing and skills certification.

Among the topics the committee will consider are the gaps in coverage and market failures in this part of the labor market, the current and preferred public- and private-sector roles in financing and providing employment training and skills certification, and the incentives and information for individuals to improve their work skills. The committee will also consider selected employment preparation practices in other countries (e.g., European apprenticeship programs) and of foreign-headquartered firms and their relevance to the U.S. labor market.

In addition to reviewing and synthesizing the existing social science and program evaluation literature, the committee will commission papers and organize a national symposium bringing together researchers, industry representatives from diverse sectors, policy makers, and other stakeholders involved in technical workforce education and training. Based on its understanding of the evidence and experience, the committee will write a report with conclusions and action-oriented recommendations.

During its first meeting, in February 2015, the committee highlighted 11 key areas of analytical attention and identified capable researchers to prepare detailed reviews of the existing literature and practices in these areas. Box 1-3 provides a list of the papers commissioned for this study. Collectively, these papers provide comprehensive coverage of salient definitions, labor market dynamics, pathways and pipelines, the role of community colleges, the role of employers, apprenticeship programs, federal workforce development programs, pathways to skilled technical allied health care occupations, veteran unemployment benefits and transition assistance, information resources, and competing on innovation.

In addition to commissioning this research, the committee organized a national symposium, held in June 2015, that brought together researchers, representatives from various industry sectors, policy makers, and other stakeholders involved in technical workforce education and training (NASEM, 2015). The agenda for this meeting is presented in Appendix A. During the symposium, the commissioned papers were presented by their authors and

BOX 1-3
Papers Commissioned for This Study

- Jonathan Rothwell, The Brookings Institution: "Defining Skilled Technical Work"
  This paper helps frame how skilled technical workers should be defined and analyzed, with an emphasis on the skills that distinguish them from those in less advanced occupations.

- Alicia Sasser Modestino, Northeastern University: "Middle Skill Workers in Today's Labor Market"
  This paper provides a framework for analyzing the potential mismatch between the supply of and demand for skilled technical workers over the next two decades. The goal is to understand the magnitude of the problem, as well as the efficacy of alternative approaches aimed at addressing the skills gap.

- David Stern, University of California, Berkeley: "Pathways or Pipelines: Keeping High School Students' Future Options Open While Developing Technical Skills and Knowledge"
  This paper describes work-related education in high schools, and offers suggestions about the role of high school programs in the supply chain for jobs that do not require a baccalaureate or higher degree.

- Melinda Mechur Karp, Columbia University: "Community College Pathways"
  This paper examines sub-associate degrees offered by community colleges, both in terms of their stand-alone impact and in terms of their connection to a broader education and training system.

- Robert L. Lerman, Urban Institute, American University, and IZA: "Are Employers Providing Enough Training? Theory, Evidence, and Policy Implications"
  This paper examines the types and amounts of skill development, especially employer-sponsored training, that are taking place in the United States.

- Andrea Messing-Mathie, Northern Illinois University: "Apprenticeship Pathways to Skilled Technical Jobs"
  The focus of this paper is on the potential for expanding apprenticeship as part of the development of career pathway systems, particularly for young people, as they transition from secondary into postsecondary institutions and/or careers.

(Continued)

BOX 1-3
Continued

- Carolyn J. Heinrich, Vanderbilt University: "Federally Funded Workforce Development"
  This paper describes evolving administrative and organizational structures of the federal workforce development system. The paper also examines the Workforce Innovation and Opportunity Act of 2014 (WIOA) and the opportunities this law presents for improving system structures, aligning incentives, and strengthening program coordination and effectiveness.

- Bianca K. Frogner and Susan M. Skillman, University of Washington: "Pathways to Middle-Skill Allied Health Care Occupations"
  This paper explores the education and training pathways to skilled technical occupations in allied health care, which generally require less than a bachelor's degree for entry.

- Susan Payne Carter and Brian J. Miller, U.S. Military Academy: "Analysis of Army Veteran Unemployment Benefits and Transition Assistance"
  This paper analyzes how the incentives created by the Unemployment Compensation for Ex-Service Members (UCX) program affects how the program is used to facilitate ex-service members' transition back into the civilian labor market.

- Andrew Reamer, George Washington University: "Information Resources to Facilitate Middle Skills Workforce Development"
  This paper begins with a summary of the types of labor market participant decisions that require good information, follows with an overview and assessment of currently available information resources, and then offers recommendations for enhancing these information resources.

- Robert G. Sheets, George Washington University, and Jason A. Tyszko, U.S. Chamber of Commerce Foundation: "Competing on Innovation: Implications for Building the Middle-Skill Talent Pipeline"
  This paper proposes that to compete on innovation, it is necessary to rethink how high schools, community colleges, and universities could potentially partner with employers to provide more cross-functional and interdisciplinary experiences.

SOURCE: http://nas.edu/SkilledTechnicalWorkforce.

discussed by a diverse set of experts. The papers were revised based on the discussion at the symposium and later posted on the National Academies study website.[2]

The committee convened a further four times in 2015 and 2016 to gather additional evidence from experts on topics including the scope and nature of applicable federal legislation, the role of state programs and policies, the value of online learning technologies, impediments to transitioning military personnel into the civilian skilled technical workforce, and the challenges facing efforts to collect data on the market for skilled technical workers. The agendas for these meetings are presented in Appendix A. These meetings were supplemented by further research on the academic and policy literature.

As the committee learned more about current workforce development issues, its thinking about the nature of the workforce development challenges evolved. This evolution, which has important implications for the committee's findings and recommendations, included refining its definition of the workforce, and rethinking the nature of the policy problem and the feasible set of approaches to addressing related issues and challenges.

1.4 DEFINING THE WORKFORCE

As a first step in developing its findings and recommendations, the committee refined its conception of the segment of the workforce addressed by this study and decided to refer to it as the "skilled technical" rather than "middle-skill" workforce. The committee determined that the term "middle-skill," which has been widely used to describe skilled technical occupations, fails to capture the high value and dynamism of this segment of the U.S. workforce. Some participants in the June 2015 symposium also observed that the term "middle-skill" is perceived by some to have pejorative connotations. This view may make some students reluctant to obtain training for these jobs because of a stigma attached to "middle-skill" jobs and related educational pathways and careers.[3] Industry experts at the symposium noted that such

[2]A webcast of the symposium, research papers, and presentations can be found at http://nas.edu/SkilledTechnicalWorkforce.

[3]According to Jeff Strohl, director of research at Georgetown University's Center on Education and the Workforce, "Sub-baccalaureate education suffers the stigma of the vocational-technical high school. That's where other people's kids went. People see those programs as tracking into something that's dead end." In fact, he says, "It's very clear that that perception does not hold up" (see Marcus, 2013). The impact of social perceptions on career choices is also discussed in Holzer (2015b).

negative perceptions may limit the ability to attract workers to skilled technical jobs.[4]

After reviewing a number of different definitions and approaches to measuring the skilled technical workforce, the committee adopted the following definition: "The occupation requires a high level of knowledge in a technical domain, and it does not require a bachelor's degree *for entry*." Using this definition of skilled technical work, Rothwell (2015) estimates that in 2014, there were 16.1 million skilled technical workers in the United States, collectively representing 11.9 percent of the total U.S. workforce.

The committee noted that some analysts use slightly different definitions of and analytical approaches to measuring the skilled technical workforce, and therefore derive different estimates of its size. Box 1-4 provides an overview of the estimation challenges, which are discussed in more detail in Chapter 2.

Rothwell (2015) reports that although skilled technical workers are found in most occupation groups, 82 percent are concentrated in the areas of installation, maintenance, and repair; health care; construction and extraction; and production (see Figure 1-2). The remaining 18 percent are employed in computer and mathematical occupations (5 percent), architecture and engineering (4 percent), and 16 other occupations in a wide range of categories (9 percent). The labor markets for each of these occupations are quite different, as discussed in more detail in Chapter 2, because they are all affected by local rather than aggregate changes in demographics, technology, and educational and economic opportunities.

More detailed analyses of the nature of skilled technical work led the committee to emphasize that a simple cutoff of education or salary levels is an inadequate basis on which to define these jobs. While skilled technical jobs are often described as requiring some postsecondary education and training but less than a 4-year college degree, Rothwell (2015) found that there is considerable variation in education and training among these workers (Holzer and Lerman, 2007). He estimated that most workers in these occupations hold some form of postsecondary certification but do not hold a 4-year degree. However, his estimates indicate that 31.9 percent of workers in skilled technical occupations have a high school diploma or less, 18.7 percent have a bachelor's degree or higher, and about 15 percent have a 2-year degree. Relative to the average worker, the middle-wage occupations have a higher rate of bachelor's degree attainment and a similar rate of high school diploma or lower attainment. Finally, it appears that skilled technical workers receive significantly more on-the-job training and have more work experience relative to the average worker.

[4]The Manufacturing Institute has pursued the "Dream It. Do It." campaign in an effort to "overcome the negative stigma that a career in manufacturing is a dirty, low-wage job" (see The Manufacturing Institute, 2015).

BOX 1-4
Estimation Challenges

One of the committee's first tasks was to define and identify skilled technical occupations and then describe the characteristics of workers in those occupations. In a paper commissioned by the committee, Jonathan Rothwell describes the strengths and limitations of several approaches that use various proxies to estimate the skill level of a given job (Rothwell, 2015). Researchers have typically used either a relative or absolute ranking to determine skill level based on either education or wages. For example, relative rankings classify occupations by skill level from lowest to highest and then use cutoffs at specific percentiles of the distribution to determine what falls in the middle (e.g., occupations falling into the 20th to 80th percentiles).[a] By contrast, absolute rankings of skilled technical jobs use predefined skills criteria for specific jobs (e.g., education beyond high school but less than a 4-year degree) and then categorize occupations accordingly.[b] Both methods rely on the characteristics of incumbent workers (e.g., either education or wages) to categorize occupations.

Rothwell notes that it may be misleading simply to use wages or educational requirements as an indicator to identify skilled technical jobs. Workers in the middle of the wage distribution may be relatively unskilled but compensated well. Similarly, low-wage workers may be relatively skilled but subject to downward wage pressure because of changes in international competition or technology. Using educational requirements is also troublesome because there is potentially large variation in the technical skills of people who have acquired similar levels of education.

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[a]For example, Autor and colleagues (2006) sorted (three-digit) occupations into percentiles by mean years of schooling in 1980 using data on incumbent workers in those jobs. Alternatively, Autor (2010) used the average wage of workers in 1980 as a proxy for skill to classify occupations at the three-digit level and subsequently examine employment and wage trends.

[b]For example, Holzer and Lerman (2009, p. 1) argue: "Classifying occupations into a few skill categories is awkward, given the many elements of skill required for most jobs. Under an approach that classifies jobs based on education and training levels, 'middle-skill' jobs are those that generally require some education and training beyond high school but less than a bachelor's degree. These postsecondary education or training requirements can include associate's degrees, vocational certificates, significant on-the-job training, previous work experience, or some college, but less than a bachelor's degree."

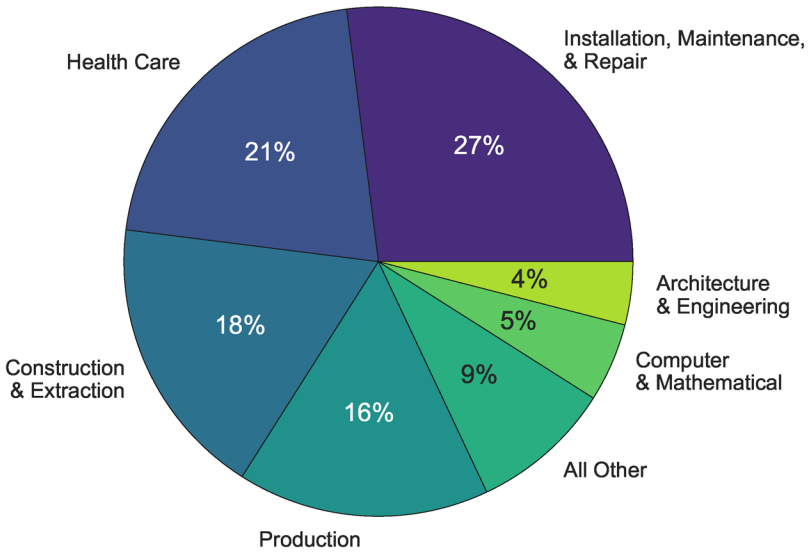

FIGURE 1-2 Skilled technical workers by major occupational group.
SOURCE: Committee's compilation based on Rothwell (2015, Table 3).

1.5 STRUCTURE OF THE SYSTEM FOR U.S. SKILLED TECHNICAL WORKFORCE DEVELOPMENT

The committee's investigation of the distributed structure and wide-ranging scale of the system for skilled technical workforce development—presented in Chapter 4—challenged assumptions that a single set of policy recommendations or reforms can address workforce development issues in the United States. As Figure 1-3 shows, the American system for skilled technical workforce development encompasses two broad components. The first is public and private academic and career and technical education and training in grades K-12, which are governed by more than 98,000 public schools in more than 18,000 public school districts, as well as more than 30,000 private schools. The second component is postsecondary skilled technical workforce development, which is equally complex. Its primary elements are degree-granting programs governed by 4,207 public and private institutions scattered across 50 states, an unknown number of certificate programs, an unknown number of certification

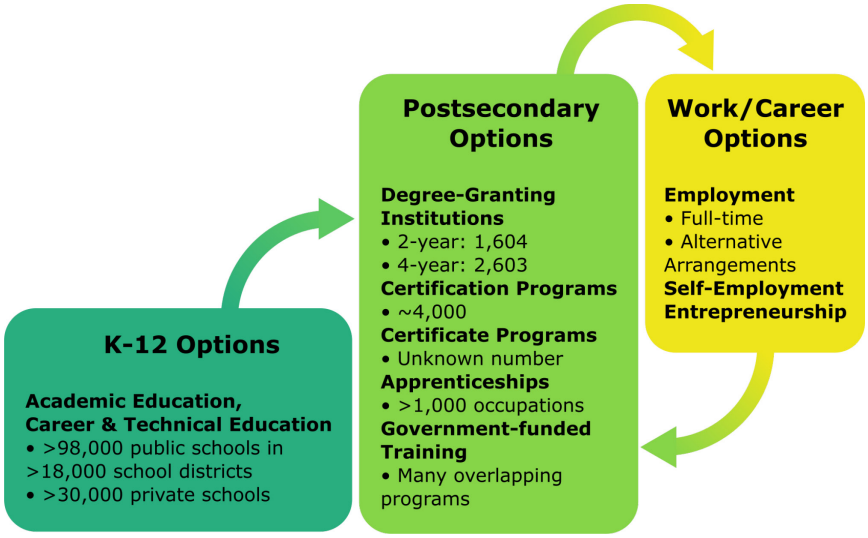

FIGURE 1-3 Overview of the components of U.S. system for skilled technical workforce development.
SOURCE: Committee's compilation.

programs governed by an estimated 4,000 certification entities, registered civilian apprenticeship programs for more than 1,000 occupations, and many overlapping government-funded training programs.

As Figure 1-3 shows, work/career options are similarly varied and include regular full-time employment, alternative and contingency work arrangements, self-employment, and entrepreneurship. In addition, as the reverse arrow in Figure 1-3 indicates, American workers can and do continue their education and training throughout their work lives, cycling back through postsecondary education and training to pursue alternative occupations, expand their knowledge and skills, maintain and expand their credentials, and retrain as advances in science and technology are disseminated into the workplace.

1.6 A NETWORK-CENTERED APPROACH

Understanding and making recommendations for improving the nation's skilled technical workforce amid a complex and rapidly changing market is a considerable challenge. In addressing this challenge, the committee sought to take advantage of the diversity of experience across the nation and the efforts of many business leaders, educators, labor organizations, and policy makers to integrate academic education, technical training, and hands-on work experience to produce better outcomes for students, workers, businesses, and states and regions (see Box 1-5 for an example). In this regard, Chapter 6 presents

BOX 1-5
Building a Network of Solutions—An Example

In his September 2015 presentation to the committee, Dale Allen of Quinsigamond Community College (QCC) in Worcester, Massachusetts, described how his institution is building robust relationships with K-16 partners, industry, universities, regional government, and other community organizations to build a robust workforce development system in his region. Key features of the strategy he described include the following:

- **Collaborating with industry.** In addition to seeking industry input to meet industry demand, QCC partners with the regional offices of the federal Manufacturing Extension Partnership (MEP) program, the state's Workforce Investment Boards (WIBs), local cluster associations, business incubators, and the National Science Foundation's (NSF's) Advanced Technical Education (ATE) programs, among others, to identify workforce development needs.
- **Redesigning education and training delivery.** This includes developing an industry-aligned curriculum and bridging courses with internships, apprenticeships, and job training to meet regional labor market demands.
- **Leveraging technology.** This includes making available customized software applications or "apps" that combine real-time data on the labor market drawn from federal, state, and local sources. Students, local firms, and educational institutions can use this information directly to weigh alternatives and guide career and investment decisions.

evidence that schools that combine high-quality career and technical education programs with a college preparatory curriculum are more effective in preparing students for both employment and postsecondary education (see, for example, Clark et al., 2007). A growing body of research on a variety of promising experiments under way across the United States—also described in Chapter 6—is instructive for designing and implementing supportive policies and for allocating resources across organizations and programs.

Accordingly, the committee has sought to draw attention to the importance of growing the rich set of networks among the various actors, as well as the significant challenges they face in making decisions and working cooperatively in the absence of sufficient information and trust. These challenges are cataloged in Chapter 5. For example, a lack of information on job opportunities available in their region may lead community college students to select courses that do not adequately equip them with the skills demanded by local firms. In turn, firms in a regional industry may need to determine how to share investments in worker training in ways that can also produce sufficient private returns. In other cases, prevailing rules and norms may lead to incentives that foster suboptimal outcomes. For example, some community colleges operate within state funding

formulas that support enrollment rather than course completion (Altstadt, 2012). In another example, transition assistance provided by the military to its retiring service members to help them adjust to the civilian workforce may be misapplied as a form of unemployment benefit (Payne Carter and Miller, 2015).

In addressing its task to review the "effectiveness, flexibility, and coordination among the nation's programs," the committee has highlighted the diversity of approaches available to students, guidance counselors, workers, business owners, manufacturers, labor leaders, school administrators, and community college teachers and others for working together to create local solutions that address their workforce challenges. To support and complement these activities, the committee calls for specific actions by Congress, federal agencies, state governments, employers, and civic organizations to improve the nation's polycentric system of workforce development.

1.7 ORGANIZATION OF THIS REPORT

The committee began its work by reviewing existing efforts to standardize education and training in the United States, hearing from experts who recommended further standardization. Chapter 2 takes a closer look at the patterns and trends emerging from the current structure of the labor markets for skilled technical occupations.

A wide range of structural factors affect these trends and patterns in workforce development. They begin with child care, nutrition, and the quality of primary education, and extend to working opportunities and living conditions and the quality and quantity of postsecondary education and training. Workforce policies at the federal and state levels, which are described in Chapter 3, and the components of the workforce development system, which are described in Chapter 4, further influence the character and performance of the skilled technical workforce in significant ways. These policies and components, which are controlled and funded primarily at the local level, are in turn shaped by local social and economic structures and conditions.

A diversity of actors also is involved, including local educators, students, workers, employers, industries, associations, labor organizations, agencies of the federal government, state and local governments, and civic associations, all of which play a role in developing the nation's skilled technical workforce. These actors operate in complex environments, and they often have slightly different and sometimes competing priorities and incentives. Many of the workforce development challenges, discussed in Chapter 5, reflect significant coordination problems within and across these diverse groups of actors. In contrast, Chapter 6 provides examples of notable local strategies and initiatives aimed at

overcoming these challenges to training skilled technical workers. Chapter 7 concludes with a summary of the committee's findings and recommendations for policy and program design to enhance the nation's skilled technical workforce.

2

Labor Market Patterns and Trends

In its most recent employment projections for 2014-2024, the Bureau of Labor Statistics (BLS) reports that 5 of the 15 fastest-growing occupations will require some level of postsecondary education but will not require a bachelor's degree (BLS, 2015, Table 3). Occupations that typically require postsecondary education for entry are expected, on average, to grow faster than occupations that require a high school diploma or less. However, growth rates can be misleading because some fast-growing occupations employ very few workers. For example, one of the fastest-growing occupations is biochemical engineer, but the expected increase in the number of these jobs is among the smallest of all occupations. Some analysts argue that the trend is for a "hollowing-out" of the workforce, in which high-skill occupations requiring a minimum of a 4-year degree and low-skill occupations requiring a high school diploma or less continue to grow, but skilled technical occupations shrink (see, for example, Acemoglu and Autor, 2010; Autor, 2010; Autor and Dorn, 2013; Autor and Price, 2013; Autor et al., 2003; Levy and Murnane, 2013).

This chapter turns to the question of whether the U.S. supply of skilled technical workers adequately meets demand now and in the foreseeable future. The first section looks at evidence of possible gaps and imbalances in specific skilled technical occupations, industries, and locations. The second section examines local and sectoral trends in the demand for and supply of technical skills. To understand better the policy issues affecting skilled technical labor markets, the next two sections review the dynamics in two sectors with high numbers of skilled technical occupations—health care and manufacturing. These sectors also serve as examples of how advances in science and technology can affect skilled technical labor markets. Providing an international perspective, the chapter then addresses how information and communication technologies are changing how work is organized and performed in Organisation for Economic Co-operation and Development (OECD) and partner countries. The Survey of Adult Skills conducted by OECD's Programme for the International Assessment of Adult Competencies (PIAAC) reveals that shortages of and gaps or mismatches in skills are common across the countries studied, suggesting the

need for a more comprehensive analysis of the demand for and use of skills. The final section presents conclusions.

2.1 THE SUPPLY OF AND DEMAND FOR SKILLED TECHNICAL WORKERS

Recent surveys show that the demand for higher levels of workforce skills has increased over time and is likely to continue to do so. As Figure 2-1 shows, some analysts estimate that the demand for nonroutine skills in the United States rose during the period 1960-2009, while the demand for routine skills fell. However, these estimates include the demand for a wide range of skills—from those that require some postsecondary preparation but less than a baccalaureate credential to those that require doctoral and postdoctoral education and training. An increasing demand for higher-skilled workers does not necessarily provide evidence of the need for skilled technical workers.

Citing a 2010 study by Carnevale and colleagues of Georgetown University that looks specifically at the demand for skilled technical workers,

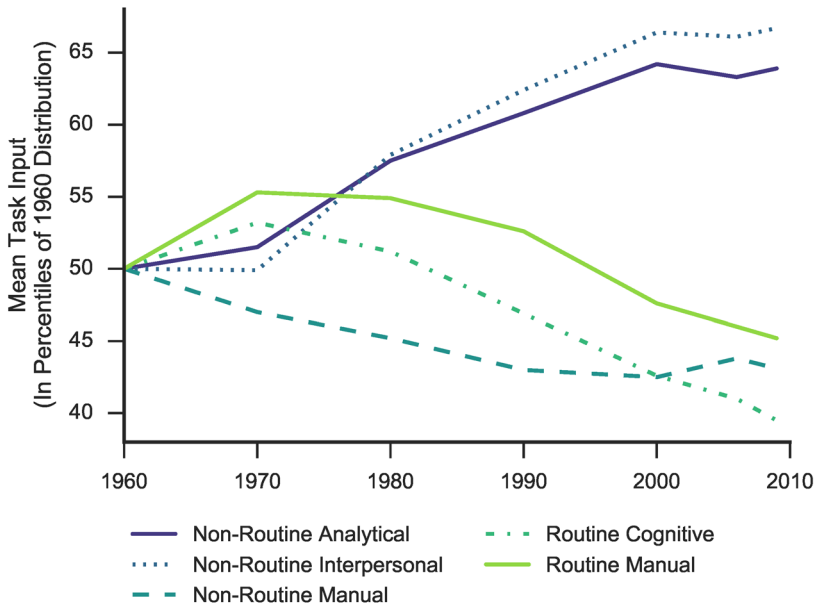

FIGURE 2-1 Change in demand for skills: Trends in routine and nonroutine tasks in occupations, United States, 1960-2009.
NOTE: The authors assigned task scores to each worker on the basis of his or her reported Census Occupation Category.
SOURCE: Autor and Price, 2013, p. 5.

the National Governors Association (NGA) Center for Best Practices warned that of the 48 million job openings projected through 2018, 63 percent will require some postsecondary education, while only 42 percent of the current workforce has an associate's or higher degree (Hoffman and Reindl, 2011). The NGA estimated that the nation will need to increase the current number of skilled technical workers by 3 million by 2018. Analyzing and projecting the demand for skills in the U.S. economy is important because these estimates are critical inputs for a wide range of workforce development decisions, including choices to pursue education and training, the design of education and training programs and infrastructure, teacher preparation, employer investments in production and innovation, and policy making with respect to economic development. However, there is considerable controversy about the nature of U.S. labor market shortages, skills gaps or mismatches, and the analytical approaches used to develop these estimates.[1]

To address questions about patterns and trends in the demand for and supply of technical skills, the committee sought data and analyses on the current supply of and demand for workers, labor market projections, and the forces likely to affect supply and demand conditions over time. As discussed in more detail in Chapters 3 and 5, the limitations of the current U.S. labor market information system make it very difficult to measure change in the skilled technical workforce precisely. Looking at recent trends and future projections across a variety of measures, however, the committee was able to develop a collage of evidence that can be used to detect broad changes in the direction of the skills gap.

For example, recent trends in job vacancies, employment, and wages can be used to suggest current labor market conditions and highlight areas in which potential imbalances may exist. In the short term, these data include persistent high vacancy rates coupled with strong employment growth and rising wages within specific occupations or regional labor markets.[2] Similarly, future projections of demographic changes and employment growth can indicate where future gaps may arise. Long-term changes in the size and composition of the available workforce can affect the cost of labor and the need for workforce development. Changes in the workforce can have important implications for the ways in which employers organize, operate, and compete: if labor is too costly in one location, employers may move jobs to another location or automate tasks that would otherwise be performed by human workers. The committee's pattern and trend analysis suggests that there may be gaps and imbalances in specific

[1]For additional background on the debate, see Kimmel and Martin (2015), Faberman and Mazumder (2012), and Fichen and Pellizzari (2014).

[2]Even this type of evidence can be seen as consistent with temporary imbalances due to cyclical forces. One would need to observe these trends over a period longer than the business cycle to conclude that structural forces are indeed at work.

skilled technical occupations, industries, and locations. These issues are explored at the national, local, and sectoral levels in the sections that follow.

2.1.1 National Trends in the Demand for and Supply of Skilled Technical Workers

Monitoring and measuring change in the types of skills possessed by the skilled technical workforce and the size of this workforce at the national level is difficult.[3] To derive the number of skilled technical workers in the labor force, economists typically categorize the skill level of a worker based on the person's reported educational attainment. However, these data have significant limitations (Reamer, 2015; Rothwell, 2015). Until very recently, for example, nationally representative demographic surveys of work and education experience did not ask about or draw careful distinctions between traditional formal education and other types of education and training or skills acquisition, such as alternative credentials or education and training that do not confer credit toward a credential. Thus, the use of education as an indicator of skill level can mask variation in skill levels within educational categories (Lemieux, 2006).

The National Science Board reports that data accumulated over decades reveal that in the United States, "degree is not destiny," and that only a very loose association exists between degrees and jobs at all education levels and in all degree fields (NSB, 2015). It finds that, compared with those of other nations, U.S. graduates are generally less constrained by their degree field in pursuing career options. Moreover, sorting into education and training programs is based primarily on student choices. In some nations in Europe and Asia, it is more common than in the United States to require certification for jobs and more difficult for businesses or other types of organizations to redesign jobs. By contrast, U.S. employers can be quite fluid and can acquire and use employees' skills in differing ways.

2.1.2 Exploring Imbalances across the Skilled Technical Workforce in the United States

With the foregoing caveats in mind, the committee explored imbalances in the skilled technical workforce at the national level. In a commissioned paper, Alicia Sasser Modestino of Northeastern University examines job vacancy

[3]Monitoring and measurement difficulties are identified in most of the papers commissioned for this study. For discussion of the issues regarding measurement of the entire skilled technical workforce, see Rothwell (2015), Modestino (2015), and Reamer (2015). For discussion of the issues regarding analysis of local labor markets, see GAO (2013). For discussion of the need for innovation in labor market measurement and research, see Reamer (2015).

measures to determine which major occupation groups experienced the tightest labor market conditions as of the peak of the most recent business cycle (2006), and whether these conditions persisted through the economic recovery (2012) (Modestino, 2015, 2016). She then delves more deeply into the data to examine recent wage growth (2012-2014) and future employment projections (2012-2022) by specific occupations within these major occupation groups.

Modestino finds that major occupation groups with persistently high vacancy rates employ a relatively high share of both skilled technical and higher-skilled workers (Modestino, 2015, Table 1.1). Occupation groups with critical vacancy levels include management, business, computer and mathematical science, architecture and engineering, and health care practitioners and technical occupations.[4] These occupation groups also have low unemployment relative to the number of vacancies—less than one unemployed worker per job opening—suggesting particularly tight labor markets. Many of these occupations include a significant percentage of skilled technical jobs.[5] For example, within the health care practitioner and technical occupation group, critical vacancies exist in occupations that employ a high percentage of workers with only some college or an associate's degree, such as medical and clinical laboratory technicians, surgical technologists, licensed practical and licensed vocational nurses, and medical records and health information technicians (Modestino, 2015, Table 1.2). In addition, most of the occupations that require technical skills offer high and rising wages, as well as significant projected employment growth through 2022. Among all occupations with critical vacancy levels, those that employed a larger share of skilled workers had higher job vacancy rates both before and after the recession.

Modestino also analyzed aggregate data for the supply of and demand for skilled workers by education level through 2022. She argues that the supply of skilled technical workers is likely to hold steady, but the composition of supply is not likely to keep pace with demand in the near future. Among individuals with skilled technical credentials, the percentage of those with some college is projected to increase, while the percentage of those with an associate's degree is not expected to change. Modestino attributes this forecast to low degree-

[4]Occupations with critical vacancy levels are defined as those having both a higher-than-average vacancy rate (number of vacancies as a percentage of total employment) and a higher-than-average vacancy share (number of vacancies as a percentage of total vacancies).

[5]In fact, skilled technical jobs are distributed throughout the broad occupation categories, suggesting that such workers are not concentrated in just a few easily identifiable sectors. Moreover, many of the jobs held by skilled technical workers appear to be complementary to those held by high-skill workers. For example, hospitals need both physicians and nursing and other support staff—jobs not easily automated or outsourced. Likewise, engineering firms need both engineers and technicians, while businesses need both systems analysts and computer support specialists.

completion rates in the nation's community colleges. She notes that these projections may overestimate the supply of technically skilled workers given that labor force participation has been declining, particularly for individuals with less than a 4-year degree.

Modestino's projections indicate that by 2022, the percentage of skilled technical job openings is likely to exceed the percentage of skilled technical workers in the labor force by roughly 1.3 percentage points, representing a shortage of about 3.4 million skilled technical workers. As the men and women of the baby boom generation continue to retire over the next decade, the absolute number of skilled technical workers will likely fall short of demand. Modestino states that her projections probably underestimate future skill imbalances because they are based on current educational requirements for jobs, which tend to increase over time.

Although Modestino's projections of future labor supply and demand may indicate where future investments in human capital may be warranted, it is important to note that future employment will be determined not only by the demands of employers and the skills of existing workers but also by future innovations that cannot fully be anticipated. For example, there is a wide-ranging debate about the impact of developments in artificial intelligence and computerization on employment and workforce development (see, for example, Arntz et al. [2016] and Frey and Osborne [2013][6]). Thus, forecasts of future labor demand are used only to place bounds on the problem and provide context rather than to pinpoint the exact number of workers that will be demanded in the future. Employers and workers are likely to adjust their behavior over the next decade if they have the incentive to do so. Workers could adjust by obtaining additional education or training or by applying their current skills in existing jobs in expanding occupations. Similarly, depending upon the structure of their incentives and the availability of skilled workers in the United States, employers could adjust by adopting new technologies, outsourcing, or restructuring jobs.

As mentioned in Chapter 1, certain conditions can create persistent labor market imbalances if demand changes rapidly and the incentives for adjustment on the supply side are weak. On the demand side, structural changes associated with advances in science and technology and competitive forces have been shown to accelerate the creation and destruction of skilled technical jobs over the course of the business cycle (Jaimovich and Siu, 2012). On the supply side, inadequate early academic preparation and weak incentives can slow the response on the part of individuals seeking to acquire technical credentials. These types of conditions could create mismatches in some specific occupational and industry sectors, such as health care. However, uncovering

[6]Whereas Frey and Osborne (2013) estimate that 47 percent of existing U.S. jobs are at risk, Arntz and colleagues (2016) estimate that this is the case for only 9 percent of existing U.S. jobs.

these conditions requires more detailed information and analyses at the organization, industry, and geographic levels. This evidence is examined in the next section.

2.2 LOCAL AND SECTORAL TRENDS IN THE DEMAND FOR AND SUPPLY OF TECHNICAL SKILLS

Many participants in the 2015 symposium convened by the committee (see Chapter 1) expressed the belief that certain regions and sectors are impeded in their ability to grow and compete because they cannot consistently meet the demand for skills.[7] Panel discussions on the current labor market (Panel 2); high school, community college, and health care pathways (Panels 3, 4, and 8); apprenticeships (Panel 6); and even federally funded programs (Panel 7) all pointed to the local and sectoral nature of skilled technical labor markets. In their keynote remarks, Senator Tim Kaine and U.S. Chamber of Commerce Foundation Senior Adviser John McKernan reinforced these comments by reflecting on their experience with and understanding of local differences.

The National Science Board argues that science, technology, engineering, and mathematics (STEM) workforces, like the skilled technical workforce, are quite heterogeneous; they consist of many different subworkforces based on degree field, occupational field, required education level, or some combination of these factors (NSB, 2015). The demand for, supply of, and career prospects for each subworkforce can vary significantly by employment sector, industry, or geographic region. The National Science Board warns that aggregate analyses and overgeneralizations that apply particular issues or challenges for a specific subworkforce to the entire workforce often lead to incorrect conclusions about the condition of the workforce. The Board argues that exploration of important questions about the STEM workforces requires a focus on disaggregated data associated with the specific subworkforce of interest.

2.2.1 Exploring the Evidence at the Local Level

A 2013 study by the Government Accountability Office (GAO) of the implementation of the federal Workforce Investment Act captures early evidence on the local and sectoral differences in skilled technical labor markets. GAO (2013) found that employers in 80 percent of the local areas surveyed in calendar year 2012 claimed some difficulty in filling skilled technical jobs and that employers' needs in some local areas were clearly not being met. Certain jobs, such as welders, machinists, and truck drivers, as well as those in health care and computer occupations, were particularly difficult to fill. Other skilled

[7]See the agenda for the symposium in Appendix A.

technical jobs that were difficult to fill and considered to be high-growth were in the construction and extraction and the installation, maintenance, and repair occupational groups.

The 2013 GAO study draws attention to the fact that workforce development is a local as well as a national issue. The study finds that 90 percent of local areas use state job banks and occupational projections to estimate labor market requirements. Moreover, the study highlights evidence of imbalances that arise from unique features of local labor markets, which means that a one-size-fits-all approach will not be efficient or effective. The demand for technical skills is even more likely to be specific to a given location if workers are unlikely to migrate to new jobs. Thus, workforce development activities that are guided by national trends are destined to miss their targets, and better data-driven matching and planning of current and future job openings and current and future job seekers at the local level would appear wise.

Some analysts, for example, assume that workers can and will move to obtain a job and that mobility is costless. However, a wide range of factors can affect mobility, including housing costs, the quality of education and training options, family responsibilities, social networks, and occupationally related regulation. For instance, many skilled technical jobs require occupational licensing, which imposes costs that can affect mobility. A key finding of a 2015 White House report is that licensing restricts the mobility of workers across states (The White House, 2015). Figure 2-2 illustrates the substantial differences in movement across state lines between workers in highly licensed occupations and other workers. The figure also shows that interstate migration rates for workers in the most-licensed occupations are lower by nearly 14 percent of the average migration rate compared with those in the least-licensed occupations.

2.2.2 Exploring the Evidence at the Sectoral Level

In addition to local concerns, many symposium participants in the pathways and pipelines panels (Panels 3, 4, and 8) expressed the view that workforce development efforts should focus on a more sectoral approach to address mismatches within specific industries or occupations. This concern stemmed directly from the observation that employers in certain sectors that rely on skilled technical workers often report that American workers are not adequately prepared for current and future job requirements in their industry.

It is difficult, however, to disentangle local and sectoral effects with aggregate-level analyses. For example, many information technology (IT) jobs are skilled technical positions. There is widespread consensus that the United States has a nationwide need to train many more people in the IT sector. However, recent data on the IT job market show that cities in Pennsylvania, Illinois, Oklahoma, and Alabama had higher demand for IT workers relative to their existing IT workforce compared with several other cities in other states (see Figure 2-3).

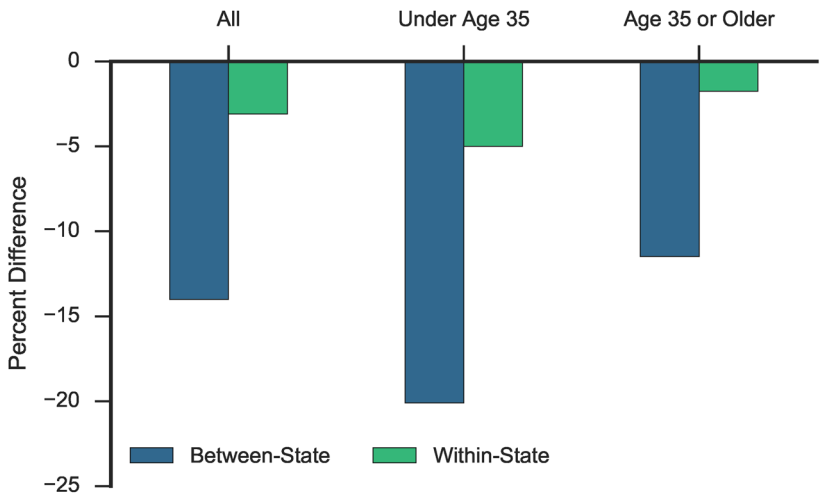

FIGURE 2-2 Difference in migration rates of workers in most- and least-licensed occupations.
NOTE: Numbers were calculated from an ordinary least squares (OLS) regression controlling for race, citizenship, sex, number of children, marital status, education, income, year, and state. Ages 25 to 65 were included.
SOURCE: The White House, 2015. Adapted from Census Bureau, American Community Survey 2010-2013; CEA calculations.

Recent employer surveys provide additional insight into the relationship between sectoral and local trends in skilled technical labor markets. In a survey of more than 800 human resources executives in February 2014, more than half of respondents reported that jobs requiring technical skills are difficult to fill, with finance, insurance, and health care companies reporting the greatest challenges (Accenture et al., 2014). Approximately 70 percent of respondent firms indicated that their inability to attract and retain individuals with technical skills frequently affected their operating performance. "Over one-third of respondents believed that inadequate availability of technically skilled workers had undermined their productivity, with manufacturing and health care the hardest hit" (Accenture et al., 2014, p. 6).

A review of Bureau of Economic Analysis (BEA) data on the sectors that contribute to growth in state economies reveals that some states and communities have larger concentrations of employers in the industries that employ high levels of skilled technical workers relative to others.[8] These

[8]BEA's most recent analysis of the value of the goods and services produced by states can be found in BEA (2015).

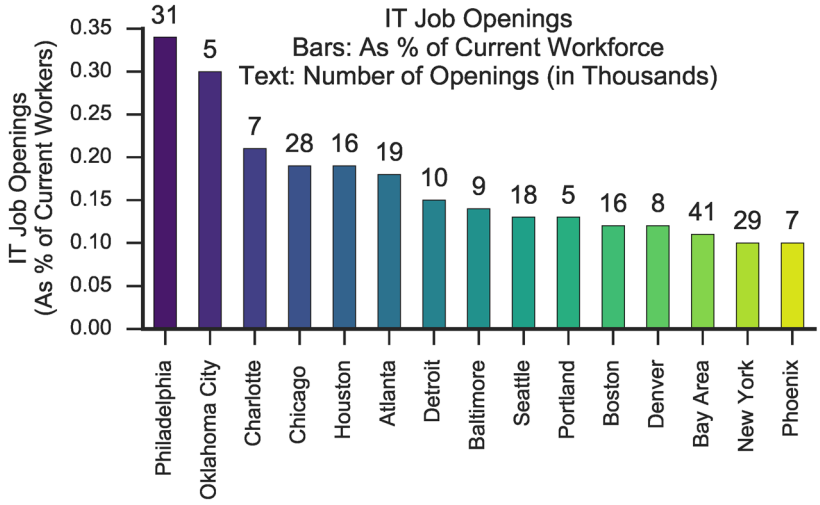

FIGURE 2-3 Cities with higher information technology (IT) demand than IT supply.
NOTE: These metropolitan areas were selected based on a "material" supply shortage. Material is defined as greater than or equal to 10 percent IT job openings as a percentage of total workforce. High vacancies can mean high turnover because jobs or employers are undesirable.
SOURCE: The White House, 2014. Adapted from CEB TalentNeuron Data.

differences are difficult to discern with analyses based on aggregate-level data. Intelligent policy responses require local labor market analyses that current labor market information systems do not adequately support.

Survey data and the preceding analysis of national occupational data on vacancies, employment, and wages suggest that certain skilled technical labor markets are experiencing tighter-than-average conditions. At the aggregate level, it does not appear that existing labor markets are currently failing to consistently provide an adequate supply of skilled technical workers. However, there may be persistent sources of imbalance in specific communities and in specific occupations and industry sectors. To understand better the policy issues affecting skilled technical labor markets, the committee looked closely at the dynamics in two sectors with high numbers of skilled technical occupations—health care and manufacturing. These sectors also serve as examples of how advances in science and technology can affect skilled technical labor markets.

2.3 TRENDS IN SUPPLY AND DEMAND IN HEALTH CARE

BLS estimates that there were about 17 million jobs in health care and social assistance in the United States in 2012 (or about 11.7 percent of total U.S.

jobs) (BLS, 2013, Table 3). Health care has been identified as an engine of job growth in the U.S. economy because of an increasing demand for health care by an aging population, as well as changes mandated by the Patient Protection and Affordable Care Act of 2010.

Bianca Frogner and Susan Skillman of the University of Washington provided the committee with an overview of labor market dynamics for health care jobs (Frogner and Skillman, 2015, 2016). They observe that many skilled technical occupations in the health care field fall within the "allied health" workforce, and while this group is not synonymous with the skilled technical workforce, there is considerable overlap.[9] Using the Occupation Finder in the BLS *Occupational Outlook Handbook*, the authors identified approximately 40 health care occupations that have prebaccalaureate entry-level requirements. They estimate that the health care field will add 3-4 million jobs over the next decade, and about 40 percent of this growth will be driven by the allied health professions, which closely resemble the committee's definition of skilled technical jobs.[10] Echoing earlier concerns, however, Frogner and Skillman argue that analyses of U.S. labor markets are very difficult to perform because models cannot predict market and population needs at the local level, and oversupply in urban areas can mask workforce gaps in rural areas.

Frogner and Skillman found several imbalances that prevent skilled technical labor markets from operating smoothly in the health care field, including the following:

- **Information deficits.** Data on the size, distribution, demographics, and work characteristics of the skilled technical workforce remain difficult to collect. Other challenges to data collection center on

[9]Frogner and Skillman (2016) discuss the definitional issues in the allied health field and the relationship of the workforce to the way they define skilled technical occupations. They argue that the allied health occupations are understudied, and workforce development in these occupations presents many issues similar to those identified with respect to other skilled technical occupations, such as improving data tracking and projections, understanding demand and supply, building ties between educators and employers, and identifying career trajectories. For additional background on the allied health field and related issues, see Wood (2011), Frogner et al. (2015), Ross et al. (2014), and IOM (1989, 2011).

[10]Frogner and Skillman (2015) note that although there is no single list of "allied health" occupations, it is generally accepted that allied health professions do not include physicians, dentists, or nurses. The authors further note that the Patient Protection and Affordable Care Act defines an allied health professional as "an individual who graduated with an allied health profession degree or certificate, and is employed as an allied health professional in a health care setting." Their analysis considers occupations requiring a high school degree or an associate's degree for entry, including an associate's degree for registered nursing (Frogner and Skillman, 2015, Table 1).

identifying the education and training pipeline and understanding which occupations can fill which roles. These information deficits impede policy makers' ability to estimate changes in supply and demand in skilled technical labor markets when considering workforce development policy. In addition, information deficits make it difficult and costly for labor market intermediaries, such as career centers, college placement offices, and community-based organizations, to match qualified workers with appropriate jobs.

- **Degree creep.** Occupational requirements are not always clear in the health care labor markets. For example, many health care occupations do not require a certificate or degree that is directly linked to a health care occupation. In addition, Frogner and Skillman (2015) found evidence of "degree creep," which entails setting increasingly higher educational and training requirements for practice.[11] Increasing these requirements can reduce the short-term supply of workers by delaying time of entry into the workforce, or they can reduce the long-term supply by putting education and training out of the financial reach of many workers and their employers. However, the reasons for and interpretation of "degree creep" remain unclear.
- **Accreditation and credentialing costs.** Many health care jobs require a degree from an accredited program or a specific credential, continuing education, license, or registration to practice. These requirements can provide incentives for workers to continually upgrade their skills. However, they also increase costs to invest in, prepare for, and sustain workers' qualifications. Moreover, requirements vary across states, increasing the cost of transferring from one location to another to alleviate geographic mismatches.
- **Changing needs.** The skills and training required for U.S. health care workers are changing because of shifts in the health care needs of the population; legislative changes that reshape the health care delivery system; increases in consumer safety and protection regulations; and advances in science, technology, and care modalities. These developments impose a variety of coordination costs related to education, training, and hiring of workers with the skills to meet these changing needs.[12]

[11]Participants in the 2015 symposium indicated that "degree creep" or "up-skilling" is a concern in many labor markets. Also see Burning Glass (2014).

[12]For a discussion of the challenges of developing training networks to support the growth of the health care workforce, see Chapter 5.

2.4 TRENDS IN SUPPLY AND DEMAND IN MANUFACTURING

BLS estimates that in 2012, the U.S. manufacturing workforce included approximately 11.9 million workers, or 8.2 percent of the total workforce (BLS, 2013, Table 3). More than 50 percent of the total manufacturing workforce involves skilled production occupations that meet the committee's definition of skilled technical jobs (Giffi et al., 2015).

Many observers have decried the loss of manufacturing jobs in the United States. A recent study by the National Academy of Engineering found that while U.S.-based companies have led high-tech manufacturing markets, they face growing competition from emerging corporations around the world (NAE, 2015). A 2014 National Academies study identified new opportunities for U.S. businesses in flexible electronics manufacturing (NRC, 2014b). As observers consistently note, however, if the United States wishes to attract and retain manufacturing facilities and compete against aggressive new competitors in developing countries, it needs to ensure that it has a qualified workforce. Robert Lerman of the Urban Institute, American University, and IZA argues in his commissioned paper that if employers cannot find the skills they need in the workforce, they may not invest or innovate (Lerman, 2015). However, the evidence with respect to this perspective is ambiguous. For example, a 2012 survey by the Massachusetts Institute of Technology found that manufacturing jobs that had moved offshore were returning to the United States (Simchi-Levi, 2012). Yet a recent A. T. Kearney (2015) report provides data that dispute this finding.

At the same time, the National Manufacturing Institute (NMI) has documented what it describes as a persistent skills gap in manufacturing.[13] Its 2015 report, prepared in collaboration with Deloitte, estimates that over the next decade, 1.5 million manufacturing jobs will go unfilled because of a skills gap in the supply of workers. According to the report, 7 of 10 manufacturing executives surveyed reported shortages of workers with adequate technology, computer, and technical training skills who can successfully pass basic screening (Giffi et al., 2015). Most of the executives surveyed indicated that the skills gap will affect their firms' ability to meet customer demand, implement new technologies, and increase productivity. Executives also reported challenges to providing effective customer service, innovating, developing new products, and expanding internationally.

On the other hand, having analyzed a nationally representative sample of manufacturing firms, Osterman and Weaver (2014b) argue that the demand for high-level skills is modest, and 75 percent of firms show no signs of hiring

[13]For a discussion of why manufacturing companies are not able to recruit and retain workers with the necessary skills, see Chapter 5.

difficulties, defined as long-term vacancies. Some analysts assert that there is limited upward pressure on manufacturing wages, which suggests limited evidence of a shortage of workers in these occupations. Other competitive pressures and low profit margins could explain the absence of upward wage pressure. Yet increasing skill requirements could make attracting workers more difficult unless wages rise at higher rates, creating a vicious negative spiral in manufacturing workforce development. The disagreement among analysts about the seriousness of current hiring difficulties in the manufacturing sector also highlights the need for more granular analyses of the skilled technical labor market, discussed in more detail in Chapter 4.

Some analysts in the manufacturing industry argue that structural factors or imbalances in skilled technical labor markets are likely contributors to the shortage of workers perceived by some employers. On the supply side, the number of baby boomers nearing retirement exceeds the number of younger workers who can replace them. At Boeing, for example, 28 percent of the firm's 31,000 machinists are older than 55 and eligible for retirement (Whoriskey, 2012). Yet industry leaders say that it is difficult to attract younger workers to an industry that was once considered "dying" and "dirty." They are concerned that as a result of the shift in focus of U.S. high schools toward college preparation, students are not obtaining the skills and credentials needed to enter manufacturing. In a recent poll conducted by the Foundation of Fabricators & Manufacturers Association, roughly half of all teenagers said they had no interest in a manufacturing career, and the majority of those who expressed this view agreed that a manufacturing career entailed a "dirty, dangerous place that requires little thinking or skill from its workers and offers minimal opportunity for personal growth or career advancement" (Shankel, 2010). In addition, in NMI and Deloitte's most recent study of U.S. public opinion on manufacturing, respondents aged 19 to 33 ranked manufacturing as their least-preferred career, and only a third indicated they would encourage their children to pursue a career in manufacturing (Giffi et al., 2015).

On the demand side, advances in science and technology have transformed production processes such that many skilled technical manufacturing jobs now require higher levels of science and math skills, placing manufacturing squarely in the class of STEM occupations. The recent National Academy of Engineering report *Making Value for America: Embracing the Future of Manufacturing, Technology, and Work* states that production work in the United States is shifting to require more specialized skills in such areas as robotics-controlled maintenance, advanced composites, and radio-frequency identification parts (NAE, 2015). Figure 2-4 illustrates that the number of skills required for proficiency in manufacturing occupations has consistently increased over time and is projected by leading global manufacturing firms such as Siemens to continue to do so.

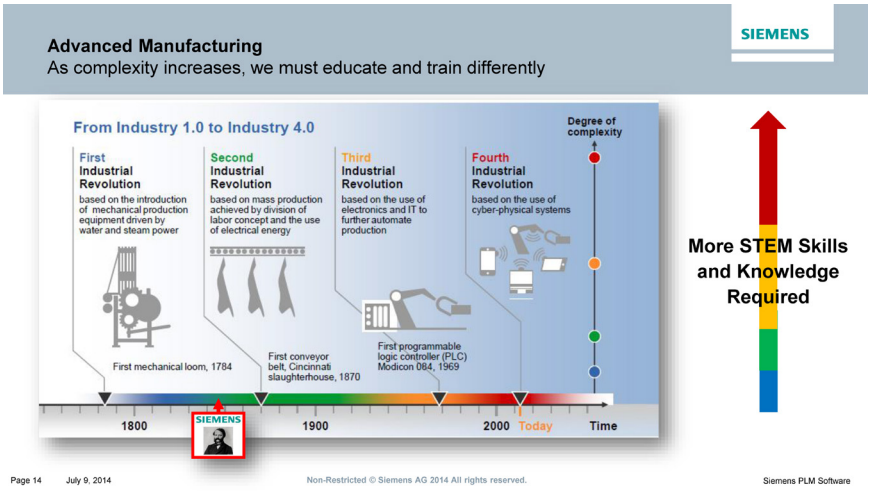

FIGURE 2-4 The evolution of skills required in production occupations.
NOTE: IT = information technology; STEM = science, technology, engineering, and mathematics.
SOURCE: Bill Boswell, Senior Director, Siemens PLM Software, Sustaining an Advanced Manufacturing Workforce presentation, September 23, 2014.

2.5 INTERNATIONAL PERSPECTIVES: OECD COUNTRIES AND PARTNERS

As the global economy continues to grow and as new markets emerge across the globe, policy makers around the world are concerned about their country's ability to trade and compete effectively (OECD, 2012a). They recognize that their workforce is a critical asset in meeting the challenges of globalization: uncompetitive firms and workers create political pressure to engage in protective measures that ultimately harm prospects for peace and prosperity at the individual, country, and global levels.

Reflecting this concern, OECD's PIAAC developed the Survey of Adult Skills to help policy makers in OECD countries assess the proficiency of adults aged 16 to 65 in key competencies that are necessary for fully integrating and participating in labor markets, education and training, and social and civic life.[14] The most recent survey identifies several trends that are influencing the development and use of technical skills in OECD and partner countries.

[14]The PIAAC survey does not specifically address the skilled technical workforce; therefore, its results have only general implications for this workforce.

First, access to computers and information and communication technologies is widespread and growing. More than 70 percent of households have access to computers and the Internet, and most workers have access to and use the Internet as part of their jobs (OECD, 2013). Moreover, the use of computers and information and communication technologies is changing the ways in which public and private services are provided and consumed. Many governments are increasingly delivering public services via the Internet. PIAAC estimates that in 2010, an average of 40 percent of citizens and 80 percent of businesses in OECD and partner countries interacted with public authorities via the Internet. In addition, the volume of e-commerce is growing rapidly in many countries.

The use of information and communication technologies also is changing the structure of how work is organized and performed in OECD and partner countries. Technology is enabling structural change in workplaces and markets by increasing the reach and speed of communication and reducing costs, thus facilitating the flow of goods, capital, people, and information across units, organizations, and borders. These changes mean that workplaces frequently reorganize, which compels workers to acquire new skills to adapt. According to OECD (2013, p. 48), "In most OECD countries, more than a quarter of all workers are professionals, associate professionals, or skilled technicians. Between 1998 and 2008, the number of people employed in these categories increased more rapidly than did overall employment rates in most countries." Although the evolution of employment shares for occupations with technical skills is more complex, as depicted in Figure 2-5, there is clear evidence of a significant and persistent evolution of employment in occupations requiring higher-than-average skills proficiency. Yet PIAAC estimates that imbalances between the supply of and demand for skills in OECD-country labor markets are widespread and coexist with high levels of unemployment. Skills shortages and gaps or mismatches are common, suggesting the need for "a more comprehensive account of the demand for and use of skills, including how work and organizational practices perpetuate or eliminate skills imbalances" (OECD, 2013, p. 52).

2.6 CONCLUSIONS

In the United States, the occupations that drive human development and economic growth, such as health care and manufacturing, have high proportions of jobs requiring technical skills. Such occupations as installation, maintenance, repair, and construction that develop and sustain Americans' way of life have similarly high proportions of job opportunities for workers with technical skills.

Although the ability to analyze changes in these markets with precision is limited, the evidence accumulated to date suggests that the policies and

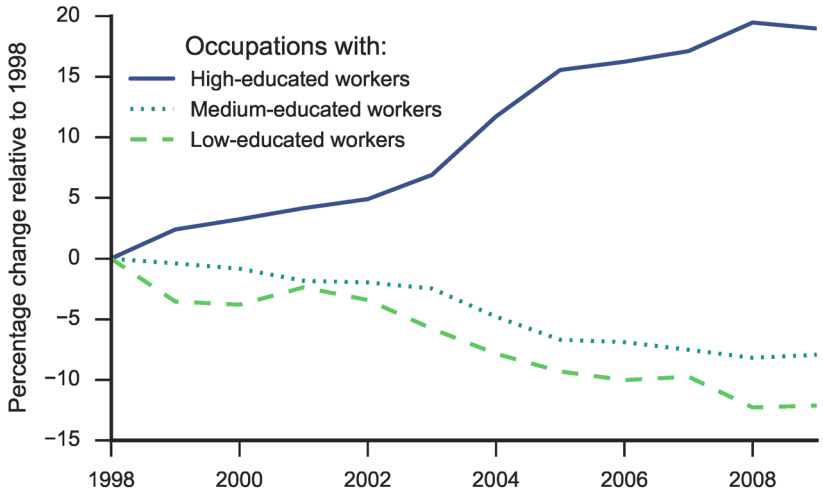

FIGURE 2-5 Evolution of employment in occupational groups defined by level of education: Percentage change in the share of employment over all employed people relative to 1998, by occupational groups defined by workers' average level of education.
NOTES: Only the 24 OECD countries available in the 1998 LFS database are included in the analysis. High level of education refers to the tertiary level or more than 15 years of schooling; medium level of education refers to no tertiary but at least upper-secondary education or around 12 years of schooling; low level of education refers to less than upper-secondary education or 11 years of schooling.
SOURCE: OECD, 2013. Adapted from Eurostat, LFS Database. Table A1.4 in Annex A.

programs governing the markets for skilled technical jobs matter. National data and industry surveys indicate a tightening of certain skilled technical labor markets. Changes in demographics, technology, and international competition create the potential for medium- and long-term mismatches in certain occupational and industry sectors. Detailed information about and analyses of how labor markets for skilled technical jobs operate at the organization, industry, sector, and local geographic levels are needed to properly understand these conditions.

A review of skilled technical occupations in health care and manufacturing suggests that markets for skilled technical jobs may not be clearing as efficiently as they could, and these imbalances are likely to be exacerbated by global patterns and trends. On the demand side, skilled technical workers face increasingly higher competency requirements as a result of structural changes associated with advances in science and technology; new business models; "degree creep"; requirements for "soft skills," including the ability to pass a drug test or meet other security-related requirements; and competitive forces.

On the supply side, factors that prevent U.S. labor markets from clearing for skilled technical jobs include a dearth of workplace and workforce

information that creates barriers and raises search costs, low or stagnant wages, inadequate investment in education and training, a lack of transferability of certifications and experience that inhibits occupational and geographic mobility, and inaccurate or outdated perceptions of certain occupations that reduce incentives for individuals to invest in training. In addition, the evidence suggests that prevailing policies often affect incentives to invest in continual education and training. These incentives, discussed in more detail in subsequent chapters, have important implications for labor market clearing, where demand matches supply, in specific locations and sectors.

Developing and maintaining skills proficiency is essential to U.S. leadership in innovation, manufacturing, and competitiveness and to the creation and retention of high-wage and high-status jobs. In this report, the committee makes recommendations for how policy makers at the federal, state, and local levels can create an environment that encourages and enables adaptiveness in the skilled technical workforce. The next chapter turns to the policy landscape for workforce development.

3

The Public Policy Context

The U.S. skilled technical workforce development system is characterized by many, often competing, sources of authority and enforcement in government, business, civil society, and private life. The nation has no single, centralized system for developing a skilled technical workforce and—given the dynamics of its political and economic systems—little hope of practically achieving one. Skilled technical workforce development in the United States is the concern and shared responsibility of students; workers; labor unions and other worker associations; families; educators; businesses; industry associations; and the federal, state, and local governments.

In reviewing the public policy context, the first two sections of this chapter take note of the varied policy agenda and landscape for technical skill development. The third section summarizes key federal legislation that shapes federal policy, including the Workforce Innovation and Opportunity Act (WIOA) and the Post-9/11 Veterans Educational Assistance Act. Next is a review of the Higher Education Act (HEA) and the Carl D. Perkins Career and Technical Education Act (Perkins Act), which are under consideration for reauthorization by the U.S. Congress, followed by an overview of state policies on career and technical education. Together, these federal and state policies shape the nation's complex system of workforce education and training. Broader policy issues related to the development of a skilled technical workforce, including reforms of labor laws and rules governing occupational licensing, improvements in science, technology, engineering, and mathematics (STEM) proficiency, and upgrades to the Workforce Labor Market Information System, are then examined. The final section presents conclusions.

3.1 THE POLICY AGENDA FOR THE SKILLED TECHNICAL WORKFORCE

Educating and training a skilled technical workforce is a priority for policy makers at the federal, state, and local levels. Civic leaders, employers, industry

and trade associations, labor unions, and philanthropists also have emphasized the critical role of postsecondary education and training in the development of technical skills.

Workforce development is a priority at the federal level. A bipartisan majority of Congress passed WIOA, and in 2014, President Obama signed a *Presidential Memorandum on Job Driven Training for Workers,* which tasked Vice President Biden and the secretaries of labor, commerce, and education with developing an action plan to make America's workforce development system "more job driven, integrated and effective."[1] In response to this directive, the vice president's task team reviewed what is working best nationwide and delivered a report to the President in July 2014 that includes a seven-point "Job Driven Checklist" (The White House, 2014).

The development of a skilled technical workforce is a top priority that is connected to economic competitiveness for the states' governors. Over the past 10 years, seven National Governors Association (NGA) chairs have sponsored initiatives that have included an element related to workforce development.[2] The 2013-2014 NGA chair, Governor Mary Fallin, tackled the subject in her initiative "America Works: Education and Training for Tomorrow's Jobs" (see NGA, 2015a; Simon, 2015). The NGA's current initiative, the NGA Talent Pipeline project, aims to achieve systemic change to increase the number of U.S. citizens with a postsecondary credential.[3] The focus of this initiative, which currently includes 14 states, is on aligning education and workforce development with economic development strategies and the needs of industries.

Workforce development is a concern for U.S. mayors as well. In 1977, the U.S. Conference of Mayors (USCM) created a Workforce Development Council as a USCM standing committee to ensure that workforce development would be a key focus of cities.[4] The council works to shape legislative and policy agendas related to technical skills development; provide timely information to support these efforts at the local level; and build capacity by creating networks, identifying innovative approaches, and providing technical assistance. Recent meetings reflect a concerted focus on the development of a skilled technical workforce.[5]

Policy makers' initiatives at the local, state, and federal levels all seek to engage civic leaders in the private and nonprofit sectors. In addition to employer and trade association initiatives in industries with high numbers of occupations requiring technical skills, such as health care and manufacturing, the committee noted relevant initiatives in the U.S. Chamber of Commerce, labor

[1] *Workforce Innovation and Opportunity Act*, Public Law 113-128 (July 22, 2014).
[2] For a historical list of NGA chair initiatives, see NGA (2017).
[3] Additional information is available at NGA (2015b).
[4] See http://www.uscmwdc.org/about-wdc.
[5] See http://www.uscmwdc.org/past meeting resources.

organizations, and philanthropic organizations across the United States. Many of these initiatives are described in more detail in the sections and chapters that follow.

3.2 THE POLYCENTRIC POLICY LANDSCAPE

Workforce development policy has a substantial history reflecting the structure of U.S. policy making: it is polycentric, having many centers of decision making and control.[6] As Figure 3-1 shows, technical skills development and regulation of labor markets are governed principally by public laws and other policies on education and labor at the federal, state, and local levels. However, they are also a concern for agencies that address health and human services, such as the Department of Health and Human Services (HHS), and the advancement of science and technology, such as the National Science Foundation (NSF). Public policies and programs that are concerned with Native Americans (Department of the Interior [DOI]) and military personnel (Department of Defense [DoD]) also address the skills development needs of their constituencies. In addition, several other initiatives, such as the Hollings Manufacturing Extension Partnership program, the America COMPETES Reauthorization Act of 2015, and small business and trade facilitation programs, provide policy direction for certain types of initiatives aimed at skilled technical workforce development.

In addition to state and local programs, several federally funded programs in the United States target specific populations such as ex-offenders, disconnected youth, and displaced or injured workers. For fiscal year (FY) 2009, for example, the Government Accountability Office (GAO) identified 47 federally funded employment and training programs administered across nine agencies (GAO, 2011a; for additional background, see GAO, 2011b,c). However, most direction and funds are provided by a relatively small set of policies and programs at the federal and state levels, and considerable effort has been made to integrate and align these policies in recent years.[7]

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[6]For an overview of U.S. job training policy and additional context, see, for example, Decker and Berk (2011) and Holzer (2012). For an analysis of polycentricism in American political and administrative life, see the work of Ostrom (1994, 2008), for example.

[7]One of the most obvious examples of efforts to integrate and align federal and state workforce development policies occurred with the enactment of the WIOA. For an overview of these efforts, see Heinrich (2015), as well as The White House (2014). A GAO (2012) report to Congress on the Workforce Investment Act examines efforts to integrate and align state and federal activities prior to WIOA enactment. Policy alignment and integration efforts were also consistently noted in presentations and discussions during the committee's 2015 symposium and in presentations at committee meetings held

FIGURE 3-1 Federal agencies participating in the policy-making landscape for the development of a skilled technical workforce.
NOTE: ACF = Administration for Children and Families; ATE = Advanced Technological Education; CTE = career and technical education; DoD = U.S. Department of Defense; HHS = U.S. Department of Health and Human Services; HRSA = Health Resources and Services Administration; NSF = National Science Foundation; VA = U.S. Department of Veterans Affairs; WIOA = Workforce Innovation and Opportunity Act.
SOURCE: Compiled by the committee.

3.3 FEDERAL-LEVEL POLICIES AND PROGRAMS

As Table 3-1 shows, federal policy has provided scope for many federally funded employment and training programs that apply to a wide range of workforce development issues and populations. In a review of these programs for FY 2009, the GAO noted that almost all of them overlap with one or more other programs in that they provide at least one similar service to a similar population, although differences may exist in eligibility, objectives, and service

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September 10, 2015, and February 17, 2016. A webcast of the symposium, research papers, and presentations can be found at http://nas.edu/SkilledTechnicalWorkforce.

TABLE 3-1 Federally Funded Employment and Training Programs by Agency, Fiscal Year 2009

Agency	Programs
Department of Labor	• Community-Based Job Training Grants • Employment Service/Wagner-Peyser Funded Activities • H-1B Job Training Grants • Homeless Veterans' Reintegration Project • Job Corps • Local Veterans' Employment Representative Program • National Farmworker Jobs Program • Native American Employment and Training • Registered Apprenticeship and Other Training • Reintegration of Ex-Offenders • Senior Community Service Employment Program • Trade Adjustment Assistance • Transition Assistance Program • Veterans' Workforce Investment Program • WIA Adult Program • WIA Youth Activities • WIA Dislocated Workers • WIA National Emergency Grants • WANTO • YouthBuild
Department of Education	• American Indian Vocational Rehabilitation Services • Career and Technical Education - Basic Grants to States • Career and Technical Education - Indian Set-aside • Grants to States for Workplace and Community Transition Training for Incarcerated Individuals • Migrant and Seasonal Farmworker Program • Native Hawaiian Career and Technical Education • Projects with Industry • Rehabilitation Services - Vocational Rehabilitation Grants to States • State-Supported Employment Services Program • Tech-Prep Education • Tribally Controlled Postsecondary Career and Technical Institutions

(Continued)

TABLE 3-1 Continued

Agency	Programs
Department of Health and Human Services	• Community Services Block Grant • Refugee and Entrant Assistance Voluntary Agency Matching Grant Program • Refugee and Entrant Assistance - Targeted Assistance Grants • Refugee and Entrant Assistance - Social Services Program • Refugee and Entrant Assistance - Targeted Assistance Discretionary Program • Temporary Assistance for Needy Families • Tribal Work Grants (Native Employment Works)
Department of the Interior	• Conservation Activities by Youth Service Organizations • Indian Employment Assistance • Indian Vocational Training - United Tribes Technical College
Department of Agriculture	• SNAP Employment and Training Program
Department of Defense	• National Guard Youth Challenge Program
Environmental Protection Agency	• Brownfield Job Training Cooperative Agreements
Department of Justice	• Second Chance Act Prisoner Reentry Initiative
Department of Veterans Affairs	• Vocational Rehabilitation for Disabled Veterans (VetSuccess Program)

NOTE: SNAP = Supplemental Nutrition Assistance Program; WANTO = Women in Apprenticeship and Nontraditional Occupations; WIA = Workforce Investment Act.
SOURCE: Testimony of Andrew Sherrill, director of education, workforce, and income security issues, before the Subcommittee on Labor, Health and Human Services, Education and Related Agencies, Committee on Appropriations, House of Representatives, GAO 11-506T.

delivery (GAO, 2011a). The GAO reports that federal employment and training programs spent approximately $18 billion on employment and training services in FY 2009. However, seven programs accounted for about three-fourths of that spending, and most participants received employment and training services through either the Employment Service/Wagner-Peyser Funded Activities (Employment Service) or the Adult Program of the Workforce Investment Act of 1998 (WIA) (GAO, 2011a, Table 1). Together, these two programs, both of which are administered by the Department of Labor (DOL), served more than

18 million individuals, or about 77 percent of the total number of participants served across all federal employment and training programs, in 2009.

Mary Alice McCarthy of the New America Foundation states that one way to understand federal policy efforts aimed at helping people gain skills for work is to analyze *all* the funding streams for programs that prepare individuals for a specific occupation, including tuition assistance (McCarthy, 2014). Looking at the sources of federal funding for postsecondary education assistance in 2013, she observes that this funding comes disproportionately from the Title IV federal student aid programs—not from the 47 federal employment and training programs identified by the GAO study and not from the 3 programs dedicated specifically to workforce development and career and technical education.[8] As Figure 3-2 shows, of the $145 billion in education assistance provided in 2013, the vast majority ($130.7 billion) was governed by Title IV of HEA, while $10 billion was governed by the Post-9/11 Veterans Educational Assistance Act of 2008, $2.5 billion by WIOA, $1.1 billion by the Perkins Act, and $575 million by the Trade Adjustment Assistance Act (TAA). In McCarthy's view, postsecondary education is influenced primarily by the goals, policies, and funding of higher education.

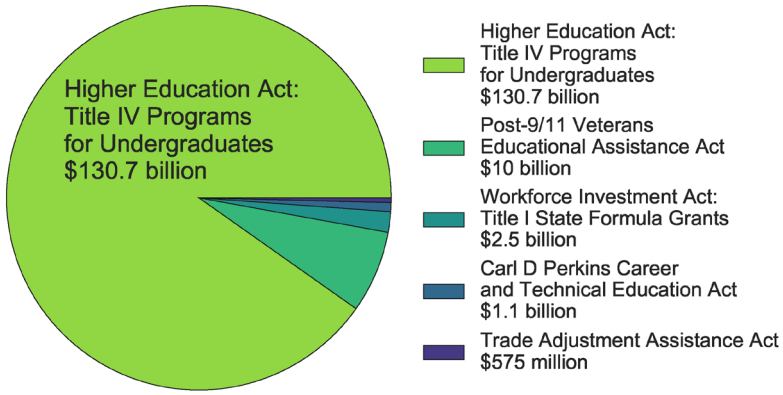

FIGURE 3-2 Annual federal funding for postsecondary education and training.
SOURCE: McCarthy, 2014.

[8]McCarthy (2014) identifies the three programs specifically dedicated to workforce development as the Perkins Act, WIOA, and the Trade Adjustment Assistance Act (TAA).

To understand the dynamics and incentives of workforce development, it is important to analyze all the policy, program, and funding mechanisms that prepare individuals for specific occupations. As described in more detail in this chapter and in Chapter 4, however, policies, programs, and funding streams for postsecondary skilled technical workforce development are largely under the purview of local- and state-level policy makers and other stakeholders.

The remainder of this section and the section that follows provide an overview of the four federal laws the committee believes are most likely to contribute to synchronizing activities focused on skilled technical workforce development across the nation and provide the greatest support for postsecondary education and training. This section continues by describing recently enacted laws that are directly related to workforce development: WIOA and the Post-9/11 Veterans Educational Assistance Act of 2008. Congress also recently passed the Every Student Succeeds Act (ESSA), summarized in Box 3-1, which indirectly affects workforce development.[9] The section that follows describes federal policy directly related to workforce development that is currently under deliberation for reauthorization: HEA and the Perkins Act. Both of these reauthorizations could have implications for policies and programs related to skilled technical workforce development.

3.3.1 Workforce Innovation and Opportunity Act

Passed on July 22, 2014, WIOA represents the first major legislative reform of the public workforce system in 15 years. It is designed to help job seekers and workers access employment, education, training, and support services that can help them succeed in the labor market and to match employers with the skilled workers they need to compete in the global economy. WIOA is administered by DOL and the U.S. Department of Education (ED). It supersedes WIA and amends the Adult Education and Family Literacy Act, the Wagner-Peyser Act, and the Rehabilitation Act of 1973.[10] Box 3-2 provides an overview of the purposes of WIOA.

In her review of federal workforce development efforts, presented at the committee's 2015 symposium, Carolyn Heinrich of Vanderbilt University states that a number of new WIOA provisions appear to be based on evidence of proven and promising strategies, such as incentivizing the development of sectoral training partnerships and requiring active coordination across agencies

[9]The text of ESSA can be found at https://www.congress.gov/bill/114th-congress/senate-bill/1177/text. More information about the new law is available at http://www.ed.gov/essa. Developments in career and technical education (CTE) are discussed in more detail in Chapter 4.

[10]See http://www.doleta.gov/WIOA/Overview.cfm (accessed February 28, 2017).

BOX 3-1
Every Student Succeeds Act

The Every Student Succeeds Act (ESSA), a bipartisan bill, was signed into law by President Obama on December 10, 2015. ESSA reauthorized the 50-year-old Elementary and Secondary Education Act (ESEA), replacing the prior version of the law, the No Child Left Behind Act (NCLB). The new law requires states to establish high college- and career-ready academic standards and guarantees that steps will be taken to help students and schools improve. It reduces the burden of testing that existed under NCLB while maintaining annual information for parents and students, and provides increased access to high-quality preschool.

ESSA seeks to promote local innovation and improvement in teaching and learning by authorizing various programs designed to (1) ensure that low-income and minority students are not being taught at disproportionate rates by ineffective teachers; (2) support improved teaching and learning through the implementation of human capital management systems that include sustainable performance-based compensation; and (3) support innovative and evidence-based approaches to teacher and leader recruitment, preparation, and development. To improve teaching and learning in science, technology, engineering, and mathematics (STEM), the law authorizes a STEM Master Teacher Corps program, which supports state-led efforts to elevate the status of the STEM teaching profession.

SOURCE: U.S. Department of Education, 2017.

in the development of priorities and programs (Heinrich, 2015). Recognizing the local nature of workforce development, WIOA grants states more flexibility to transfer funding between programs.

Observing that WIOA has yet to be fully implemented, Heinrich provides the following suggestions for policy makers:

- Begin training earlier for youth through approaches that blend vocational and on-the-job training, and involve employers as partners in the delivery of the training.
- Provide more funding and technical support to better link secondary, postsecondary, and workforce development data; assess the value of skills acquired in programs; and better direct job seeker training choices and American Job Center strategies.
- Improve data resources and their availability for research, and use these data to develop better performance incentive systems for guiding state and local resource allocations.

BOX 3-2
Workforce Innovation and Opportunity Act (WIOA)

Each of the act's purposes and key reforms is relevant to the development of technical skills. The purposes of WIOA are as follows:

> (1) To increase, for individuals in the United States, particularly those individuals with barriers to employment, access to and opportunities for the employment, education, training, and support services they need to succeed in the labor market.
> (2) To support the alignment of workforce investment, education, and economic development systems in support of a comprehensive, accessible, and high-quality workforce development system in the United States.
> (3) To improve the quality and labor market relevance of workforce investment, education, and economic development efforts to provide America's workers with the skills and credentials necessary to secure and advance in employment with family-sustaining wages and to provide America's employers with the skilled workers the employers need to succeed in a global economy.
> (4) To promote improvement in the structure of and delivery of services through the United States workforce development system to better address the employment and skill needs of workers, jobseekers, and employers.
> (5) To increase the prosperity of workers and employers in the United States, the economic growth of communities, regions, and States, and the global competitiveness of the United States.
> (6) For purposes of subtitle A and B of title I, to provide workforce investment activities, through statewide and local workforce development systems, that increase the employment, retention, and earnings of participants, and increase attainment of recognized postsecondary credentials by participants, and as a result, improve the quality of the workforce, reduce welfare dependency, increase economic self-sufficiency, meet the skill requirements of employers, and enhance the productivity and competitiveness of the Nation.

SOURCE: 29 U.S.C. § 3101, http://uscode.house.gov/view.xhtml?req=(title:29%20section:3101%20edition:prelim).

- DOL should consider making additional federal funding contingent on service levels to disadvantaged adults and youth, and on expanded training capacities in high-demand fields and for skilled technical jobs.
- DOL should lend greater financial and institutional support to cross-state research efforts and exchanges that seek to test innovative workforce development strategies.

3.3.2 Post-9/11 Veterans Educational Assistance Act of 2008

The Post-9/11 Veterans Educational Assistance Act of 2008 amends federal veterans' benefits provisions to provide updated and comprehensive educational assistance under the Montgomery GI Bill to individuals in certain length-of-service categories serving on active duty in the armed forces commencing on or after September 11, 2001.[11] Congress reports that a Congressional Budget Office (CBO) estimate for this measure has not been received.[12] The U.S. Department of Veterans Affairs reports that since the bill's implementation on August 1, 2009, it has provided more than $20 billion in educational benefits to 773,000 veterans and their family members.[13] Nearly 1 million eligible individuals participated in FY 2011, a 15 percent increase over FY 2010 and a 71 percent increase over FY 2009. Although the act requires that educational assistance be used within 15 years of an individual's discharge or release from active duty (with exceptions), it does allow individuals currently under the Montgomery GI Bill educational assistance program to elect to participate in the Post-9/11 Veterans Educational Assistance program with respect to any unused entitlement.

Congress notes in findings related to this act that the United States has a history of offering educational assistance to millions of veterans, as demonstrated by the many "GI bills" enacted since World War II. Educational assistance for veterans reduces the costs of war, assists veterans in readjusting to civilian life after wartime service, boosts the U.S. economy, and has a positive effect on recruitment for the armed forces. It is in the national interest for the United States to provide veterans who served on active duty in the armed forces after September 11, 2001, with enhanced educational assistance benefits that are worthy of such service and are commensurate with the educational assistance benefits provided to World War II veterans.

[11]The text of H.R.5740, the Post-9/11 Veterans Educational Assistance Act of 2008, is available at https://www.congress.gov/bill/110th-congress/house-bill/5740/text. For additional background on the bill, see Dortch (2014b).
[12]See https://www.congress.gov/bill/110th-congress/house-bill/5740/all-info.
[13]See http://www.va.gov/opa/issues/post_911_gibill.asp.

The act supports the development of technical skills in a number of ways. For example, it allows for the pursuit of (1) programs on less than a half-time basis, (2) apprenticeship or other on-the-job training, (3) correspondence courses, (4) flight training, (5) tutorial assistance, and (6) licensure and certification tests. The act also requires the secretary of the U.S. Department of Veterans Affairs to carry out the Yellow Ribbon GI Education Enhancement Program, under which colleges and universities may enter into an agreement with the secretary to cover, for certain individuals, a portion of established charges not otherwise covered and to match contributions toward such costs.

3.4 FEDERAL LEGISLATION UNDER CONSIDERATION

3.4.1 The Higher Education Act

HEA, which is administered by ED, authorizes numerous federal aid programs that provide support to individuals who pursue postsecondary education and to institutions of higher education.[14] Title IV authorizes the federal government's major student aid programs, which are the primary source of direct federal support to students who pursue postsecondary education, while Titles II, III, and V provide aid and support to educational institutions. HEA also authorizes services and support for less-advantaged students, students pursuing international education, and students and institutions engaged in certain graduate and professional degree programs. Title VIII supports the goals of improving access to postsecondary education and improving enrollment, persistence, and completion rates for specific groups of students, including veterans.

The rules and regulations governing access to HEA's financial aid programs, including institutional accreditation and student outcome reporting requirements, play a role in shaping how skilled technical education and training programs are designed and delivered and what is known about labor market outcomes for students. The nature and extent of this role need to be examined in parallel with the roles of local and state policies and programs.

Congress is considering reauthorization of HEA. The last time Congress comprehensively reauthorized the act was in 2008, when it passed the Higher Education Opportunity Act of 2008 (HEOA). HEOA authorized most HEA programs through FY 2014 but has been extended while Congress prepares for the next reauthorization (Hegji, 2014). Among the issues likely to be addressed in the final bill are affordability and college costs; access, persistence, and completion; better information for consumers; student loan programs; accreditation and oversight; innovation; and reduction of the burden of federal regulations.

[14]For a primer on HEA, see Hegji (2014).

On July 30, 2014, for example, Senator Kaine introduced the Jumpstart our Businesses by Supporting Students Act, which seeks to amend HEA by expanding eligibility for Pell Grants to students enrolled in short-term job-training programs.[15] The corresponding press release indicates that the initiative would authorize Pell Grants for job-training programs at community colleges and other institutions of higher education, ensure that qualifying programs align with the needs of local employers and lead to a recognized postsecondary credential, encourage eligible institutions to connect short-term credential programs to career pathways, and provide basic skills instruction to support student success (Kaine, 2015).[16]

3.4.2 The Perkins Act

The purpose of the Perkins Act is to develop the academic and career and technical skills of secondary and postsecondary education students who enroll in career and technical education (CTE) programs. The act, which is administered by ED, was last authorized on August 12, 2006 (Perkins IV).[17] The goals of Perkins IV include the attainment of rigorous academic standards by CTE students, "the integration of secondary and postsecondary CTE elements into single programs of study, and the assessment and accountability of the achievement of educational and post-educational outcomes" (Dortch, 2012). The act's original authorization period ended on June 30, 2013, and the act is currently scheduled for reauthorization.

3.5 STATE-LEVEL POLICIES

Policies, programs, and funding streams for skilled technical workforce development at the state and local levels are extensive and varied. At the K-12 level, the National Center for Education Statistics (NCES) reports that in 2013-2014, there were 98,271 operational public schools in more than 18,000 districts (NCES, 2015a, Table 2). In the fall of 2011, there were also 30,861 private schools offering kindergarten or higher grades (NCES, 2013a). NCES reports that current expenditures for public elementary and secondary schools are projected to be $634 billion for the 2015-2016 school year. State and local

[15]The federal Pell Grant program provides need-based grants to low-income undergraduate and certain postbaccalaureate students to promote access to postsecondary education. Financial need is determined by ED using a standard formula established by Congress. See the ED website, http://www2.ed.gov/programs/fpg/index.html.

[16]The remarks made by Senator Kaine to the committee at its 2015 symposium can be found at http://nas.edu/SkilledTechnicalWorkforce.

[17]For background on the evolution of the Perkins Act, see Dortch (2012).

government agencies are the primary source of funding for community colleges. In 2013-2014, expenditures for community colleges totaled $55.9 billion, with nearly half (49.4 percent) coming from state or local funding, 22.6 percent from federal funding, and the remainder from student tuition and fees (16.7 percent) and other sources (11.3 percent) (NCES, 2015b, Table 333.10).

Local governance and funding for K-12 education can have an important influence on postsecondary skilled technical workforce development (see Chapter 5 for more detail).[18] However, consistent with the scope of this study, the committee focused on CTE policy making, which is one of the most common ways in which states address the challenges associated with skilled technical workforce development.

CTE is offered by high schools, area CTE centers, community colleges, technical schools, and employers through classrooms, project- or work-based learning, online courses, apprenticeships, on-the-job training, and other methods (Dortch, 2014b). The goal of CTE, which must be aligned with business and industry requirements, is preparation for employment or family life. CTE occupations generally require 2 years or less of postsecondary education or training and span a wide range of technical skills and subjects in fields other than the liberal arts. For example, CTE provides preparation in homemaking, nursing, business administration, culinary arts, automotive maintenance, software programming, engineering technology, and cosmetology.

A recent paper prepared jointly by the National Association of State Directors of Career Technical Education Consortium (now known as Advance CTE and formerly known as NASDCTEc) and the Association for Career and Technical Education (ACTE) provides an overview of CTE-related state policies enacted in 2014 (NASDCTEc et al., 2015; see also Blosveren, 2015). This report shows that, for the second year in a row, a significant number of states developed and implemented new policies and programs to advance CTE at the secondary and postsecondary levels. Nearly every state had CTE-related activity: state legislatures and regulatory bodies approved approximately 150 policies across 46 states and the District of Columbia. As Table 3-2 shows, the top three issues for state action are related to (1) funding, (2) engaging employers, and (3) earning postsecondary credit in high school and articulating credit across institutions.

Advance CTE and ACTE report on several notable developments in 2014 at the state policy level. California formalized a $250 million investment in its Career Pathways Trust Grant, and South Dakota created a $50 million Build Dakota scholarship program for students entering high-demand workforce programs. Alabama and Iowa created tax incentives to encourage donations and

[18]The committee recognizes the important role of K-12 STEM education in fostering a skilled technical workforce, but defers to a recent National Academies study for a detailed discussion of this topic (see NRC, 2014a).

TABLE 3-2 State-Level Policy Making on Career and Technical Education in 2014

Policy Area	Number of States Addressing Policy Area in 2014	States
Funding	36	AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, ID, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, NE, NJ, NM, NY, OH, OR, SD, TN, UT, VT, WA, WV, WI
Industry/Partnerships/ Work-based Learning	28	AL, AK, AR, CA, CO, CT, DE, GA, IL, IN, IA, LA, ME, MD, MI, MN, MO, NH, NJ, NY, OH, OR, RI, SD, TN, VT, WV, WI
Dual and Concurrent Enrollment/Early College/Articulation	24	AL, AK, CT, DE, FL, GA, ID, IL, IN, KS, KY, LA, ME, MD, MA, MS, MO, NV, NJ, OH, OR, SD, TN, TX
Industry-recognized Credentials	19	AZ, CA, DE, FL, GA, ID, IL, IN, KS, LA, MI, MN, MS, MO, OH, RI, TN, UT, WV
Graduation Requirements	15	AZ, FL, IL, IN, LA, MI, MN, MS, MO, NY, OH, OK, SC, VA, WA
Data/Reporting/ Accountability	15	CA, CO, CT, FL, IN, IA, KY, LA, ME, MI, MN, MO, NJ, UT, VA
STEM	10	AZ, DC, IA, NH, NY, OK, OR, UT, VT, WA
CTE Standards/ Accreditation	10	CO, FL, ID, LA, MN, NJ, OK, TN, WA, WY
Technical/Employability Assessments	7	AZ, MS, MO, NV, NY, OH, SC
CTE Teacher Certification/ Development	7	IL, ME, NJ, ND, RI, TN, VA
Career/Academic Counseling	6	AL, AR, CA, KY, OH, RI
Governance	5	AL, NM, OR, RI, UT

*Note: A single bill or policy can address multiple policy areas.
NOTES: This table is not exhaustive, and therefore, not every state policy found is included. STEM = science, technology, engineering, and mathematics.
SOURCE: NASDCTEc et al., 2015, p. 2.

grants to increase business–education collaboration. Twenty-eight states approved policies to accelerate employer engagement with CTE to help align programs with labor market demands and offer work-based learning opportunities. Twenty-four states addressed earning and articulating credit issues. The Nevada State Board of Education and Board of Regents, for example, approved a new policy to develop statewide articulation agreements for all CTE programs.

Examples of policy-making activities related to business engagement and workforce preparation include measures in Kansas and Tennessee to accelerate credential attainment, Florida's measure to inform parents about the return on investment for certain credentials, and activities of Illinois and Delaware to establish grant programs that will provide training for leading industries in those states (NASDCTEc et al., 2015). In Massachusetts, the Workforce Competitiveness Trust Fund provides $5 million to support 15 active regional industry-sector partnerships of employers and education and workforce organizations that are engaged in training unemployed individuals and placing them in high-demand jobs.

3.6 CURRENT POLICY ISSUES RELATED TO DEVELOPING A SKILLED TECHNICAL WORKFORCE

3.6.1 Labor Law Reform

U.S. labor laws and enforcement agencies at the federal, state, and local levels regulate the rights, duties, costs, and benefits associated with the relationship between skilled technical workers and employers. These rules create important incentives for investing in education and training, a point made by Daniel Marschall, executive director of the AFL-CIO Working for America Institute, during the first panel discussion at the committee's 2015 symposium, and echoed in other panel discussions, papers, and presentations.[19] For example, if workers and employers can be reasonably sure that the labor market will function in a way that enables them to capture returns on their investments in education and training, they are more likely to make these investments. As discussed in more detail in Chapter 5, there is evidence that some employers may not be committed to hiring specific groups of workers, paying high enough wages, or providing sufficiently stable employment to ensure an adequate return on investment in education and training for either their workers or their organization.

[19]In his commissioned paper, Lerman (2015) explores incentive issues for employers. These issues were a particular topic of discussion in Panels 1, 2, and 5 of the committee's 2015 symposium, as well as in each of the keynote speeches.

U.S. labor rules are based principally on laws that are more than 80 years old, including the National Labor Relations Act of 1935 (Wagner Act) and the Fair Labor Standards Act of 1938. However, technological change in the U.S. economy has given rise to a proliferation of nontraditional and contingent employment relationships, which are creating pressure to review and revise these rules to ensure that incentives to promote education, training, innovation, and growth are sustained over time.[20] These developments have been referred to as the "online gig" or "on-demand" economy: work is taking place in a series of one-off or temporary assignments rather than in an ongoing relationship with a single employer. For example, technology-driven online platforms for delivering goods and services make it possible to contract for specific, on-demand services in many occupations, such as maintenance, repair, information technology (IT), and health care assistance.

Technological change presents a separate but related issue in skilled technical workforce development.[21] Most of the papers commissioned for this study, as well as discussions in the symposium panels, alluded in some way to the opportunities and challenges posed by technological change for skilled technical workers and their employers; however, these changes are an immediate and prevalent concern in the health care industry (Frogner and Skillman, 2015). As machines increasingly are integrated into the ways people think about and perform tasks, human–machine teams will proliferate in the workplace. Heterogeneous, symbiotic work teams raise entirely new issues concerning how to allocate labor rights and responsibilities, assign credit for work performed, train both human and machine workers, and allocate returns to labor.

How policy makers decide to classify and regulate these emerging work relationships has important implications for investing in the development and maintenance of a skilled technical workforce in the U.S. economy. A detailed explanation of these issues is beyond the scope of this study, but the committee believes they are important and urges policy makers across governments and locations to address them.

3.6.2 Occupational Licensing Reform

Many skilled technical jobs in maintenance, repair, construction, and health care occupations require some form of licensing or certification. In their commissioned paper, for example, Frogner and Skillman (2015) discuss the impact of licensing requirements on developing and sustaining qualifications in many health care jobs and on moving from one employer or geographic location

[20]For an overview of the estimates and issues, see Dokko et al. (2015).
[21]For an overview of the issues and challenges, see Brynjolfsson and McAfee (2011).

to another. And in their paper, Carter and Miller (2015) discuss the impact of licensing requirements on veterans' employment.

Occupational licensing has important benefits. It is usually justified because it improves quality and protects the public from incompetent or dangerous practitioners. Licensing helps consumers assess a provider's competency when it is difficult for them to do so before buying. In addition, licensing potentially contributes to the development of professional standards, legitimacy, and social status. It can build community and cohesiveness within an occupation and help standardize knowledge, skill, and practices. When licensing functions in these ways, it can offer benefits to providers through increased recognition of occupational work and influence.

Licensing and regulation also can increase the availability of information that helps markets function more efficiently. If consumers are unable to assess the quality of providers before purchasing a good or receiving a service, for example, low-quality providers can remain in the market without being recognized as such, reducing the average quality in the market as well as incentives for other providers to invest in quality improvements (Akerlof, 1970; Kleiner, 2000; Shapiro, 1986). If consumers are uncertain about the quality of a provider, moreover, they may not buy the service, depressing market demand for potentially valuable services. Licensing is one way to address information problems by compelling providers to meet certain quality standards and creating incentives to invest in training and skill development.

However, occupational licensing also imposes costs that can affect incentives to invest in skill development. The imposition of such requirements as additional training and education, fees, exams, and paperwork potentially reduces employment in the licensed occupation and hence competition, which can drive up the price of goods and services for consumers. This could benefit licensed providers, who might earn more than they would in an unlicensed market, or the financial benefits could flow elsewhere, such as to educational institutions or other licensing entities (Friedman and Kuznets, 1954; Kleiner, 2006; Law and Kim, 2005; Smith, 1776).

Licensing requirements also can create a barrier to entry for many jobs. If licensing places too many restrictions on workers, it can reduce the overall efficiency of the labor market. When workers cannot enter jobs that make the best use of their skills, growth and innovation may be depressed. Licensing also may affect entrepreneurship (Slivinski, 2015). Licensed workers are more likely than other workers to be self-employed. In addition, entrepreneurs in new areas that overlap with a licensed occupation may find that they are required to obtain a license because a small part of their work overlaps with that of a licensed occupation.

Finally, licensing can affect worker mobility and the availability of technical skills in labor markets. Many occupations are licensed by the states, and licensed providers typically must acquire a new license when they move to a different state. States set their own licensing requirements, which often vary

with respect to education, experience, training, and testing. The resulting costs in both time and money can discourage people from entering or remaining in an occupation. Licensing requirements can be particularly costly for some workers, such as military spouses, who are very likely to move across state lines. Constraints on worker mobility can create inefficiency in labor markets if workers are unable to migrate easily to the jobs in which they are most productive.

A White House (2015) report on occupational licensing contains several noteworthy findings:

- The share of U.S. workers holding occupational licenses has grown sharply over the past several decades: more than 25 percent of U.S. workers now require a license to perform their jobs, and most of these workers are licensed by the states.
- About two-thirds of the changes in licensing stem from an increase in the number of professions that require a license, and about one-third from the changing composition of the workforce.
- Although licensing can increase incentives to invest in education and training, it also can reduce employment, lower wages for excluded workers, and increase costs for consumers if it makes entry into a profession more difficult.
- As noted above, licensing requirements can vary considerably both within and across states, potentially imposing costs on workers seeking to move across state lines, as well as inefficiencies for businesses and the economy as a whole.

These developments and issues call for DOL to work with local and state policy makers to review their licensing requirements, encourage them to limit licensing to those occupations entailing demonstrable public safety concerns, seek ways to reduce the costs of learning about and obtaining licenses, and coordinate with other in- and out-of-state authorities to harmonize requirements across occupations and sectors.

3.6.3 Science, Technology, Engineering, and Mathematics (STEM) Proficiency

STEM skills are essential components of the bundle of skills that define skilled technical occupations and qualify workers to succeed in these occupations.[22] Moreover, the STEM proficiency of the workforce is a prominent

[22]This observation is supported in each of the papers commissioned for this study, as well as in keynote speeches and discussions at the committee's 2015 symposium. See, in particular, the papers by Rothwell (2015) and Sheets and Tyszko (2015) and

concern in discussions of national competitiveness, education policy, innovation, and even immigration.

In a 2014 companion study to its annual study of STEM indicators, the National Science Board (NSB) explored STEM indicator data, examined recent STEM workforce studies and debates, and consulted numerous experts to develop insights that could facilitate more constructive discussions about the STEM workforce and inform decision makers (NSB, 2015). NSB's findings include the following:

- The STEM workforce is extensive and critical to innovation and competitiveness. As Box 3-3 shows, it is also defined in various ways and consists of many subworkforces. It includes the scientists and engineers who further scientific and technological progress through research and development (R&D) activities, workers in non-R&D jobs who use STEM knowledge and skills to devise or adopt innovations, and workers in technologically demanding jobs who need STEM capabilities to accomplish occupational tasks.
- STEM knowledge and skills allow for multiple, dynamic pathways to STEM and non-STEM occupations alike. Although many individuals with a STEM degree do not work in a STEM field, most of these workers indicate that their job is related to their STEM education. The relatively loose links between degrees and occupations are a distinctive feature of the U.S. workforce. This feature enables individuals to apply STEM skills in jobs across the economy and employers to utilize workers with STEM skills in whatever ways add the greatest value.
- Assessing, enabling, and strengthening workforce pathways are essential to the mutually reinforcing goals of individual and national prosperity and competitiveness. A well-rounded precollege education that includes significant engagement with STEM unlocks pathways into the technical STEM workforce and enables pursuit of additional STEM studies at the bachelor's, master's, and doctoral levels.

Yet a more recent NSB study suggests that policy makers still have a great deal of work to do to ensure that education and training programs effectively help students and workers build and sustain their STEM skills (NSB, 2016).

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presentations and discussions in Panel 4, "Community College Pathways (Advanced Technical Education)," and Panel 11, "Building the Middle-Skill Talent Pipeline and Innovation." For additional insight on the topic, see NASEM (2016a,b,c) and NAE and NRC (2012). As noted earlier, a webcast of the symposium, research papers, and presentations is available at http://nas.edu/SkilledTechnicalWorkforce.

BOX 3-3
What are the STEM Capabilities?

Efforts are underway to gather data on STEM knowledge and skills. This research promises to supplement degree- and occupation-based analyses by clarifying our understanding of the interconnections among skills, education, and occupation. The U.S. Department of Labor's Occupational Information Network (O*NET) program is developing a database with detailed information on the competencies of workers in nearly 1000 occupations.[a]

Anthony Carnevale and colleagues have analyzed O*NET data to identify which competencies are highly associated with STEM occupations.[b] Among the cognitive competencies associated with STEM are knowledge of math, chemistry, and other scientific and engineering fields; STEM skills, such as complex problem solving, technology design, and programming; and STEM abilities, including deductive and inductive reasoning, mathematical reasoning, and facility with numbers. Among the non-cognitive competencies associated with STEM are preferences for investigative and independent work.

[a]The database, O*NET Online, can be found at http://www.onetonline.org/.
[b]Anthony Carnevale, Nicole Smith, Michelle Melton, "STEM," (Washington, DC: Georgetown University Center on Education and the Workforce, 2014). See p. 8 for a full list of the O*NET competencies associated with STEM. Retrieved from: https://cew.georgetown.edu/wp-content/uploads/2014/11/ stem-complete.pdf.

SOURCE: Excerpted from NSB, 2015.

Although 4 of 10 Americans say they are "very interested" in new scientific discoveries that contribute to innovation, growth, and national competitiveness, and 6 of 10 say they have an equally high level of interest in new medical discoveries, only 46 percent of Americans can demonstrate an understanding of scientific inquiry. Moreover, most Americans believe that other countries are doing a better job of providing STEM education and supporting lifelong education and training (NSB, 2016, Chapter 7):

- Although the percentages of 4th-, 8th-, and 12th-grade students achieving a level of proficient or higher on National Assessment of Educational Progress mathematics assessments increased from 2000 to 2013, those percentages remained well below the 50 percent mark.
- Average mathematics and science literacy scores in the United States are below those for all other developed countries, and the United States has substantially fewer high scores and more low scores than those other countries.

The development of STEM capabilities begins in K-12 education. The quality of K-12 education, particularly students' preparation in STEM subjects,

has long been a concern. A 2010 report of the President's Council of Advisors on Science and Technology (PCAST) expresses concern about uneven levels of proficiency and interest in careers in many STEM fields among African Americans, Hispanics, Native Americans, and women (PCAST, 2010). The PCAST report suggests several strategies for addressing these issues, such as supporting higher standards in mathematics and science, recruiting well-prepared teachers for STEM subjects, leveraging educational technology for improvement, expanding students' opportunities to engage in rich STEM experiences, and creating more STEM-focused schools. These strategies for improvement and others are being implemented across the country. Among the most visible initiatives are the new standards in both mathematics and science—the Common Core State Standards in Mathematics (CCSS-Math) and the Next Generation Science Standards (NGSS). These standards provide a national model for states to use as they develop their own specific standards. Both the CCSS-Math and the NGSS are influencing conversations about high-quality K-12 STEM education, even in states where they have not been formally adopted.

Deep exploration of the challenges facing K-12 STEM education and the improvement initiatives across the country is beyond the scope of this study. For further information, see the portfolio of work by the Board on Science Education of the National Academies, including *A Framework for K-12 Science Education* (2012), *Successful K-12 STEM Education* (2011), *Monitoring Progress toward Successful K-12 STEM Education* (2013), *STEM Integration in K-12 Education* (2014), *Developing Assessments for the Next Generation Science Standards* (2014), *Guide to Implementing the Next Generation Science Standards* (2015), and *Science Teachers' Learning* (2015).

All citizens need STEM skills to function effectively in a modern economy that is increasingly based on advances in science and technology. The range and level of required STEM proficiency vary across occupations, including skilled technical occupations, and evolve as new discoveries and technologies are disseminated in life and work. Chapter 6 provides examples of additional approaches that some cities and states are taking to address this important issue.

3.6.4 The Workforce Labor Market Information System

The information system that supports policy making and labor market function—the workforce labor market information system (WLMIS)—is administered primarily by DOL (GAO, 2013; Reamer, 2015).[23] All stakeholders in workforce development seek high-quality data, analyses, and projections of

[23]The WLMIS consists of systems and data owned and controlled by each state. In addition, the Department of Commerce manages and owns data from surveys such as the census that are inputs for the WLMIS.

key segments of the U.S. workforce, such as skilled technical workers. For example, labor market data and analyses are used by policy makers and civic leaders to address education and workforce development needs; by students and workers to make choices about education, training, and credentialing; and by employers to make investment and hiring decisions. In his commissioned paper, presented at the committee's 2015 symposium during the panel on "Data Resources to Support Middle Skill Workforce Development," Andrew Reamer of Georgetown University argues that the WLMIS is less effective than it could be (Reamer, 2015).

Reamer attributes the problems in the current system to several factors. For example, funding for the WLMIS is insufficient, and coordination across local and federal agencies that contribute to and use the system could be improved. Reamer also finds a lack of understanding among analysts of how participants in labor markets at the microeconomic level rely on the WLMIS to make decisions. Moreover, many analysts are using outdated and ineffective research methods. They have not innovated in response to advances in the data and computational sciences.

Reamer notes that DOL is actively exploring how it might better use advanced, low-cost IT to improve the WLMIS. Moreover, WIOA mandates and provides a detailed framework for providing most of the information resources that labor market participants need, and aims to address many of the systemic problems. However, Reamer observes that the predecessor to WIOA (WIA of 1988) gave the secretary of labor a similar mandate to create and maintain a national employment statistics system, but succeeding secretaries did not pursue this mandate (Reamer, 2015).

Based on Reamer's detailed analysis and supporting evidence from other papers and panel discussions, the committee observes that the WLMIS does not effectively support the country's skilled technical workforce development needs.[24] Chapter 6 provides examples of additional approaches that some cities and states and are taking to address this issue.

3.7 CONCLUSIONS

In the United States, incentives to develop technical skills are influenced by a complex, polycentric system of labor and education policies and programs that operate at the federal, state, and local levels. Skilled technical workforce

[24]Every paper commissioned for this study notes the inadequacy of the existing WLMIS. It is not unusual for analysts to call for more and better data; however, some participants in Panel 10 at the 2015 symposium echoed Reamer's call for analysts to be more creative in their research methods.

development is currently a high priority for the Executive Branch, Congress, the states' governors, and the cities' mayors.

Congress recently passed WIOA, which represents the first major reform of the workforce development system in 15 years. This legislation requires extensive alignment and integration across federal, state, and local workforce development activities. Although the reforms contained in this act are appropriate to address many issues concerning the skilled technical workforce and are based on the best available evidence about effective strategies, the act has yet to be fully implemented, and ongoing research is needed. Many experts express concern about whether and how well these reforms will be fully implemented and whether the findings of salient research will be addressed. At the state level, policy makers are focusing on two interconnected types of improvements: (1) CTE, which prepares secondary and postsecondary students for skilled technical jobs and postsecondary education; and (2) better articulation and alignment of the incentives of skilled technical workers, educators, employers, trade associations, labor unions, and industry to achieve workforce development objectives. Several policy areas require high-priority attention at the federal, state, and local levels: labor law reform, occupational licensing reform, lifelong STEM skills improvement, and investment in an improved WLMIS and associated analyses.

The next chapter explores the incentives of participants who are most directly involved in producing the skilled technical workforce.

4

The Complex U.S. System of Workforce Education and Training

Education and training take place in a variety of contexts in the United States. There is no single, formal system for training workers, and Americans are responsible for finding their own path, based on their preferences, capacities, and means. Students are encouraged to begin making these choices at the secondary school level, when they have the option to pursue both academic and technical education. After earning a high school diploma, students may enter full-time employment in a technically skilled job, continue their education and training, or do both at the same time. Americans can select from a large menu of degree- and non-degree-granting postsecondary education and training programs at any time during their work lives. Unless students receive scholarships, grants, or education benefits from public or private sources, they are ultimately responsible for paying all the costs associated with their education and training by drawing on savings or current earnings or by incurring debt.

The federal, state, and local governments provide resources that support education and training both directly and indirectly. In addition, although the incentives for employers to support education and training for workers are highly variable, many employers either provide education and training directly to workers on the job or subsidize their employees' education and training through reimbursement programs. But whether employees are using these programs to their greatest advantage and to what extent employers are contributing to the development of a skilled technical workforce remain unclear.

This chapter describes the complexities of workforce development in the United States and the components of this system that are particularly relevant for preparing skilled technical workers. Section 4.1 introduces the quasi-public characteristic of education and training. Section 4.2 describes the primary components of workforce development, including career and technical education (CTE) and degree-granting postsecondary education and training programs. Section 4.3 examines other postsecondary education and training programs, including apprenticeship, certificate, and certification programs, that do not

confer a degree. Section 4.4 reviews key funding sources for skilled technical workforce education and training, including federal, state, and employer sources. Section 4.5 presents conclusions.

4.1 EDUCATION AND TRAINING AS A QUASI-PUBLIC GOOD

Education and training are examples of a quasi-public good, having characteristics of both private and public goods. Society as a whole is better off when all of its members are able to develop their innate capacities. Education and training also can potentially serve public purposes by ensuring the availability of a pool of workers who can contribute to economic growth. At the same time, the benefits of private investments in education and training potentially accrue to individuals in the form of opportunities and wages. Hence both society and individuals have a role to play with respect to investment in education and training.[1]

Given that both the costs and benefits associated with investments in education and training affect individuals, employers, and the broader society, it can be difficult to separate, measure, and allocate returns on these investments.[2] For example, by observing others, their way of doing things, and the knowledge products they produce, one can educate and train oneself. In other words, knowledge and learning spill over to others, and it is difficult to fully recover the costs of production and distribution. Moreover, because some of the benefits accrue to society as a whole, individuals may undervalue and underinvest in education and training, suggesting a role for public provision or subsidies (Cornes and Sandler, 1996).

Americans have a long history of pursuing and publicly supporting elementary and secondary education and training. The colonists began to establish public schools in the early 1600s; Boston Latin School was established in 1635. By the time of the Revolution, some colonies, such as Georgia, were partially funding grammar schools (*Education News*, 2013). By 1918, attendance in elementary school was compulsory in all states, and by 1920

[1]Several theories aim to explain why individuals invest in education and training. For example, Becker (1964, 1993) conceptualizes the set of marketable skills of workers as a form of capital in which workers make a variety of investments to obtain better opportunities and wages. Alternatively, Spence (1973, 2002) conceptualizes education and training as a way for individuals to signal the nature of their abilities to prospective employers and thereby gain above-average wages. Theoretical perspectives are potentially important in understanding investment incentives and the structure of wages and earnings. However, exploring the range of theories and the evidence that supports them is beyond the scope of this study.

[2]For a more detailed explanation and the theoretical underpinnings of this analysis, see Cornes and Sandler (1996).

roughly one-third of Americans aged 14-17 had attended some form of secondary school. During the period 1940-2014, the percentage of U.S. adults with a high school degree increased from 24.1 to 88.3 percent (Ryan and Bauman, 2016, Table A-1).

In contrast with many other countries that are members of the Organisation for Economic Co-operation and Development (OECD), however, most federal- and state-level policies in the United States treat postsecondary education more like a private good than a public or quasi-public good. These policies often assume that workers will capture all of the returns on their investments in education and training and that no one else in society will benefit from those investments. Yet despite this fundamental misalignment of incentives, education is valued by an increasing proportion of the population. During the period 1967-2013, the percentage of Americans who completed high school and then enrolled in either a 2- or 4-year degree-granting institution increased from 25.5 to 68.4 percent (BLS, 2016a). Moreover, approximately 44 percent of individuals aged 16 or older participate in some form of formal adult education, such as basic skills training, apprenticeships, work-related courses, personal-interest courses, English as a second language classes, part-time college, or university degree programs (NCES, 2007).

Seeking to further invigorate commitment to workforce development, the OECD secretary general argued in a 2012 report that skills have become the "global currency" of 21st-century economies. Reflecting on the results of a survey conducted by the Programme for the International Assessment of Adult Competencies, he urged member countries to find ways to improve skill levels and invest continuously in the identification and acquisition of new skills so these countries can effectively organize and compete in the 21st century (OECD, 2012a).

4.2 THE PRIMARY COMPONENTS OF WORKFORCE DEVELOPMENT

As in many other aspects of public life, the United States does not have a single, formal system for educating and training workers. Americans who wish to develop technical skills and prepare themselves for success in skilled technical occupations have a wide range of education and training options that depend on several factors, including their access to funding, their social networks, the availability of programs in their geographic location, and their interests.

These specifics aside, in general Americans have the range of formal options for skilled technical education and training depicted in Figure 4-1, which they may pursue simultaneously, sequentially, or in idiosyncratic order. Beginning with secondary education, students may choose to take advantage of

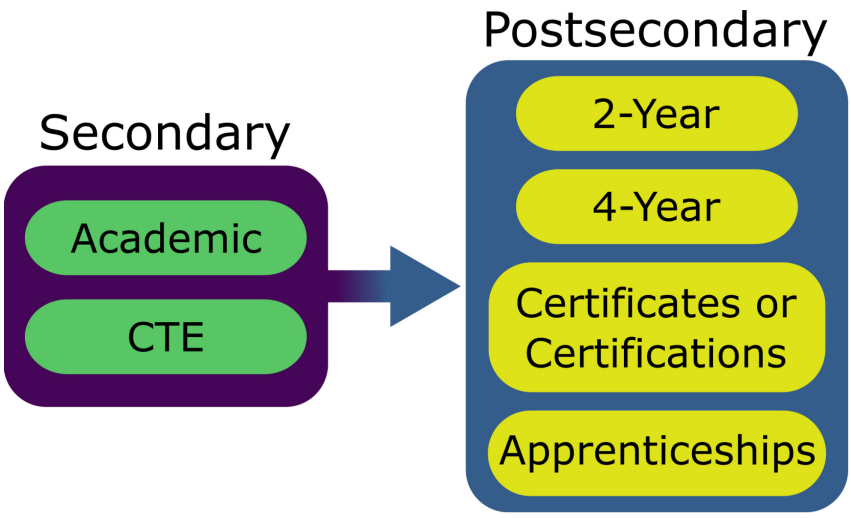

FIGURE 4-1 Decision options at the secondary and postsecondary levels for skilled technical education and training.
NOTE: CTE = career and technical education.

CTE programs offered, often in conjunction with cooperative work experience programs, in comprehensive high schools, full-time CTE schools, and area or regional CTE centers. CTE students can take work-related courses in subjects related to skilled technical occupations, acquire hands-on work experience, and prepare to enter full-time employment upon obtaining their high school diploma. Some proponents argue that secondary CTE is valuable because it serves as pedagogy for science, technology, engineering, and mathematics (STEM) subjects. Because many students learn better with a hands-on approach and skilled technical CTE requires some level of STEM proficiency, secondary CTE provides a way to reinforce and integrate academic education and technical training. Moreover, if CTE programs are overseen by effective committees whose members come from business and industry, they can advise CTE educators, administrators, and education board members on employment needs and requirements.

Concurrent with secondary studies or upon graduation from high school, a student may prepare for a skilled technical occupation through programs in an institution of higher education; an organization that certifies skill competencies, such as an industry association or professional society; or an apprenticeship. Finally, youth and adults may enroll in skilled technical job training through

various programs funded by the Workforce Innovation and Opportunity Act (WIOA) through the American Job Centers or community-based organizations.[3]

To inform understanding of the education and training decisions being made by students and workers, the following subsections review enrollment and other salient quantitative data for formal skilled technical education and training programs.[4]

4.2.1 Secondary Career and Technical Education

The U.S. Department of Education reports that from 1990 to 2009, the average number of CTE credits earned by U.S. public high school graduates declined from 4.2 to 3.6, while the average number of credits earned in other subject areas increased. By contrast, average credits earned in core academic fields (i.e., English, mathematics, science, and social studies) rose during this same period. Also in this period, the percentage of graduates who reportedly earned credit in any occupational CTE area declined from 88 to 85 percent (NCES, 2013b). Within occupational CTE, however, the direction and magnitude of change differed by specific occupational area. Occupational areas with declining participation were business, manufacturing, computer and information sciences, engineering technologies, repair, and transportation. Occupational areas with increasing participation were communications and design, health care, public services, and consumer and culinary services, with communications and design being the area of greatest increase.

In the review of work-related education in high schools commissioned for this study, Stern (2015) found that CTE programs are provided in about 9,500 comprehensive high schools in the United States. In addition, he found that about 1,000 technical high schools offer both CTE and academic subjects, and about 800 area or regional technical schools offer only CTE courses.

Looking at trends in enrollment, Stern found that the percentage of high school graduates who concentrated in an occupational area by taking three or more CTE credits in the same area fell from 33 percent in 1982 to 19 percent in 2009. Overall, the percentages of CTE concentrators among high school graduates decreased among all socioeconomic, racial, and ethnic groups over the same period and are no longer skewed toward less-affluent students. As Table 4-1 shows, however, in the aggregate, CTE programs still enroll relatively large proportions of students from low-income families. Many CTE students

[3]These programs are relatively small in scale. See Figure 3-2 in Chapter 3.

[4]In addition to formal education and training options, some workers may elect to engage in self-study programs or to participate in employer-sponsored on-the-job training. However, it is difficult to find data on informal choices; hence, the analysis here is limited to formal programs.

TABLE 4-1 Percentages of Career and Technical Education (CTE) Concentrators from Different Demographic Groups

Group	Percentage in 2004
Lowest socioeconomic quartile	21
Middle socioeconomic quartiles	19
Highest socioeconomic quartile	12
Black	18
Hispanic	13
White	19

SOURCE: Compiled based on Stern (2015).

also have lower levels of prior academic performance. While these aggregate data may differ at the local and state levels, they suggest the need to raise awareness about the value of skilled technical work and the opportunities associated with CTE preparation. In addition, curricula need to address career awareness, exploration, and preparation in elementary as well as secondary school, and younger children need to have the opportunity to develop skills and explore technical work.

Looking at the percentage of CTE concentrators in 12th grade who state their expected level of education, Stern found that 54 percent aim to obtain a bachelor's degree or higher, and another 28 percent expect to attend some college. Stern concludes that preparing students for immediate entry into full-time employment after high school is no longer a widely espoused goal: most students who take work-related courses in high school now also complete sufficient academic coursework to enter some form of postsecondary education.

4.2.2 Postsecondary Degree-Granting Institutions

The U.S. Department of Education reports that there were 4,207 degree-granting institutions—2,603 4-year and 1,604 2-year—in the United States in 2014-2015 (NCES, 2016c, Chapter 4). Figure 4-2 shows the number of degree-granting institutions with first-year undergraduates in the academic years 2000-2001 and 2014-2015 by level (4- or 2-year) and type (public, private nonprofit, or private for-profit) of institution. Most 2-year institutions were public (919), whereas most 4-year institutions were private nonprofit (1,283). One interesting change pertains to the total number of private for-profit institutions, which almost doubled from 687 in 2000-2001 to 1,258 in 2014-2015. However, most of this growth occurred in 4-year institutions, whose number more than tripled from 207 to 656, compared with an increase in 2-year institutions from 480 to 602.

Public, private nonprofit, and private for-profit institutions are regulated in different ways. These regulations may have consequences for innovation, scale, quality, cost-effectiveness, and other factors. Investigating regulatory differences is beyond the scope of this study; however, it may be useful for policy makers to examine these differences in detail in local contexts.

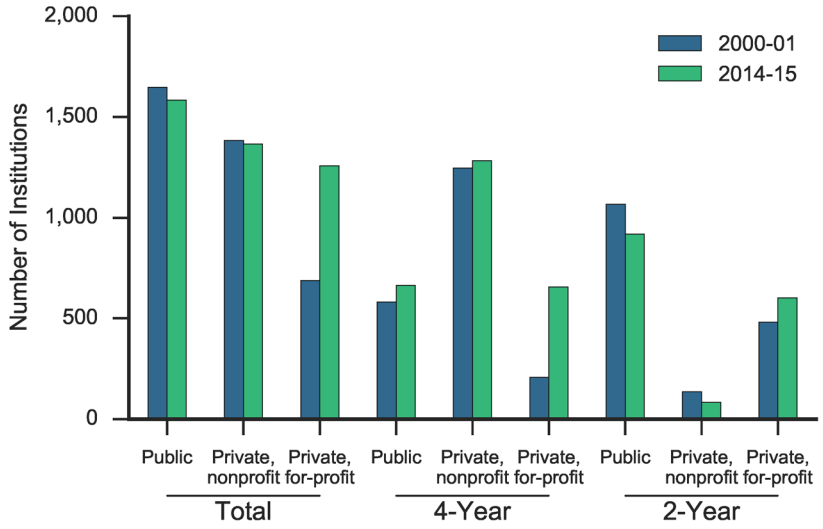

FIGURE 4-2 Number of degree-granting institutions with first-year undergraduates.
SOURCE: NCES, 2016c.

Degree-granting postsecondary institutions vary in many ways, but two dimensions in particular are frequently noted: admissions policies and completion rates.

In academic year 2014-2015, 29 percent of all 4-year institutions had open admissions policies (accepted all applicants). In that same year, a higher percentage of private for-profit 4-year institutions (66 percent) than private nonprofit (15 percent) and public (19 percent) 4-year institutions had open admissions policies. By contrast, the majority of 2-year institutions (91 percent) had open admissions policies. Open admissions policies were in operation at 98 percent of public 2-year institutions and 84 percent of private for-profit 2-year institutions, compared with 56 percent of private nonprofit 2-year institutions (NCES, 2016c).

Looking at completion rates, the majority (60 percent) of all first-time full-time undergraduates enrolled in 4-year institutions graduate within 6 years (NCES, 2016c). Private nonprofit institutions have the highest completion rates (65 percent), followed by public institutions (58 percent) and private for-profit institutions (just 27 percent). By contrast, only 28 percent of all first-time full-time undergraduates enrolled in 2-year institutions graduate within 150 percent of the normal time, and these statistics are skewed by low rates of completion in

public institutions, where just 20 percent of students graduate at all.[5] The majority of students at private institutions graduate within 150 percent of the normal time, and students at for-profit institutions graduate at higher rates than those at nonprofit institutions (59 versus 51 percent).

4.2.3 Student Enrollment

In fall 2014, 17.3 million Americans were enrolled in a degree-granting institution (NCES, 2016c). Most of these students were enrolled in 4-year institutions (10.6 million), and the remainder in 2-year institutions (6.7 million). Students in 4-year institutions typically enroll full-time (76 percent), whereas students in 2-year institutions typically enroll part-time (70.4 percent). Data show rather modest participation in distance education. Students who do participate in this form of education appear to prefer combining it with residential learning: about 28 percent of students enroll in some distance education, whereas just 12 percent pursue all of their education and training through this modality (NCES, 2016c).

As Figure 4-3 shows, U.S. Department of Education statistics indicate that although most students of degree-granting institutions are young and in the early stages of their work life, a significant portion (22 percent) are age 30 or older. In contrast, just 1 percent of these students are under age 18. These data suggest that to support the achievement of skilled technical workforce objectives, institutions need to develop adept curriculum designs, pedagogy, and support services that are appropriate for students of a wide range of ages and experience levels. And given that young students will have different needs, options, and incentives from those of their older adult counterparts, policies and programs need to be designed to create incentives for both youth and older cohorts to invest in skilled technical education at all stages of their work lives.

4.2.4 Community Colleges

Most 2-year degree-granting institutions are community colleges, which are Title IV institutions that provide affordable postsecondary education and a potential pathway to a 4-year degree.[6] Community colleges are a key component

[5]Low completion rates impact the return on postsecondary vocational degrees and certificates. Chapter 5 reviews the evidence that the return is associated with receipt of the degree (the so-called "sheepskin effect"), not with the training alone.

[6]Title IV of the Higher Education Act of 1965 (HEA) covers the administration of the U.S. federal student financial aid programs. American colleges and universities are generally classified with regard to their inclusion under Title IV, such as under U.S. Department of Education statistics.

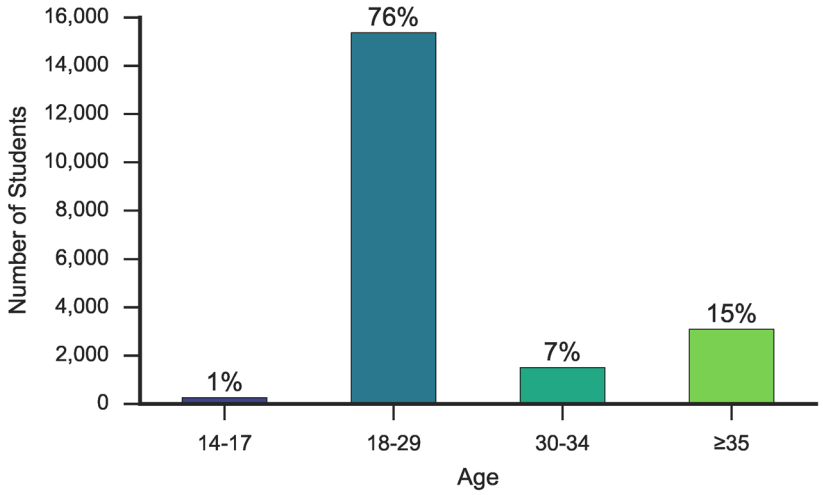

FIGURE 4-3 Postsecondary enrollment in degree-granting institutions by age group in 2015 (projected).
SOURCE: Compiled based on NCES (2014a, Table 303.40).

of skilled technical workforce development in local economies. The American Association of Community Colleges (AACC) reports that 1,108 U.S. community colleges enroll approximately 12.3 million students, or about 45 percent of all undergraduate students in the United States (AACC, 2016).

The mission of community colleges is to provide education to all individuals in a local area, and as noted above, most have an open-access admissions policy. Community colleges offer a comprehensive range of education and training to support lifelong learning that includes both credit and noncredit programs. For example, community colleges typically offer associate's degrees that are transferrable to 4-year degree programs, terminal associate's degrees, certificates, certification, apprenticeships, and contract or custom training on a noncredit basis. According to AACC, most community college students (60 percent) are enrolled in credit programs on a part-time basis (AACC, 2016). In addition, most work while they attend school: 73 percent of part-time and 62 percent of full-time students work either part- or full-time. Most community college students also receive some form of financial assistance. The U.S. Department of Education reports that 78 percent of first-time 2-year degree-/certificate-seeking students receive financial assistance to meet the costs of tuition, books, and other educational expenses (NCES, 2016c).

Aggregate data suggest that public funds, particularly state and local funds, are crucial sources of revenue for community college operations. Table 4-2 shows that most community college revenues come from tuition (29.5 percent) and from state (29.8 percent) and local (18.1 percent) sources. AACC data for

TABLE 4-2 Community College Revenues by Source (2013-2014)

Source	Revenue	%
Tuition	$17,242,025,437	29.5
Federal	8,264,032,954	14.1
State	17,442,989,183	29.8
Local	10,568,296,830	18.1
Other	4,929,830,599	8.4
Total	**$58,447,175,003**	**100.0**

SOURCE: AACC, 2016.

academic year 2011-2012 reveal that although most student financial aid was received from federal sources, state and institutional aid were also important (AACC, 2016).[7] In addition, in 2013-2014, community colleges received federal aid in the form of Pell Grants, Federal Supplemental Educational Opportunity Grants, and Federal Work-Study programs.

Researchers at Columbia University Teacher's College report that 80 percent of community college students intend to earn a bachelor's degree, but only one-quarter of them transfer to a 4-year institution within 5 years (Jenkins and Fink, 2015). However, AACC (2015) data indicate that community college students who earn an associate's degree as a first credential are more likely to transfer to a 4-year institution to earn a bachelor's degree: 41 percent of college students who earned an associate's degree in 2008-2009 as a first credential subsequently earned a bachelor's degree within 6 years. Community College Research Center analysts have shown that the completion outcomes of community college transfer students vary depending on the type of institution to which they transfer, as well as the number of credits accepted by the receiving institution (Jenkins and Fink, 2015). The analysis shows that approximately 72 percent of community college students who transferred went to public 4-year institutions. Data on bachelor's degree completion 6 years after transfer show that 65 percent of students who transferred to a public 4-year college/university earned a bachelor's degree.

4.3 OTHER POSTSECONDARY EDUCATION AND TRAINING PROGRAMS

Skilled technical workforce development encompasses education and training programs that complement degree-granting programs, including apprenticeships, work-related courses, certificate programs, and certification

[7]AACC analysis for the year 2011-2012 reveals that of students who received financial aid, 38 percent received federal grants, 19 percent received federal loans, 12 percent received state aid, and 13 percent received institutional aid.

programs. In many cases, students pursue both types of education and training either simultaneously or sequentially.

The National Center for Education Statistics (NCES) collects data on adult education that include participation in apprenticeships and work-related courses.[8] It reports that participation in all forms of adult education "among individuals aged 16 or older increased from 40 percent in 1995 to 46 percent in 2001 and then declined to 44 percent in 2005….In 2005, among the various types of adult education activities, individuals aged 16 or older participated most in work-related courses (27 percent), followed by personal interest courses (21 percent), part-time college or university degree programs (5 percent), and other activities (3 percent)" (NCES, 2007, Indicator 10).

Table 4-3 summarizes the 2005 NCES data (the most recent data) relevant to overall worker participation in skilled technical workforce development. These data suggest that aggregate participation rates vary by sex, age, and occupation: participation is higher for women than for men, for those aged 30-65 relative to other age groups, and for those working in health-related occupations relative to those working in other skilled technical occupations, although these data may vary by location.

The most common types of worker education and training programs that do not confer degrees and are particularly relevant to skilled technical workforce development are apprenticeships, certificate programs, and certification programs. Students and workers who wish to participate in such programs and earn a degree must concurrently enroll in a degree-granting program in an accredited secondary or postsecondary institution. An overview of these programs is provided below.

4.3.1 Apprenticeships

Apprenticeships are formally structured work training programs in which workers are employed in a job and earn wages while receiving on-the-job training and job-related technical instruction. In the United States, registered apprenticeship programs must meet national standards: the U.S. Department of Labor and the states' apprenticeship agencies register and administer formal apprenticeship programs. At the conclusion of the apprenticeship, the worker earns a nationally recognized credential.

The U.S. Department of Labor estimates that the U.S. registered apprenticeship network currently includes 150,000 employers and more than

[8]For background and links to data, see NCES (2007).

TABLE 4-3 Participation in Job-Related Courses and Apprenticeship Programs in 2005

Characteristic of Employed Persons	2005					
			Percent Participating			
	No. of Employed Persons (in thousands)		In Career- or Job-Related Courses		In Apprentice-ship Programs	
Total	**133,386**	**(1,508.1)**	**38.8**	**(0.83)**	**1.4**	**(0.24)**
Sex						
Male	71,754	(934.7)	31.7	(1.22)	2.0	(0.37)
Female	61,632	(1,219.3)	47.1	(1.43)	0.8	(0.23)
Age						
17-24	15,027	(1,030.4)	26.4	(3.01)	3.0[a]	(1.03)
25-29	14,555	(918.4)	36.1	(2.94)	3.1[a]	(1.12)
30-34	15,250	(977.2)	41.0	(3.06)	2.7[a]	(1.10)
35-39	15,286	(922.4)	41.7	(4.16)	1.0[a]	(0.46)
40-44	18,141	(946.3)	39.8	(2.73)	[b]	[c]
45-49	18,149	(842.5)	45.0	(2.15)	0.7[a]	(0.29)
50-54	14,624	(732.1)	42.6	(2.49)	0.7[a]	(0.32)
55-59	10,522	(676.0)	44.7	(2.98)	[b]	[c]
60-64	6,021	(498.8)	38.9	(3.97)	[b]	[c]
65 and over	5,812	(493.3)	21.6	(3.48)	[d]	[c]
65-69	3,385	(415.5)	19.1	(4.05)	[d]	[c]
70 and over	2,427	(282.3)	25.1	(5.81)	[d]	[c]
Occupation						
Health diagnosing and treating practitioners	978	(208.8)	78.9	(7.10)	[b]	[c]
Registered nurses, pharmacists, dieticians, therapists, and physician assistants	2,794	(238.8)	79.7	(4.60)	[b]	[c]
Health technologists and technicians	3,060	(436.7)	70.6	(7.31)	[b]	[c]
Technologists and technicians, except health	1,774	(336.5)	29.4	(8.10)	[b]	[c]
Mechanics and repairers	5,241	(521.6)	28.3	(4.47)	4.0[a]	(1.44)
Construction and extractive occupations	6,827	(647.1)	12.4	(3.04)	5.3[a]	(2.26)

TABLE 4-3 Continued

Characteristic of Employed Persons	2005					
	No. of Employed Persons (in thousands)		Percent Participating			
			In Career- or Job-Related Courses		In Apprentice-ship Programs	
Precision production	10,483	(839.3)	23.5	(3.79)	*b*	[c]
Production workers	[e]	[c]	[e]	[c]	*e*	[c]
Miscellaneous occupations	801	(189.4)	17.2	(6.87)	*b*	[c]

[a]Interpret data with caution.

[b]Reporting standards not met.

[c]Not applicable.

[d]Rounds to zero.

[e]Not available.

NOTES: Standard errors appear in parentheses. Neither this table nor the National Center for Education Statistics (NCES) data on which it is based are all-inclusive or represent a comprehensive study. The table indicates potential areas of further analysis and research.

SOURCE: Based on NCES (2014b, Table 507.30).

1,000 occupations (see DOL, n.d.).[9] Included in this total is the United Services Military Apprenticeship Program (USMAP), which accounted for nearly one in four registered apprenticeships in the United States in 2013 (Lerman et al., 2015).[10] However, NCES data (Table 4-3) suggest that fewer than 2 percent of all U.S. workers participate in apprenticeship programs. More detailed analyses of participation would likely reveal differences across groups and locations.

In a survey of apprenticeship theory and practice, Wolter and Ryan (2011) find that apprenticeships vary greatly across countries in terms of the numbers of workers who are trained and the skill content of the training.[11] Apprenticeship

[9]Not all registered programs are active. Interested researchers need to adopt innovative methods and tools to analyze the dynamics of U.S. apprenticeship programs and the policy implications of these dynamics.

[10]USMAP is a formal military training program implemented by the Center for Personal and Professional Development that provides active duty Coast Guard, Marine Corps, and Navy service members with the opportunity to improve their job skills and to complete their civilian apprenticeship requirements while on active duty. The U.S. Department of Labor provides the nationally recognized "Certificate of Completion" upon program completion. See Chapter 5 for further detail.

[11]For example, in a recent survey of European work-based education and apprenticeship systems, Lerman and Rein (2015) find that only one-quarter of Europe's enterprises with more than 10 staff take on apprentices. The reasons for this may be related to the costs associated with administration, apprentices' time away from the workplace, and employees' time spent training. For a comprehensive analysis of the economic issues and evidence, see Wolter and Ryan (2011).

practices also vary across sectors and occupations within countries, as do the ways in which the programs are provided and financed by employers and other stakeholders. The authors observe that no "general theory" as yet explains the full range of practices within, let alone among, countries.

Wolter and Ryan (2011) also report variation in program performance and cost. While some apprenticeships produce superior labor market outcomes, others may be poorly integrated into their local economy. Apprenticeships also are not costless, and their costs may not be symmetrically distributed.[12] If educators do not provide the appropriate curriculum to complement on-the-job training, for example, employers may end up bearing more of the apprenticeship costs, which they may or may not be able to recover. Box 4-1 reviews some of the challenges of setting up apprenticeship programs in the United States.

Despite the challenges described in Box 4-1, however, the potential benefits of apprenticeship have attracted the interest of policy makers, educators, and employers. Apprentices may produce benefits for firms that are not reflected in the value of their wages or other benefits. For program participants, benefits include the cognitive and motivational effects of combining academic learning and practice with skill learning, better integration of the content of skill learning with occupational requirements, increased youth employment rates, and better school-to-work transitions.[13]

Indeed, the past decade has seen a growing interest in apprenticeship programs in the United States. In a paper commissioned for this study, Messing-Mathie (2015) finds that interest in developing apprenticeship models in the United States is oriented around the "dual-education (or dual-study)" model, which is common in Germany, Austria, and Switzerland. This model combines classroom education in a postsecondary program of study with a direct relationship with an employer through a multiyear apprenticeship. Students apply to apprentice directly with a firm. The firm has an agreement with an institution of higher education, which in the United States is typically a community college, to provide the academic portion of the training.

U.S. apprenticeships have traditionally been limited to such sectors as construction, maintenance and repair, manufacturing, and service occupations. However, Messing-Mathie reports that since 2004, the United States has seen a

[12]Wolter and Ryan (2011) find that empirical observations show not only that there is a large degree of heterogeneity in the training costs that firms share but also that many firms reap net benefits even during the training of apprentices.

[13]In addition to the Wolter and Ryan (2011) survey of the literature, see Backes-Gellner (2014); Bolli and Hof (2014); Bolli and Renold (2015); Eggenberger et al. (2015); Muehlemann and Wolter (2014); Rupietta and Backes-Gellner (2015); Wolter and Muehlemann (2015); Ferm (2008); and Rosenfeld et al. (2014).

BOX 4-1
Apprenticeships: Challenges from Concept to Application

- **No clear definition.** A variety of different models confuse the notion of what constitutes an apprenticeship. Variations include time-based versus competency-based models and various levels of on-the-job learning versus external training. Given the lack of industry-recognized standards for apprenticeship, many short-term programs call themselves "apprenticeships" but are more like internships or coop programs.
- **High investment to start up a program.** Small businesses often find it too costly to create their own apprenticeship programs with defined curricula, to partner with community colleges or other educational institutions, and to recruit apprentices (which includes building relationships with feeder high schools and providing "train-the-trainer" courses for employees).
- **Lack of intermediaries.** One way to get around high start-up costs is to have an intermediary aggregate several companies into one program. However, funding generally is not available for such intermediaries, except for short-term grants.
- **Lack of long-term investment culture.** Given that apprenticeship programs take a minimum of 3-5 years to truly pay off, companies that offer such programs must have a culture of long-term investment. As a result, companies that offer these programs tend to be privately held, with less pressure to file quarterly or annual financial reports relative to publicly held companies.
- **Ineffective standards.** Very few U.S. apprenticeships are tied to a standardized, comprehensive, competency-based credential. Such standardization is critical in European programs and builds confidence in the ability of apprenticeships to deliver high-quality employees that meet specific standards.
- **Lack of in-company training resources.** Many companies, especially small and medium enterprises, lack the resources to develop in-house training curricula. Employees often lack the pedagogical skills and confidence to train new apprentices, human resources staff often lack the technical capability to evaluate external training experiences, and leadership for the development of a "training culture" is often absent within a company.

rise in the registration of new apprenticeship programs in such high-growth industries as health care, advanced manufacturing, information technology, and biotechnology, and that these programs—including the Kentucky Federation for Advanced Manufacturing Education (KYFAME), Apprenticeship Carolina, and the Michigan Advanced Technician Training Program (MAT2)—take a hybrid approach that deviates from the European dual-education model (Messing-Mathie, 2015).[14] Observing that apprenticeships are situated in specific social, economic, and regulatory contexts, she argues that such programs should be designed to allow for flexible responses to local requirements.

4.3.2 Alternative Credentials

Recognizing that education credentials other than academic degrees have potential labor market value, some researchers have begun to consider the role of these alternative credentials in education and training related to skilled technical workforce development (see, e.g., Carnevale et al., 2012; Kleiner and Krueger, 2010). A coordinated federal government effort to develop a better understanding of alternative credentials is currently under way as well. The Interagency Working Group on Expanded Measures of Enrollment and Attainment (GEMEnA) is developing and validating national measures of credentialing for work and is building government-wide consensus for the adoption of these measures in key federal data collections.[15] Box 4-2 lists GEMEnA's working definitions of alternative credentials. The following subsections provide an overview of issues related to educational certificates and certifications in skilled technical workforce development. Issues related to occupational licensing are described in Chapter 3.

Educational Certificates

Many postsecondary institutions offer certificate programs, which are stand-alone programs of specialized study or training that award a certificate

[14]See Chapter 6 for a discussion of the role of these intermediaries. In this hybrid approach, the educational organization acts in partnership with the employer to provide a dual-training model of apprenticeship learning, but the primary relationship is between the student (i.e., employee) and the employer (Messing-Mathie, 2015).

[15]GEMEnA consists of staff from the following federal offices: Bureau of the Census, Department of Commerce; Bureau of Labor Statistics, Department of Labor; Council of Economic Advisers; National Center for Education Statistics, Department of Education; National Center for Science and Engineering Statistics, National Science Foundation; Office of Statistical and Science Policy, Office of Management and Budget; and Office of the Under Secretary, Department of Education. To ensure the relevance of its work, GEMEnA also meets regularly with a panel of experts and collaborates with a wide range of partners and stakeholders (NCES, n.d.).

BOX 4-2
Working Definitions of Alternative Credentials

Certification

A credential awarded by a certification body based on an individual demonstrating through an examination process that he or she has acquired the designated knowledge, skills, and abilities to perform a specific job. The examination can be either written, oral, or performance-based. Certification is a time-limited credential that is renewed through a recertification process.

Educational Certificate

A credential awarded by a training provider or educational institution based on completion of all requirements for a program of study, including coursework and test or other performance evaluations. Certificates are typically awarded for life (like a degree). Certificates of attendance or participation in a short-term training (e.g., 1 day) are not in the definitional scope for educational certificates.

License

A credential awarded by a licensing agency based on predetermined criteria. The criteria may include some combination of degree attainment, certifications, certificates, assessment, apprenticeship programs, or work experience. Licenses are time-limited and must be renewed periodically.

SOURCE: GEMEnA based on Bielick et al. (2013, p. 4).

rather than a degree to students who complete the program satisfactorily. Certificate programs may be offered on a credit or noncredit basis, and usually take more than 1 month but less than 1 year to complete. NCES (2016c) estimate that public and private postsecondary institutions awarded a total of 969,353 certificates in 2013-2014. In a review of the literature commissioned for this study, Karp (2015a) defines a certificate as "a credential awarded by a postsecondary institution, recognizing completion of coursework in a discipline."[16] In general, Karp finds that individuals with a certificate are likely to earn more money in the labor market than individuals with only a high school degree or some college. Positive returns range from 7 to 24 percent after controlling for individuals' preexisting skills and abilities. However, Karp notes that recent research indicates that the return on investment for a certificate varies considerably depending on length of study, occupation, geographic region, gender, race, and ethnicity.

[16]Karp's (2015a) paper focuses on Title IV community colleges. For additional perspective and data on certificate and certification holders, see Ewert and Kominski (2014).

Karp found no studies examining the extent to which certificate holders subsequently earn an associate's degree. Her own analysis suggests that only 7 percent of first-time students who earned a certificate went on to earn an associate's degree. She also found evidence that it is uncommon for certificate completers to transfer to a 4-year institution. She concludes that the existing evidence indicates that certificates do not generally serve as pathways to degree-granting education programs, despite the aspirations expressed in the career pathways literature.

Certifications

Industry groups, professional organizations, and employers award certifications to individuals who meet program standards for knowledge, skills, and abilities. In a report for the Lumina Foundation, Ewert and Kominski (2014) estimate that more than 4,000 entities offer certifications in the United States. Governments are the most common certifying entities (71.4 percent), followed by professional associations (10.5 percent) and industries (10.3 percent) (Ewert and Kominski, 2014, Table 7). Certifications appear to be most common in health-related occupations. In one survey, the majority of individuals with certifications (76 percent) indicated that certification was required for their job, that they attended courses to prepare for certification (93 percent), and that continuing education units were required to maintain their certification (66 percent) (Ewert and Kominski, 2014).

Defining a certification as "[an award] to individuals who pass an assessment, usually sponsored by an industry or firm," Karp (2015a) finds that although the research on certifications is growing, existing studies show great variability in the involvement of community colleges in preparing students for certifications. Approaches range from aligning curricula with certification exams, to creating certification exam preparation programs, to becoming a certification-testing center. Preparation activities can include credit or noncredit courses.

4.3.3 Challenges in Assessing the Impact of Certificates and Certifications

Karp (2015a) concludes that the large volume of certification programs, the high degree of program variation, and a lack of accountability and comprehensive data make it difficult to assess the value or impact of completing these programs.

In conducting her review, Karp was unable to identify comprehensive listings of certificates or certifications in the United States or a system that collects outcome data for these programs. National datasets, for example, record certificates in very broad occupational areas, such as health and technical trades, thus precluding the more fine-grained analyses needed for large-scale workforce development initiatives. Likewise, state databases usually do not record the

occupation in which certificate holders are employed; hence there is little research examining certificates as a component of workforce development programs and systems. Karp notes that the existing research also does not examine the employer perspective. These deficits make it difficult to account for all stakeholders in skilled technical workforce development and to address basic questions such as the following:

- How many certificate and certification programs exist?
- Who is in the process of acquiring a certificate or certification?
- Who has acquired a certificate or certification, and how is it associated with career trajectories and outcomes?
- What is the return on investment for certificates and certifications?

As a first step in addressing data requirements, GEMEnA is developing survey items for use in assessing (1) the attainment of nondegree credentials, including industry-recognized certifications, occupational licenses, and educational certificates; and (2) enrollment in education and training that prepare people for work. GEMEnA member NCES plans to field an in-depth survey of U.S. adults (the Credentials for Work Survey [CWS]) to provide detailed cross-sectional time series data beginning in 2016. NCES also is incorporating survey items on nondegree credentials into its post–high school longitudinal studies. Other GEMEnA agencies have started to deploy survey items on certifications and licenses in their own surveys of households and individuals, including the redesigned Survey of Income and Program Participation (Census Bureau), the National Survey of College Graduates (National Science Foundation), and the Current Population Survey (CPS) (Bureau of Labor Statistics [BLS]).

BLS recently released new data on certifications and licenses from the CPS based on the GEMEnA-developed survey items. In January 2015, questions were added to the CPS to identify persons with professional certifications and licenses. A highlight from these data is that 17.8 percent of the civilian noninstitutionalized population aged 16 and over held a currently active certification or license.[17] In addition, consistent with Karp's (2015a) analysis, the data show that certifications and licenses were more prevalent in some occupations than others: more than three-fourths of workers in health care and technical occupations held these credentials, compared with fewer than 1 of 10 in building and grounds cleaning and maintenance occupations (BLS, 2016b, Table 5).

Although promising, these data collection efforts need to be expanded, accelerated, and aligned at the local, state, and federal levels so that stakeholders

[17]The report and data table are available in BLS (2016a).

have the information necessary to make better choices about skilled technical workforce investments.

4.4 FUNDING FOR SKILLED TECHNICAL WORKFORCE EDUCATION AND TRAINING

In the United States, the costs of producing and providing postsecondary skilled technical workforce development are financed by students and workers, employers, labor unions, governments, and philanthropic organizations. In addition to investing time and effort, most Americans who wish to develop technical skills pay tuition and fees, as well as other associated costs, such as those for books, supplies, transportation, and child care, as well as opportunity costs, such as lost wages. If they are not prepared by virtue of their previous education, training, or experience, they must also invest in acquiring prerequisite skills, such as relevant STEM proficiency, or in completing a specific series of courses to qualify for admittance to a program or accreditation in the program.

On the supply side, student tuition and fees rarely cover the entire cost of building and maintaining effective skilled technical education and training centers. The remainder is supported by public revenues from federal, state, and local sources; employers; and civic-minded philanthropists.

Although co-production and co-provision are widely used strategies in the United States, they result in complex public service delivery systems that make it difficult to identify causal relations and outcomes, assign responsibility, and assess performance. "Co-production" refers to public–private partnerships to *produce* public goods and services, while "co-provision" refers to public–private partnerships to *finance or distribute* public goods and services. Education and training are examples of public goods that are co-produced and co-provided by students and their families, educators, employers, governments, and the civic sector (Davis and Ostrom, 1991). The implications of these approaches to skilled technical workforce development are discussed in more detail in Chapter 5. The following subsections describe the main components of these systems.

4.4.1 Public Funding Sources

Public sources of funding for skilled technical workforce development include federal, state, and local revenues collected from a wide range of sources. The 2016 *Condition of Education* report estimates that elementary and secondary public school revenues, which support academic and CTE programs, totaled $618 billion in academic year 2012-2013 (NCES, 2016c). Similarly, as described in more detail in Chapter 3 and the following sections of this chapter, public funding sources offset a significant portion of the costs of employment and training services, as well as postsecondary degree-granting institutions. For

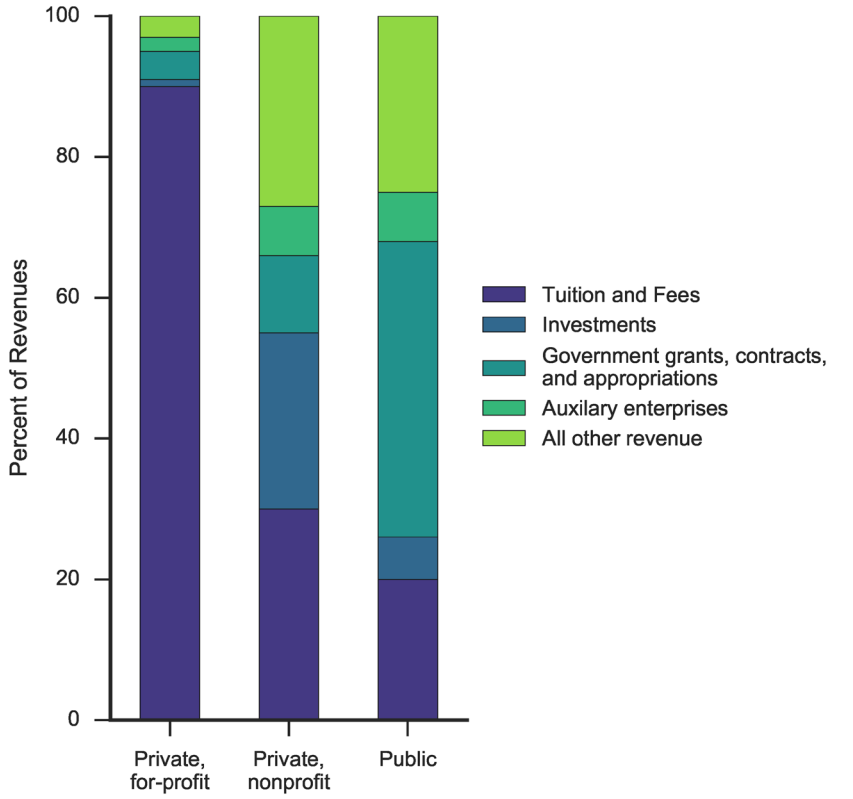

FIGURE 4-4 Sources of revenue of all postsecondary institutions.
SOURCE: NCES, 2016c.

example, Figure 4-4 shows the sources of revenue for all postsecondary institutions in 2013-2014. The primary sources of revenue for all institutions were tuition and fees, investments and government grants, contracts and appropriations, and other unspecified sources. However, the percentage shares differed significantly by type of institution. At public institutions, the largest percentage of revenue (42 percent) was from government sources, which include federal, state, and local government grants, contracts, and appropriations. At private nonprofit institutions and private for-profit institutions, by contrast, student tuition and fees constituted the largest percentage of total revenues (30 and 90 percent, respectively).[18]

[18]Note that Pell Grants are included in the federal grant revenues at public institutions but tend to be included in tuition and fees and auxiliary enterprise revenues at private

The sources of and formulas for allocating public revenues in education and training create incentives that can affect outcomes for stakeholders and society more generally.[19] However, calculating and accounting for the myriad public expenditures and the rules that govern their use in a large polycentric workforce development system such as that of the United States is a painstaking process that to the committee's knowledge has yet to be undertaken, one that also is beyond the scope of this study. To obtain a general sense of the issues, the committee focused on the largest aggregate funding sources at the federal, state, and local levels.

Federal Funding Sources

As described in more detail in Chapter 3, the federal government provides two general types of funding that are potentially relevant to skilled technical workforce development: funding for employment and training services, which is relatively small and administered principally at the local level; and funding for education assistance, which is considerable and administered through programs authorized under the Higher Education Act (HEA), the Post-9/11 Veterans Educational Assistance Act, WIOA, the Carl D. Perkins Career and Technical Education Act (Perkins Act), and the Trade Adjustment Assistance Act.[20]

Federal funds for employment and training services are provided through competitive grants, formula grants, and contracted programs, and they are subject to directives issued by the Office of Management and Budget. The majority of funding for federal employment and training services is distributed by formula grant programs that allocate the funds to state and local entities based on established noncompetitive criteria such as population, unemployment rates, or other economic conditions. In addition, greater than 90 percent of the funds appropriated under Perkins IV, which are important for skilled technical workforce development, are used to provide Basic State Grants that supplement state and local funding of CTE (Dortch, 2014a).[21] States use these funds to make

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nonprofit and private for-profit institutions. Thus, some categories of revenue data are not directly comparable across public, nonprofit, and for-profit institutions (NCES, 2016c).

[19]This issue arose in nearly every panel discussion at the committee's 2015 symposium but was particularly prevalent in Panel 3, on "High School Pathways"; Panel 4, on "Community College Pathways"; and Panel 7, on "Federally-funded Workforce Development." Papers, presentations, and a webcast of the symposium are available at http://nas.edu/SkilledTechnicalWorkforce (accessed March 19, 2017).

[20]The Government Accountability Office (GAO) identified 47 federal employment and training services programs in fiscal year 2009, which together provided $18 billion for workforce development. The College Board estimates that the federal government funded $145 billion in postsecondary education assistance in 2013. See the section on federal policy in Chapter 3 for more detail and citations.

[21]Note that Basic State Grants are formula grants.

grants that support CTE activities at the secondary and postsecondary levels in local education agencies, CTE schools, community colleges, and American Job Centers. The funds are used to develop the career and technical skills of students, acquire instructional materials and equipment, provide professional development, offer career and academic counseling, develop CTE curriculum, and assess CTE programs.

The U.S. Department of Education estimates that 85 percent of all first-time 4-year undergraduate students and 78 percent of all first-time 2-year undergraduate students receive financial assistance from federal, state, and local governments; institutions; or private sources (NCES, 2016c). Grants and loans are the major forms of federal financial aid for undergraduates. Most of the federal funding for undergraduate education and training is authorized under Title IV of HEA and the Post-9/11 Veterans Educational Assistance Act.[22] The largest federal grant program available to undergraduates is the Pell Grant program. To qualify for a Pell Grant, a student must demonstrate financial need. Federal loans, on the other hand, are available to all students.

Although federal legislation regulates eligibility for and disbursement and repayment of financial assistance to students, it is the student-recipients who determine how they will invest in education and training. The implication is that if policy makers wish to encourage increased investment in skilled technical education and training, they need to persuade students as well as educators and employers of the potential benefits of making this investment.

Local and State Government Funding Sources

Local and state governments provide two general types of funding that are relevant to skilled technical workforce development: public education in grades K-12 and a portion of postsecondary education. On average, the states allocate about a third of their direct general expenditures to education. Most of these funds are spent on elementary education, which is intended to build the foundation for success in secondary and postsecondary academic and career and technical education, work, and life.

For example, the U.S. Department of Education reports that from 2010 to 2011, direct general expenditures of state and local governments for education averaged $2,764 per capita, or 33.3 percent of all functions (NCES, 2013c, Table 106.50). Expenditures for elementary education averaged $1,813 per capita, or 21.9 percent of all functions; $810 per capita for colleges and universities, or 9.8 percent of all functions; and $141 per capita for other types

[22]Using the GAO and College Board estimates cited in Chapter 3, total federal funding for all education and training is approximately $163 billion annually. The total amount of education assistance under HEA and the Post-9/11 Veterans Educational Assistance Act is approximately $141 billion annually.

of education, or 1.7 percent of all functions. The data show considerable variability in education expenditures across the states. Per capita spending on education ranged from $1,975 in Idaho, where education expenditures represented 29.9 percent of all functions, to $4,672 in Alaska, where these expenditures represented 26.4 percent of all functions.

As described in more detail in Chapter 3 and earlier sections of this chapter, in addition to funding public K-12 education and training programs, local and state governments play an important role in funding postsecondary education and training, particularly in community colleges. State and local sources provide about 48 percent of community college revenues (see Table 4-2). The implication is that state and local policy makers can use this funding as a means of exercising considerable influence over skilled technical workforce development programs offered by community colleges.

4.4.2 Private Funding Sources

Private sources of funds for skilled technical workforce development potentially include the income of students, workers, and their families and friends; the income of employers; and the income of churches, civic associations, labor unions, trade associations, and philanthropies. The latter organizations tend to fill funding gaps in the production and provision of public goods based on their specific missions and interests. In this sense, their incentives align directly with the individuals they serve and only indirectly with public policy functions. Hence, the three groups that appear to be most directly involved in producing skilled technical workers are the workers, employers, and the public (of which they are a part) in their sphere of activity.

As discussed in preceding sections of this report, U.S. policy frameworks generally place the burden of funding postsecondary education and training on individuals, who potentially earn returns on their investments in the form of increased wages, promotions, and other forms of social recognition and achievement. If properly aligned with contemporary conditions, these returns can create incentives for continual, lifelong individual development.

Recognizing that public benefits can be derived from individual education and training activities, governments subsidize individual investments by funding public schools and providing various forms of grants and financing on generous terms. However, employers also benefit from workers' self-development, as well as public subsidies for these efforts. Skilled technical workers potentially contribute to innovation, increased output, productivity, and profitability. Public policies recognize this linkage by allowing employers to deduct the cost of employee education and training from their taxable income, thereby subsidizing employer investments in workforce development.

The remainder of this section explores joint labor–management programs that support workers' participation in skilled technical workforce development and provides an overview of U.S. employers' workforce development strategies.

Joint Labor–Management Programs

Unions have historically leveraged member dues to work with employers in helping workers from a wide range of career fields develop and maintain skills to meet local needs. The AFL-CIO reports that joint labor–management skill training programs currently contribute about $1.5 billion to the American economy each year (AFL-CIO, n.d.).[23] These programs potentially offer opportunities for a diverse group of workers in skilled technical occupations in such fields as health care, building and construction, manufacturing, hospitality, and aerospace. In the building and construction industry, thousands of local Joint Apprenticeship and Training Committee (JATC) groups oversee apprenticeship and journey-level skills upgrade training in such growing occupations as energy conservation and alternative energy. The committee sees the need for additional research on the role of unions in skilled technical workforce development and on the effectiveness of joint labor–management programs.

The AFL-CIO reports that national joint training programs currently exist in the automotive, telecommunications, steel, rubber, health care, hospitality, and aerospace industries, as well as in the public sector. In the steel and rubber industries alone, 72 local joint committees in 24 states have started to offer courses in renewable energy systems and energy-efficiency technologies. The AFL-CIO estimates that there also exist 18 consortia of unions, management, universities, and health and safety organizations. Box 4-3 describes a 30-year alliance originally created through collective bargaining between the Communication Workers of America and AT&T. Additional examples of labor–management training partnerships include

- the International Association of Machinists and Aerospace Workers and Boeing,[24]
- the United Auto Workers (UAW) and Ford and UAW and GM,[25]
- the United Steelworkers,[26] and
- the Kaiser Labor Management Partnership.[27]

[23]An AFL-CIO program description can be found at http://www.aflcio.org/Learn-About-Unions/Training-and-Apprenticeships/Labor-Management-Partnerships (accessed March 19, 2017).
[24]See http://www.iam-boeing.com (accessed March 19, 2017).
[25]For information on the UAW-Ford partnership, see http://uawford.org (accessed March 19, 2017). For information on the UAW-GM partnership, see https://www.uawgmjas.org (accessed March 19, 2017).
[26]See http://icdlearning.org (accessed March 19, 2017).
[27]See http://www.kaiserpermanentejobs.org/labor-management-partnership.aspx (accessed March 19, 2017).

BOX 4-3
The Alliance for Employee Growth and Development, Inc.

The Alliance for Employee Growth and Development, Inc. is a private nonprofit corporation designed to provide training to individuals to enhance their employability. The Alliance was established and funded through the AT&T and Communication Workers of America (CWA) national bargaining process in 1986, and over the years has expanded to include Alcatel-Lucent, Avaya, Optical Fiber Cable and Connectivity Solutions (OFS), and the International Brotherhood of Electrical Workers (IBEW).

The Alliance has become a primary education resource for union-represented employees at its partner companies. Since its inception, it has provided more than 16.5 million training hours to more than 175,000 individuals. In the most recent fiscal year, nearly 50 percent of eligible individuals participated in more than 168,000 hours of Alliance training.

To address the needs of a diverse, nationwide workforce, the Alliance has developed an array of training delivery options that includes on-site classrooms, virtual classrooms, hands-on technical training, and online self-paced courses. Regardless of the training modality, customer satisfaction with Alliance training remains high, with a 92 percent satisfaction rating from trainees.

The Alliance remains an enduring labor–management success. Working at the local, regional, and national levels, the Alliance has joined together companies and their unions in a variety of win–win training partnerships. These cooperative efforts have had a direct impact on the workplace and technological skills of individuals and the success of the participating businesses.

SOURCE: The Alliance, http://www.employeegrowth.com/about (accessed March 19, 2017).

Employer Funding

Economists who study innovation and growth observe that labor and the STEM knowledge and skills it embodies are among the key drivers of economic growth and development.[28] The nation cannot innovate and compete without

[28]Contemporary theories of economic growth are based on Solow (1956), who argued that sustained economic growth requires capital, labor, and a residual factor associated with innovation and technological progress. North (1990) expanded on Solow's work, arguing that institutions—the rules that determine who participates in the economy and their property rights and duties—and location are additional factors. Romer (1994) further elaborated, emphasizing the endogenous role of knowledge in the standard economic production function. For a survey of the economic literature related to employer-financed skills training, see the paper by Lerman (2015) commissioned for this study. For an extensive survey of theory and evidence on apprenticeship, see Wolter and Ryan (2011).

technical skills, and if it cannot compete effectively, it will not enjoy long-term economic prosperity.

Innovation means different things to different people. In this report, the committee uses the OECD Oslo Manual definition (OECD and Eurostat, 2005):

> An innovation is the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

The logic chain that relates innovation and workforce development suggests that employers who prioritize innovation and rely on technical skills have strong incentives to contribute to the development of a skilled technical workforce. Taking specific institutional and locational differences into account, for example, Rupietta and Backes-Gellner (2015) find that firms in developed countries that train apprentices through a combination of school- and work-based learning (a dual-education or vocational education and training [VET] approach) are more innovative than firms that do not. As discussed in Chapter 2, however, Capelli (2004, 2012, 2015) argues that employer training has declined over time, shifting the burden of skill development to individuals and governments. He attributes this trend to declining job tenure, which limits the ability of firms and workers to earn an adequate return on their training investments.

Surveying the literature on the role of employers in developing and training skilled technical workers, Lerman (2015) argues that the evidence is mixed. He finds that although employer-led training is effective for workers and firms and is widespread in the United States, data limitations make it difficult to determine the scale of training with any rigor. And as Table 4-4 shows, the survey data that have been collected vary widely. Lerman finds, for example, that government survey data provide a dated and very mixed picture of such training. Among individuals aged 25-64, the Survey of Income and Program Participation shows a decrease in employer-led training from 32.8 percent in 1996 to 21.6 percent in 2008, while the National Household Education Survey shows an increase from 31 percent in 1999 to 42.4 percent in 2005. The National Assessment of Adult Literacy survey, which reports on the incidence of training for 2003, indicates that 56.9 percent of workers in this age group were involved in employer-led training in the previous 12 months.

Employers support skilled technical workforce development in several ways, including by providing on-the-job training and apprenticeships, supporting certification and recertification, and offering tuition reimbursement programs. The Society for Human Resource Management (SHRM) (2015) estimates that 84 percent of U.S. employers provided some form of workforce development benefit in 2015, while 78 percent supported certification and

TABLE 4-4 Percentage of Workers Aged 25-64 Participating in Employer-Led Training in the Previous 12 Months

	Government Survey						
Group	Survey of Income and Program Participation				National Assessment of Adult Literacy	National Household Education Survey	
	1996	2001	2004	2008	2003	1999	2005
Total	32.8	27.9	21.8	21.6	56.9	31.0	42.4
Male	30.4	25.3	19.7	20.5	53.6	29.4	31.8
Female	35.7	31.0	24.2	22.7	60.6	21.8	46.0

SOURCE: Lerman, 2015, Table 1.

recertification (SHRM, 2015). Yet SHRM's analysis suggests that it is not clear whether employees are fully utilizing these benefits, and if not, why not (SHRM, 2015). SHRM notes, for example, that 30 percent of employees in large companies but only 1 percent of those in small companies use the benefits. SHRM speculates that employers may create more and less supportive cultures for using education and training benefits, or that the staffing requirements of some organizations make it difficult or expensive to use the benefits. More research is needed to better understand benefit utilization.

A more nuanced view emerges from examining results of a large and continuing private survey of employer training. The Association for Talent Development (ATD) regularly surveys employers about their training and development activities. ATD's 2014 *State of the Industry* report indicates that employers spent an average of $1,208 per employee on training and development in 2013, or about $167.5 billion.[29] This spending has been relatively stable over time, ranging from $1,040 per employee in 2006 to a high of $1,228 in 2010. These numbers support the idea that employees may not be fully utilizing employer-provided opportunities, such as tuition reimbursement programs, to develop their skills and credentials.

ATD finds that the average cost of workforce development typically varies according to an organization's size. In 2013, small organizations with fewer than 500 employees spent on average $1,888 per employee, whereas midsized organizations with 500 to 9,999 employees and large organizations with 10,000

[29]The ATD study is based on a survey of 340 organizations of various sizes, industries, and locations. In 2013, ATD reported that employers spent $164.2 billion on training in 2012; the committee's estimate of total spending in 2013 is based on ATD's report in 2014 that spending increased by 1 percent over the previous year. For an overview of the 2014 study, see Miller (2014).

or more employees spent about $838. The number of learning hours per year per employee also varies across the size of organizations. Although the average across all organizations in 2013 was 31.5 hours, large organizations on average reported that their employees received 36 hours of training, or approximately 4.5 days, whereas the comparable figures for midsized organizations were 27 hours, or approximately 3.5 days (Miller, 2014).

ATD also finds differences in training across industries. In 2013, for example, manufacturing organizations, which are typically large organizations in ATD's survey, reported on average spending $535 and providing 27 hours of training per employee, compared with $1,392 and 24 hours for health care and pharmaceutical organizations and $1,107 and 33 hours for the combined group of finance, insurance, and real estate organizations.

ATD finds further that organizations provide employee training in different ways, including by developing and producing courses internally, contracting with other organizations to provide the training, and reimbursing employees for tuition. ATD estimates that 10 percent of training expenses in 2013 went to tuition reimbursement programs in which employees select courses to study, subject to approval by their managers, and are reimbursed for all or some portion of their tuition costs upon demonstrating successful completion.

Finally, ATD estimates that about one-third of employer-selected training content is focused on managerial and supervisory skills, mandatory and compliance training, and profession- or industry-specific training. The remaining two-thirds of content covers such topics as processes and procedures, customer service, sales training, and executive development (Miller, 2014).

4.5 CONCLUSIONS

Skilled technical workforce development is a quasi-public good with potential benefits for individuals, employers, and society as a whole. Americans have a long-standing commitment to education and training that predates independence and the creation of a federal republic.

Mirroring the U.S. policy-making structure, the U.S. workforce development enterprise is a very large, complex system of systems: there is no single, centralized system for developing a skilled technical workforce, and the structure of the existing system cannot easily be conceptualized in terms of pathways, pipelines, or production functions or operated in this manner. Education and training programs are co-produced and co-provided by students, workers, employers, governments, and civic society. The largest funding sources for skilled technical workforce development are state and local public revenues and tuition paid by students and workers for postsecondary degree-granting programs. WIOA encourages policy makers to better integrate and align these expenditures and programs at the local level. However, assessment of the

performance of systems based on polycentric co-production and co-provision is quite difficult and must be undertaken at the local level.

Americans who wish to prepare themselves for success in skilled technical occupations have a wide range of education and training options that depend on several factors, including their own socioeconomic means, the availability of programs in their preferred geographic location, and the occupation of interest. The primary vehicles for skilled technical education and training in the United States are CTE in secondary and postsecondary institutions, community college programs, and apprenticeships. However, enrollment trends indicate that while Americans may aspire to acquire career-related education and training throughout their lives, they are less likely to pursue skilled technical education and training today than they have been in the past.

Employers that wish to innovate and compete successfully also have a stake in developing a skilled technical workforce. Public tax policy subsidizes employer expenditures to encourage economic growth and development. However, data on employer-funded skilled technical workforce development are sparse, and the evidence that exists is mixed.

With this review of the highly complex U.S. system of workforce education and training as context, the next chapter examines the challenges associated with the development of a skilled technical workforce.

5

Challenges in Developing a Skilled Technical Workforce

Developing and sustaining a skilled technical workforce is a high-priority goal for employers and for policy makers at the local, state, and federal levels. The nation is making substantial public and private investments in achieving a broad range of education and training goals, spending an estimated $618 billion on public K-12 education and an additional $701.5 billion on postsecondary education and training each year.[1] This substantial and broad-based commitment has made it possible for U.S. workforce development practices to evolve so they now include a wide range of options that potentially accommodate the diverse needs of American students, workers, and employers. A key issue for the nation, then, is how effectively these substantial resources are used to develop and sustain a skilled technical workforce.

To address this issue, it is necessary to look more closely at the institutions—the rules, norms, and incentive structures—that shape the ability of students, workers, employers, educational organizations, and governments to work together to develop and sustain a skilled technical workforce.[2] The economic data reviewed in Chapter 2 capture the visible patterns created by these actors within prevailing institutions. At the microeconomic level, the data

[1]The estimate of annual spending on public K-12 education and training is based on NCES (2016c). The estimate includes federal education and training services ($17 billion), employer spending ($167.5 billion), and the total expenditures of postsecondary Title IV institutions ($517 billion). The source for federal spending on education and training services is The White House (2014). The source for employer spending is the Association for Talent Development (2015). The source for postsecondary Title IV institution expenditures is NCES (2016c).

[2]Institutions work by changing the structure of incentives individuals face in situations in which they need to cooperate and by creating shared expectations about the behavior of others (North, 1990). Ostrom (2005) observes that "a major problem in understanding institutions relates to the diversity of situations of contemporary life."

reveal a patchwork of outcomes whereby some labor markets appear to work better than others. Putting this information in context, Chapter 3 shows the great variation in policies and governance systems covering education and training across the nation's states and localities. And as seen in Chapter 4, this variation is reflected in the diversity of workforce education and training programs across the nation.

This chapter examines the various impediments and disincentives that pose challenges for fully leveraging the nation's investments in a skilled technical workforce. Section 5.1 looks at the factors that affect the perceived returns on investment in training and education for students, workers, and employers. Section 5.2 explains how some current social and policy frameworks, funding mechanisms, and data gaps impede better outcomes. Section 5.3 then explores the particular challenges of training the skilled technical workforce in the allied health and manufacturing sectors. It also takes up the unique challenges faced by about 200,000 service members who transition each year from active military duty to skilled technical occupations in civilian life. The final section presents conclusions. Chapter 6 addresses some of the policy proposals that might help overcome the challenges discussed in this chapter.

5.1 THE RETURN-ON-INVESTMENT CALCULUS

Americans share in the ideals of equal opportunity; fair competition; and the ability to capture a reasonable return on initiative, effort, and other investments. Individuals who invest in skill development should be able to generate enough income from a job or business to cover the associated costs and realize an equal or better return relative to an alternative use of the money. Similarly, enterprises that invest in training their workers should have a fair chance of generating enough revenue to realize a return on their investment. And taxpayers should receive a fair return on their tax dollars in the form of high-quality, reliable public education and training services. Yet limitations in both data and analyses make it difficult to determine whether and how individuals, employers, and the public are investing in skilled technical education and training, and whether they are realizing sufficient returns to sustain or increase their investments.

The returns on investment in acquiring technical skills are both tangible and intangible in nature. Some of these returns—such as higher wages or better benefits for workers; higher profits or greater worker productivity for firms; and additional tax revenues for local, state, and federal governments—can be estimated. Other returns, such as improved civic engagement (see Chapter 2), may be more difficult to measure but may be of equal or even greater importance. In some cases, intrinsic motivation and nonmonetary incentives that

signify social recognition and respect can play a greater role in individual motivation than monetary incentives alone.[3] Potential nonmonetary rewards from education and training include the joy of doing something one likes to do or is particularly good at doing; the personal satisfaction derived from accomplishment, social recognition, or respect; and the opportunity to advance.

How students, workers, and employers estimate their return on investment depends on the local context. Education and training for skilled technical jobs are influenced primarily by local policy and practice, and there can be substantial differences across locations, institutions, and industries even within the same state.

5.1.1 Evidence on Returns on Postsecondary Education and Training

Overall, there is strong evidence that postsecondary education yields high positive returns.[4] Prior research using national longitudinal survey data has shown that individuals with an associate's degree earn more than those with only a high school diploma (Belfield and Bailey, 2011). Bailey and Belfield (2013, Chapter 6) estimate that an additional year of schooling raises yearly earnings by 5 to 10 percent, or more than 10 percent after controlling for other factors. Likewise, using data from Washington State, Dadgar and Weiss (2012) observed increases in wages with an associate's degree, although the size of the increase varied depending on the field of study. A review by the California Community Colleges system estimated average returns of 10 percent in additional earnings for short-term vocational certificates and more than 25 percent for associate's degrees (AA/AS) (Stevens et al., 2015). Similar results were seen in a study in Florida focused on minorities and disadvantaged workers (Backes et al., 2014), in which students' decisions to study general humanities and failure to complete those programs had a significant negative impact on their return on postsecondary education. Another study using data from Arkansas, Colorado, Tennessee, Texas, and Virginia found that the returns on associate's degrees or certificates for career and technical programs of study were higher than those on associate's degrees for academic programs of study. In four of these five states, moreover, average first-year earnings were higher for associate's degree holders than for bachelor's degree holders (Schneider, 2013). Interestingly, researchers using data from Kentucky found that the returns on degrees or diplomas differed for men and women, with women receiving

[3]For an overview of this research and an economic theory of human motivation, see Frey (1997).

[4]For evidence on positive returns to postsecondary education, see, for example, several of the papers commissioned for this study, including Heinrich (2015), Karp (2015), Rothwell (2015), and Stern (2015).

approximately $2,400 in higher quarterly earnings compared with $1,500 for men (Jepsen et al., 2012).

Finally, completing a program and receiving a degree appear to be valued more highly by employers than acquiring credits or skills (Kane and Rouse, 1995). Using data from Kentucky, Jepsen and colleagues (2012) found that the higher earnings associated with certificates or diplomas were due to completion (the so-called "sheepskin effect") rather than the number of credits taken. However, they note that the effects of completing diplomas and certificates were mixed and varied by field of study and gender (Jepsen et al., 2012).

5.1.2 Challenges in Completing Postsecondary Programs

The large returns on investment in obtaining postsecondary education despite stagnant wage premiums over the last few decades appear still to make this a good investment, for both 2- and 4-year degrees (The White House, 2016). However, college completion rates are not rising commensurately with either costs or earnings, suggesting that there is room to improve the outcomes of college investments (see, for example, Baum and Ma, 2013; Baum et al., 2013). As of October 2014, 68.4 percent of high school graduates were enrolled in colleges or universities (BLS, 2016a). As described in Chapter 4, the data suggest that a large proportion of these students, particularly those in community colleges, will drop out without earning a college credential. Although completion rates vary considerably across colleges, comprehensive analyses of the differences are not available. Researchers have shown, for example, that even after controlling for K-12 achievement, students who attend 4-year private colleges have much higher completion rates than those who attend 2-year colleges (Stern, 2015). Other research has shown that completion rates for students enrolled in 4-year colleges are higher for those enrolled in colleges with selective admission requirements (Bound et al., 2010). Low student completion rates also have been documented among for-profit colleges (Cellini, 2012; Deming et al., 2013). Some of the factors affecting college completion are reviewed below.

Inadequate Preparation

The percentages of Americans with low literacy and numeracy skills (see Table 5-1) suggest that inadequate elementary and secondary education may be a large part of the reason for students failing to complete their education.

High Costs of Remediation

Students without adequate preparation for postsecondary education and training are often required to complete remedial programs before they can

TABLE 5-1 The Nation's Report Card: Percentage of Students Who Performed at or above Proficient in Eight Subject Areas

Subject Area	Grade 4 (%)	Grade 8 (%)	Grade 12 (%)
Civics	27 (2010)	23 (2014)	24 (2010)
Economics	—	—	42 (2012)
Geography	21 (2010)	27 (2014)	20 (2010)
Mathematics	40 (2015)	33 (2015)	26 (2013)
Reading	36 (2015)	34 (2015)	38 (2013)
Science	—	32 (2011)	—
U.S. History	20 (2010)	18 (2014)	12 (2010)
Writing	—	27 (2011)	27 (2011)

SOURCE: NAEP, n.d.

participate in more advanced programs, which increases the costs of the education and training and reduces potential returns on that investment (Bettinger et al., 2013; Long et al., 2014). Remediation is costly not only for students but also for states and employers, with some estimates reaching as high as $2.3 billion per year (NCSL, n.d.). Students who are required to take remedial courses are also more likely to drop out of postsecondary programs without a degree: 9 of 10 students subject to remediation requirements when they enter their postsecondary program of study never complete the program, and only 1 in 4 students in remedial classes will eventually earn a degree from a community college.[5]

Rising Tuition Costs

Between 2008-2009 and 2013-2014, revenues from tuition and fees per full-time equivalent (FTE) student increased by 17 percent at public institutions (from $5,681 to $6,639, in constant 2014-2015 dollars) and by 6 percent at private nonprofit institutions (from $19,206 to $20,293). At private for-profit institutions, revenues from tuition and fees per FTE student were 34 percent higher in 2013-2014 than in 2008-2009 ($19,480 versus $14,515) (NCES, 2016b). Tuition increases are particularly burdensome for students with limited financial resources (Lovenheim, 2011). The high costs of tuition, as well as the opportunity costs of time spent away from work or of child care, represent another impediment to college completion.

[5] Data from the 31 Complete College America partner states indicate that roughly 22 percent of developmental education students at community colleges complete remediation requirements and associated "gatekeeper courses" within 2 years (see Complete College America, 2017).

5.1.3 Are Students and Workers Sufficiently Engaged?

Educators and policy makers rely on students to make decisions that suit their interests, capabilities, and means and to work diligently to acquire the relevant education and training. They rely on families and employers to prepare and encourage students to learn and to reinforce education and training at home and in the workplace. David Stern of the University of California, Berkeley, notes several trends regarding investment by students and workers in skilled technical education and training (Stern, 2015):

- Public high school graduates are less likely to earn career and technical education (CTE) credits than they have been in the past.
- The percentage of Americans aged 18-24 who enroll in degree-granting postsecondary education is increasing.
- Even though most bachelor's degrees awarded in the United States are in programs of study related explicitly to occupations, such as business, education, health professions, engineering, law enforcement, and agriculture, the number of students who complete a degree by age 30 is much smaller than the number of high school students who say they want to pursue a bachelor's or advanced degree.

Stern observes that enrollment and completion patterns and trends can pose a dilemma for families, educators, and policy makers. If education policies reflect students' aspirations, many students may not acquire the technical knowledge or skills needed to earn a living. However, if policies limit access to the courses required for high levels of academic success to those students who are deemed likely to succeed (an inexact assessment at best), they are likely to shortchange many talented young people, particularly those from low-income or historically underrepresented groups.

5.1.4 Are Employers Sufficiently Engaged?

Educators and policy makers rely on employers to help them understand changing skill requirements, contribute to policy and program design, assist with program delivery, and provide access to up-to-date equipment and facilities. They also rely on employers to provide graduates with jobs or business opportunities that will deliver a return on investment in education and training. Yet these expectations of employers may not be met.

Free-Ridership

Some educators and policy makers complain that employers are "free-riding" on public resources because they are not sufficiently engaged in producing and providing education or training or fail to invest their fair share in

workforce development processes. As discussed in Chapter 4, the evidence on employer investments in education and training and the return on these investments is mixed, in large part because these data are missing or incomplete.

Growth of Contingent Work Arrangements

From the perspective of some students, workers, and policy makers, employers in certain industries and locations may not be committed to hiring specific groups of workers, paying high enough wages, or providing sufficiently stable employment to ensure an adequate return on investment in education and training. It appears that when making hiring decisions, companies increasingly prefer to hire workers under alternative, contingent work arrangements, such as temporary, on-call, contract, freelance, or part-time.[6]

For example, results of a 2013-2014 Harvard Business School alumni survey indicate that employers are reluctant to hire full-time workers:

> Forty-six percent of respondents agreed that their firms' U.S. operations prefer to invest in technology to perform work rather than hire or retain employees, while only 25 percent disagreed. Forty-nine percent said that their firms preferred to rely on vendors to perform work that can be outsourced, while only 29 percent reported that their firms would rather hire additional workers and keep work in-house.…Companies that increased their reliance on part-time workers over the past 3 years outnumbered those that had reduced their proportion of part-time workers by two to one. (Accenture et al., 2014, p. 7)

Data show that a significant share of the workforce comprises contingent or temporary workers or those who work part-time for multiple employers, and some analysts believe that this trend is increasing at a rate that is not well captured with existing workforce measures.[7] Recent data collected by the Department of Labor (DOL) show more than 30 percent of the workforce being defined as in a contingent work arrangement (BLS, 2005).[8] Among this group,

[6]For an overview of current issues and data, see the discussion in Chapter 3 and Dokko et al. (2015).

[7]For an overview of data and measurement challenges associated with estimating alternative work arrangements, see Dokko et al. (2015).

[8]Contingent workers are those who do not expect their jobs to last or who report that their jobs are temporary; they do not have an implicit or explicit contract for ongoing employment. Alternative employment arrangements include people employed as independent contractors, on-call workers, temporary help agency workers, and workers provided by contract firms.

44 percent reported working part-time, and 25 percent reported being independent contractors or freelance workers. Other contingent workers are either self-employed or employed on a temporary basis through agencies or on-call relationships. Analysis of results of a 2014 survey conducted by the Freelancers Union suggests that more than 34 percent of Americans are doing at least some freelance work (Horowitz and Rosati, 2014).

Employers who are reluctant to hire full-time and long-term workers may not be sufficiently motivated to invest in skilled technical workforce development. At the same time, contingent workers may not have sufficient incentives or resources to invest in developing and maintaining their skills, a phenomenon that in turn feeds employers' reluctance and inability to hire qualified workers.

A similar dynamic exists for full-time workers. As reported by the Society for Human Resource Management (SHRM), few full-time employees utilize available tuition reimbursement programs that would permit them to enhance their skillset.[9] If employers do not unambiguously encourage and support continued education and training and provide employment opportunities that offer a return on those investments, employees may not invest in skill development—a dynamic that limits all stakeholders.

5.2 IMPEDIMENTS TO BETTER TRAINING OUTCOMES

The perceived costs and benefits of education and training are further influenced by a number of social, economic, and institutional impediments. These range from the challenges that students may face in pursuing an education while raising children and managing households, which increase perceived costs, to the lower social prestige some accord to CTE, which reduces the perceived value of its benefits. Funding formulas that incentivize the volume of enrollment over the quality of educational options, inadequate career guidance, inconsistent standards, and limited labor market data, among other factors, also make it more difficult to make informed decisions about investing in joining or growing the skilled technical workforce.

5.2.1 Limited Support for Students

As described in Chapter 4, nearly half of all Americans enrolled in postsecondary degree programs attend community colleges. Students who attend community colleges often face greater challenges than those who attend 4-year institutions. More than 50 percent of students enrolled in 2-year degree programs work either part- or full-time while pursuing their studies, and they are

[9] http://www.shrm.org (accessed March 5, 2017).

more than twice as likely as students enrolled in 4-year degree programs to be enrolled in part-time study. They also are more likely to be older, to have lower socioeconomic status, or to belong to minority groups.[10]

Support Networks

Workers who pursue continuing education and training often have a wide range of responsibilities to coordinate along with their studies, such as establishing their households, raising their families, and caring for aging family members. These challenges can affect students' return on investment in education and training and their incentives to complete postsecondary programs (Holzer and Nightingale, 2009).[11] These factors highlight the need for a wide range of services to support students who pursue skilled technical education and training and for schools to devise effective strategies for helping them access support services that meet their particular needs (Purnell and Blank, 2004). The nature of these services is locally specific and needs to be tailored to the requirements of the local population.

Most students struggle to adjust to the expectations of college coursework and campus life. However, the evidence suggests that students without strong social support networks have more difficulty accessing support services relative to those who have such networks (Karp, 2011). Some research on access to services at community colleges, for example, has found that although support services are available to all students, few low-income students find them accessible. Typically, students who take full advantage of these services have preexisting knowledge of the available resources or social relationships that help them find the information and resources they need to be successful (Karp et al., 2008).

Career Guidance

Most American students and workers who pursue postsecondary education and training have difficulty identifying appropriate programs and courses of study, funding their costs, and developing supportive educational and career networks. Many secondary and postsecondary students receive limited career guidance. Colleges typically operate under a "cafeteria-style" model of education in which students select courses from a bewildering array of choices, with limited guidance (Bailey et al., 2015). As a result, students enroll in skilled

[10]For a more complete discussion of community college demographics, see Chapter 4. Data sources include AACC (2016) and NCES (2016c).

[11]The authors note that "wraparound services," such as career and educational guidance, stipends, child care, and transportation, can boost program completion rates.

technical programs at relatively low rates, even after controlling for academic ability (see, for example, Holzer and Nightingale, 2009).

Recent White House and congressional reviews have sought to address these challenges. Vice President Biden's committee on workforce development reported that Americans often are not sure which education and training programs to pursue or whether jobs will be available for them when they finish (The White House, 2014). Congress also has sought to address this challenge; one of the express purposes of the 2014 Workforce Investment Opportunity Act (WIOA) is to improve coordination to increase access to opportunities and support services.[12]

5.2.2 Perceptions of Career and Technical Education

As discussed in Chapter 4, for most of the 20th century and up to the present time, federal and state policies have encouraged schools to develop curriculum for skilled technical work, known today as CTE. Prior to the 1960s, high school vocational programs provided basic job training for students that included school-based learning, work-based learning, and connections between activities and employers. An evaluation of the School to Work program of the 1990s, for example, found that these types of programs were particularly beneficial for students who were less likely to go to college, especially men (Neumark and Rothstein, 2005). However, several analysts have pointed out that as the focus in education has shifted toward preparing most students for college, the occupationally oriented CTE infrastructure in secondary schools has deteriorated (Klein and Green, 2011).

Stern (2015) observes that although policy makers have encouraged improvements in the quality of high school CTE curricula, most students and parents continue to perceive CTE as a poor substitute for college preparation rather than as a complementary or alternative pathway to a good job (see also Hoffman and Reindl, 2011; Symonds et al., 2011). This sentiment is supported by a recent report of the Independent Advisory Panel of the National Assessment of Career and Technical Education, which states that "exemplary CTE programs are seen as exceptions to mainstream options. CTE is still perceived by many as an alternative to rigorous academics—a separate track for students who are not college bound" (Independent Advisory Panel of the National Assessment of Career and Technical Education, 2014, as cited by Stern, 2015, p. 3). This diminished image of CTE and preparation for skilled technical work among students and parents inhibits efforts to improve CTE offerings, enrollment, and completion rates.

Stern notes further that experience and research over the past several decades have demonstrated the necessity and the feasibility of designing high

[12]WIOA, Public Law 113-128, Section 2.

school programs that prepare students for both college and careers.[13] In many schools in the United States, however, CTE tends to be course-specific and geared to preparation for particular jobs. This tendency may be reinforced by federal and state policies that have created bureaucratic rules and funding strategies that tend to isolate CTE from mainstream education reform.

As discussed above, perceptions about skilled technical work may lead parents and students to avoid training for these jobs. In addition, there is evidence that the additional earnings from obtaining postsecondary education are smaller for individuals seeking skilled technical credentials versus 4-year degrees. Since 2000, the wage premium for a bachelor's degree compared with a high school diploma has leveled off at approximately 80 percent, meaning that college graduates make 80 percent more over their lifetime than those with only a high school diploma (Autor, 2014). While the wage premium for an associate's degree compared with a high school diploma has increased over time, it remains much smaller, at around 30 percent (Modestino, 2010). In addition, research by Bailey and Dynarski (2011) suggests that high-income students have stronger incentives than low-income students to enroll in 4-year colleges and obtain 4-year degrees.

These considerations suggest that federal, state, and local policy makers and education professionals need to improve perceptions and beliefs about skilled technical work and better align standards for CTE with academic subjects so that students will be prepared for both work and postsecondary education that leads to a full range of credentialing options.

5.2.3 Standards for Certificate and Certification Programs

Questions exist about the overall value of alternative credentials such as certificates and certifications. Reviewing the evidence on the value of these credentials in preparing for and obtaining skilled technical work, Karp (2015) notes that this evidence is inconclusive. She calls for better data and research focused on creating coherent local systems of workforce development rather than per se developing additional credentials. Karp identifies several issues with respect to certificates and certifications.

The first is variability in value. The available research on certificates and certifications indicates that outcomes are highly context dependent. While Karp observes a positive labor market return to *certificates* in the aggregate as compared with earning only a high school diploma or completing some college without earning a certificate, different types of certificates have different value. Certificates that require a long period of study (long-term certificates) and are aligned with industry certifications provide more benefits to their holders

[13]For a review of the evidence, see Stern (2015). See also Hoffman and Reindl (2011) and Symonds et al. (2011).

relative to those that require short periods of study (short-term certificates). The value of certificates also varies by field and subfield: long-term certificates provide value in such fields as health care, but not in education and child care, and certificates provide differential benefits even within a single field, such as information technology (IT). It also appears that the value of certificates may vary by geographic region, gender, and race or ethnicity, and they may not be transferable across locations or related industry segments. Karp discovered few rigorous studies of *certifications*, from either an individual or systems perspective. The Lumina Foundation (2015) estimates that fewer than 10 percent of certifications are subject to third-party review or accreditation.[14] Community colleges' involvement in preparing students for certifications is highly variable and includes aligning curricula with certification exams, creating certification exam preparation programs, and/or becoming a certification testing center. Karp explains that variability may be responsive to employer needs and provide multiple access points for students, but whether it conveys value in labor markets remains an unanswered question.

The second issue identified by Karp is stackability of credentials. Many experts are promoting "stackable credentials" as a way to prepare for skilled technical jobs. A stackable credential is one of a sequence of credentials that can be accumulated over time to build qualifications, advance in one's career, and improve earning opportunities. Karp reveals some evidence that employers value this concept, but notes that certificates and certifications are potentially associated more closely with higher wages when they are stacked on a widely understood, lower-level credential, such as a general education diploma or high school diploma. Moreover, the timing of obtaining certificates and certifications may be important: they may have a positive effect on wages only when individuals earn them before obtaining an associate's or bachelor's degree. However, existing data suggest that most certificate/certification completers do not transfer to degree programs, which in turn suggests that many of these credentials serve as terminal credentials rather than stepping stones to degrees.

Finally, Karp cites the issue of inconsistent standards and limited data. Results of her survey reveal that inconsistent standards for credentialing and limited data on the role of credentials in career outcomes make it difficult to rigorously assess the value and impacts of certificates and certifications. In turn, this difficulty points to a need to adopt consistent credentialing terminology, ensure that credentials are aligned with employer and labor market requirements, and ensure that these requirements are consistently implemented and understood. This difficulty also points to a need to collect more longitudinal data on credentials and career experience and conduct more research on the

[14]In her review, Karp found only one study that examined the labor market impact of certifications—a study of Microsoft certification holders using data from 2000, which has limited generalizability.

value and impacts of particular credentials. While efforts are under way to address terminology, measurement, and data collection issues, evidence on the desirability and feasibility of articulating specific career pathways or pipelines in many occupations is difficult to find. A 2014 review of federal workforce development programs advocates using a wider range of research strategies to understand the value of credentials (DOL et al., 2014). To date, studies on credentials have used mainly nonexperimental evaluation designs. However, several experimental demonstrations are currently using random assignment designs, which will help build a more rigorous evidence-based understanding of the impact of industry-driven credentials.

5.2.4 Quality of Curricula and Pedagogy

Improving links between K-16 education and training and work is an area of further concern. Effecting these improvements includes updating curricula to reflect advances in science and technology and changing occupational requirements; focusing on an experiential learning approach that includes work-based learning rather than on a theoretical, lecture-oriented approach to teaching; growing the number of technically qualified teachers; and providing adequate and up-to-date training equipment and facilities. Training institutions, particularly community colleges, need to develop new ways to structure and deliver education and training for both traditional and nontraditional students. Although evidence on the effectiveness of some of the emerging instructional models discussed in this report is not yet available, the face validity of several new strategies appears promising for students who are also working, workers seeking to retrain for a new occupation, and low-skilled workers with little prior postsecondary education experience (DOL et al., 2014).[15] Addressing quality issues will require attention to the framework within which educators, students, workers, and other actors in the ecosystem address a number of coordination and information issues.

5.2.5 Incentives in Institutional Funding

The role of community colleges in many communities has expanded from providing relatively easy access to college studies to providing a wide range of credentials, custom education and training, programs in English as a second language, and remedial courses. Their mission, as well as the evidence on effective education strategies discussed above, requires the formation of strong employer partnerships in strategically important economic sectors in their communities. Advances in science and technology that create new occupations

[15]The role of experiential learning and work-based learning is discussed in more detail in other sections of this chapter and in Chapter 6.

with high technical and problem-solving skill requirements create additional pressure for community college faculty and administrators to develop new curricula and acquire new equipment and facilities (Autor, 2010).

There is growing concern, however, that community colleges have insufficient resources or funding incentives to provide programs of study that meet changing economic development needs and have potentially high labor market returns (Carnevale and Hanson, 2015). For example, the funding of many community colleges is based on formulas that emphasize the volume of enrollment rather than the value or quality of the services provided (Miao, 2012). This emphasis can create a financial incentive to focus investments in faculty, equipment, facilities, and support services in widely understood, high-volume education and training programs that easily generate high enrollment rather than on innovation and organizational change.

An additional challenge for community colleges is the level and stability of funding. Unlike 4-year public institutions, community colleges serve almost exclusively local students who typically continue to live and work in the community after graduation (Mellow and Heelan, 2015). This characteristic of community colleges would suggest that they potentially offer a competitive return on public investment. Yet the data displayed in Figure 5-1 indicate that in the two time periods shown (2007-2008 and 2012-2013), annual state and local revenues per FTE student were on average $3,000 lower for 2-year than for 4-year public institutions. Moreover, annual state and local resources at public 2-year institutions declined by $1,456 per FTE student between 2007-2008 and 2012-2013 (or 18 percent) (NCES, 2015c).

Similarly, even though the majority of undergraduate students are enrolled in community colleges, these 2-year Title IV institutions provide fewer resources per pupil relative to public 4-year universities. These data suggest a need to investigate two competing hypotheses: (1) community colleges are not appropriating enough money to postsecondary skilled technical education, or (2) postsecondary education funds are adequate, but they are not being allocated effectively to achieve the objectives of skilled technical workforce development.

5.2.6 Limited Data and Information

A lack of information about skill requirements makes it difficult for policy makers, educators, employers, and workers to coordinate to address quality issues in workforce development policies, processes, and programs. Policy makers and labor market participants need better data and more useful tools with which to analyze labor market dynamics, returns on investments in workforce development, and the effectiveness of alternative strategies for making adjustments to improve outcomes. Students and workers, guidance counselors, and educators need better information on skill requirements, career pathways, and potential returns on their investments in education and training. Employers

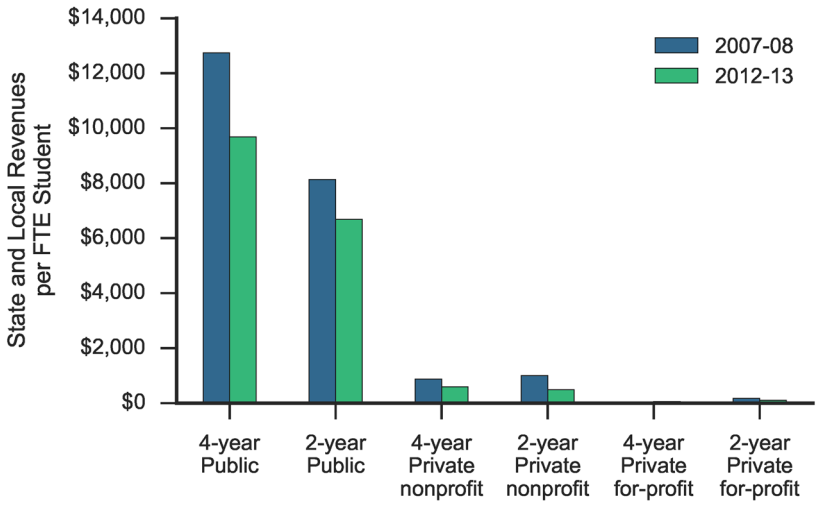

FIGURE 5-1 Revenues per full-time equivalent (FTE) student, 2007-2008 and 2012-2013.
NOTE: Revenues are from government grants, contracts, and appropriations per FTE student for degree-granting postsecondary institutions, by source of funds and institutional control and level.
SOURCE: NCES, 2015c, Figure 3, p. 220.

need better information on effective education and training resources and on viable programs and facilities for producing skilled technical workers.

The information system that supports U.S. labor market functions is funded and administered primarily by DOL. The states, which own and often collect the data, depend on DOL for supplemental data, technical support, and grants to support data capture, analysis, and research, while federal agencies depend on the states to share good-quality data in a timely and accurate manner. Reviewing the evidence on workforce labor market information issues, Reamer (2015) notes that although there are high returns to investment in the workforce labor market information system, funding has been stagnant over the past decade, and Congress has provided limited oversight. The result is a system that is less effective than it could be:

- **Funding.** Despite the potential for very high returns to investing in workforce information, Reamer observes that funding is insufficient. In his opinion, federal departments and the Office of Management and Budget tend to ask for too little funding; Congress appropriates too few funds for the President's requests; and Congress rarely approves new information budget initiatives, which typically range from $1 million to $5 million. In addition, Reamer notes a lack of federal funding for state labor market information agencies. Annual funding

for Bureau of Labor Statistics grants to state agencies has remained at about $72 million for well over a decade. Similarly, the Employment Training Administration's state workforce information grant funding has been flat at $32 million. With too little money to begin with, the utility of these grants has eroded with inflation. Therefore, state agencies have been unable to provide the level of information services needed by labor market participants.

- **Data and research methods.** Advances in information and data sciences make it possible to increase significantly the volume of data collected, analyzed, and disseminated to users. However, statisticians and other labor market researchers are in many cases using out-of-date data; methods, particularly surveys; and approaches. For example, federal statistical agencies continue to rely on legacy methods for collecting and producing data, resulting in lagged data that do not reflect the true state of the labor market. New data analysis techniques offer opportunities to improve information through greater use of federal administrative records and through commercial data vendors and service providers. However, labor market information specialists have yet to determine how to work with data and statistics that fail to meet the standards of reliability defined by the Office of Management and Budget and the National Academies of Sciences, Engineering, and Medicine. Key issues include privacy and data commodification concerns related to providing data to commercial vendors and bias associated with big data analytics.[16]
- **Tools.** Current tools for sharing and understanding the meaning of labor market data are difficult to use. Reamer argues that federal economic statistics agencies lack sufficient understanding of how participants in labor markets at the local level use information to make decisions, nor do they tend to have the relationships with data users that would provide that understanding. Moreover, the federal government does not adequately assess the performance and impacts of its investments in workforce information. There is a need to develop user-friendly tools that provide direct access to information about options and performance to assist labor market participants in their decision-making processes.

WIOA mandates provision of most of the information resources that Reamer identifies as needed by labor market participants, and the law aims to address many of the systemic problems he discusses. As Reamer observes,

[16] For a comprehensive review of the issues, see the paper by Reamer (2015) commissioned for this study. The paper and additional material related to the topic can be found at http://nas.edu/SkilledTechnicalWorkforce.

however, the predecessor act (the Workforce Investment Act [WIA] of 1998) gave the secretary of labor a similar mandate to create and maintain a national employment statistics system, but succeeding secretaries did not pursue this mandate (Reamer, 2015). Full implementation of the information system aspects of WIOA is needed to address these data issues.

5.3 CHALLENGES IN TRAINING AND TRANSITIONING THE SKILLED TECHNICAL WORKFORCE

This section turns to the special challenges of educating and training the skilled technical workforce in two major sectors of the economy—health care and manufacturing. This is followed by a review of the challenges of transitioning the skills acquired by service members over the course of their military careers to the civilian workplace.

5.3.1 Training the Health Care Workforce

As described in Chapter 3, several changes in technology and practice, social demographics, and public law and regulations are creating the need for ongoing education and training in skilled technical health care occupations. In their paper commissioned for this study, Frogner and Skillman (2015) identify data challenges with respect to analysis of health occupations and then offer the following observations that are relevant to the coordination of workforce development in this sector:

- **Confusing education and training requirements.** Frogner and Skillman see evidence that education and training requirements for skilled technical health occupations are confusing, and that not all programs succeed in opening up pathways to well-paying careers. In their opinion, the career ladder in health care is more like a lattice because of the many options faced by entrants. Career transitions also are unclear. Credentialing through exams, certificates, and licenses is necessary to ensure quality care in some health occupations. In addition, scope-of-practice laws dictate what a worker can and cannot do. These requirements add to the confusion of occupational choice, education, and training. They also impose out-of-pocket and mobility costs for qualified workers, as credentials and scope-of-practice requirements vary by state and by occupation. In addition, obtaining credentials often requires payment of fees. Frogner and Skillman aver that, without a capable mentor or role model to serve as a guide, potential workers may find these complexities too daunting to enter the field.

- **Need for training relationships.** Public–private partnerships, including practical training partnerships between employers and educational institutions, are one way to develop necessary competencies—particularly as practice models and technologies evolve. Although clinical practicums are common in the health care industry, more formal training relationships, such as registered apprenticeships, are not, and several scale and coordination issues are associated with building sustained relationships between educators and employers.
- **Cost as a barrier to education and training.** The cost of education and training can be a barrier to entry in health care occupations for many people, and funding sources for this education and training can be unstable. Among all skilled technical jobs in allied health, nursing is the fastest-growing and offers the highest return over the span of one's career. In Frogner and Skillman's opinion, however, the cost of postsecondary education may be a barrier to entry in the nursing field for many potential workers. Other health care occupations in high demand, such as personal care assistants, have low educational entry requirements; however, they are among the lowest-paid. Many workers in these high-demand positions experience high turnover, are likely to live at the federal poverty level or below, and suffer from high rates of disability. Although the Carl D. Perkins Career and Technical Education Act's Tech-Prep programs could address funding issues, Congress has not appropriated funds for these programs since 2011, and subsidized loan programs are quickly disappearing as financial aid options shrink and the Pell Grant program struggles to meet the financial needs of eligible students amid funding cuts.

Health care goods and services are significant components of the U.S. economy in every state. Frogner and Skillman's analysis suggests that policy makers may need to create incentives for health care employers to assume a more active role in designing and funding education and training; improving job quality to recognize skill attainment; and collaborating with educators and workers to improve educational, training, and career guidance programs. In addition to better aligning workforce development incentives and programs, federal and state policy makers could work across state lines with health care industries to rationalize and harmonize health care credentialing and scope-of-practice requirements.

5.3.2 Training the Manufacturing Workforce

A recent report by Deloitte and the National Manufacturing Institute (NMI) claims that U.S. manufacturers are struggling to support their strategic, business, and production plans as a direct consequence of a shortage of skilled

production workers (Deloitte and NMI, 2015). As Figure 5-2 shows, the executives surveyed by Deloitte indicated that a talent shortage affects critical aspects of business activity and expansion. Given the mixed evidence of a significant skills gap reviewed in Chapter 2, however, it is important to examine why manufacturing companies are unable to recruit and retain workers who have the necessary skills:

- **Public perception.** Public perception is a major issue for this industry: manufacturing firms often are perceived to be unstable, dirty, and dangerous workplaces with few opportunities for workers to grow and develop their skills (Panchak, 2016). Similarly, in a paper commissioned for this study, Messing-Mathie (2015) observes that students, parents, and their advisors often overlook manufacturing apprenticeship programs in favor of academic education, reflecting a bias against skilled technical education and training that tends to exist in most advanced economies. Although negative perceptions could make it difficult to attract a new generation of workers to skilled technical occupations in manufacturing, other factors also contribute to this situation.
- **Skill deficiencies.** More than half of the executives surveyed by Deloitte and NMI (2015) described difficulty in finding qualified workers and serious deficiencies in their current employees related to technology and computer, problem-solving, math, and technical knowledge. Some data show that the average manufacturing worker

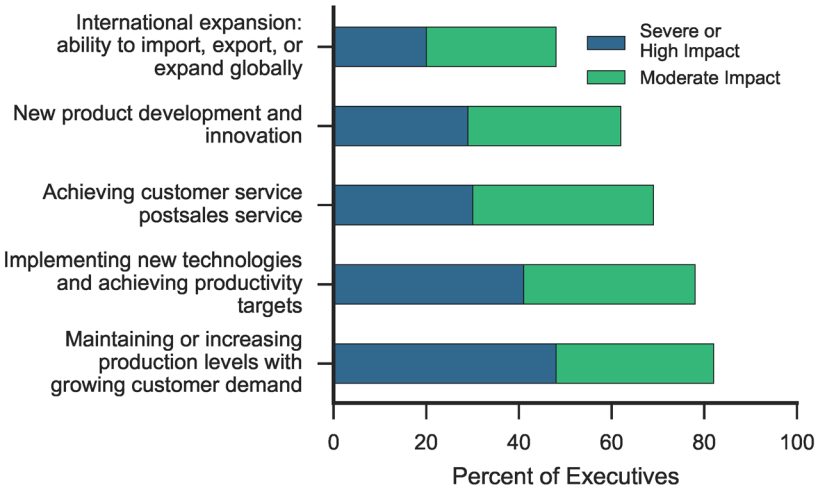

FIGURE 5-2 Business areas most affected by the talent shortage.
SOURCE: Giffi et al., 2015.

earned $77,506 in 2013—20 percent more than what an average worker earned in other industries—and that four of five manufacturing executives are willing to pay more than the current market rate to hire and retain capable workers. However, other data suggest that skill demands have risen modestly and at a pace that makes most jobs accessible to most people. In a national survey, Osterman and Weaver (2014a) found that three-quarters of establishments can find the workforce they need but that a significant minority are experiencing difficulty. They note further that a retirement wave could exacerbate this problem. In their opinion, effective policies and institutions exist to address this problem, but they are scattered and not well supported. As discussed in more detail in Chapter 2, skill requirements for technical occupations change over time and are likely to continue to do so with advances in science and technology. These data suggest that workers who are interested in and willing to work in manufacturing are not investing in, do not have access to, or are not receiving the continuing education and training they need to be successful throughout their careers.

- **Perverse incentives.** Data collected in a recent employer survey by Accenture, Burning Glass, and the Harvard Business School suggest that manufacturing executives understand the importance of investing in employee training, development, and certification programs (Accenture et al., 2014). However, 58 percent of those surveyed reported that they use overtime to mitigate the effects of being unable to attract and retain skilled workers.[17] Yet working overtime makes it difficult for workers to find time to invest in additional education and training. In addition, loss of income due to the ability to hire a sufficiently skilled workforce makes it difficult for firms to invest in education and training, potentially creating a vicious circle of competitive decline.
- **Investments in automation and outsourcing.** Market forces also may provide an incentive for firms to invest in capital rather than labor. Over the past several decades, firms have increasingly automated or outsourced tasks and jobs previously held by skilled technical workers, resulting in job losses in specific industries and occupations. In a recent survey of Harvard Business School alumni, for example, nearly half of respondents agreed that their firms' U.S. operations preferred to invest in technology to perform work instead of hiring or retaining employees, while only 25 percent disagreed.

[17]See Accenture et al. (2014, Figure 16) for an overview of manufacturing executives' response to the question, "How important are the following techniques to mitigate the effects of existing skills shortages for a skilled production workforce?"

Forty-nine percent said their firms preferred to rely on vendors to perform work that could be outsourced, while only 29 percent reported that their firms would rather hire additional workers and keep work in house. When choosing to hire, moreover, companies also showed a distinct preference for relying on part-time workers (Accenture et al., 2014).

- **Program design.** An additional set of coordination challenges in the manufacturing sector is related to how education and training programs are designed and implemented. Messing-Mathie (2015) notes that apprenticeship programs typically require a diverse range of social partners: if key partners are excluded or if roles are not clearly specified, confusion and poor coordination will result (see also Wolter and Ryan, 2011). However, manufacturing apprenticeships and other types of education and training programs do not always offer a final certification or a portable credential upon completion, which makes them less valuable across firms and industry segments. There is a growing view that some employers, particularly small and medium-sized businesses—the predominant manufacturing firm size in the United States—are concerned about their ability to earn a return on the costs of employing and supporting apprentices. In addition, apprenticeships often pay a relatively lower wage in the early phases of the program, which may make them less competitive than other job opportunities and may create a sense of inequity that can be a disincentive for participation.

These observations suggest that the policy objectives of manufacturing-driven growth and competitiveness are more likely to be realized if policy makers better align the incentives of workers and employers to improve the returns on investment in education and training in this sector.

5.3.3 The Military Transition Challenge

The U.S. Armed Services are among the largest employers in the country (DoD, 2015).[18] Most enlisted personnel serve in the armed forces for just under

[18]The total number of military personnel in fiscal year 2014 (3.5 million) includes 1,101,939 Department of Defense (DoD) Ready Reserve and Department of Homeland Security (DHS) Coast Guard Reserve members, 214,784 Retired Reserve personnel, 13,700 Standby Reserve personnel, and 856,484 appropriated and nonappropriated fund civilian personnel. The DoD active duty and DHS Coast Guard active duty members make up the largest portion of the military forces (38.4 percent). This section focuses on skill transfer possibilities with respect to active duty military personnel in the Armed Services; therefore, the discussion does not include Reserve or civilian personnel.

7 years on average. In 1979, the United States eliminated the draft and created an all-volunteer military force. The Office of the Deputy Assistant Secretary of Defense (Military Community and Family Policy) reported that in fiscal year 2014, the military community included 1.3 million Department of Defense (DoD) active duty military personnel and 39,454 Department of Homeland Security (DHS) active duty Coast Guard members (DoD, 2015). Although the size of the armed forces is declining as the engagements in Afghanistan and Iraq wind down, Table 5-2 shows that there were still about 1.3 million women and men working in the Armed Services at the end of January 2016.

Many Americans join the armed forces as a pathway to education, training, and preparation for life and careers. As Figure 5-3 shows, 43.2 percent of all uniformed active duty personnel are aged 25 or younger. Military personnel receive excellent training in the competencies associated with skilled technical work.

Jobs in the military vary by type of work and level of responsibility. The majority of active duty jobs in the Armed Services are enlisted jobs (82.3 percent), which require a high school diploma and typically involve technical skills that could transfer to jobs in civilian occupations such as those in maintenance, health care, or IT. Some enlisted members (7.0 percent) have a bachelor's degree or higher, while most (92.1 percent) have a high school diploma and/or some college experience but less than a bachelor's degree. Officer positions, which represent 17.7 percent of active duty members of the Armed Services, involve planning, directing operations, and making critical decisions (DoD, 2015). These jobs require a minimum of a 4-year degree, and some careers, such as law and medicine, require advanced degrees. Relative to 1995, the percentage of total active duty members with an advanced degree has increased for both enlisted personnel (from 7.3 percent in 1995 to 10.1 percent in 2014) and officers (from 79.9 percent in 1995 to 86.5 percent in 2014) (DoD, 2015).

TABLE 5-2 Uniformed Armed Forces Strength Figures as of January 31, 2016

	01/31/16	12/31/15	Change from Previous Month		01/31/15
			Number	Percent	
Total Armed Services	1,347,232	1,344,258	2,974	0.22	1,360,406
Army	482,816	482,264	552	0.11	498,401
Navy	328,662	328,162	500	0.15	324,911
Marine Corps	184,418	183,197	1,221	0.66	184,781
Air Force	311,590	310,996	594	0.19	312,294
Total DoD	1,307,486	1,304,619	2,867	0.22	1,320,387
Coast Guard	39,746	39,639	107	0.27	40,019

NOTE: DoD = Department of Defense.
SOURCE: DoD, 2016.

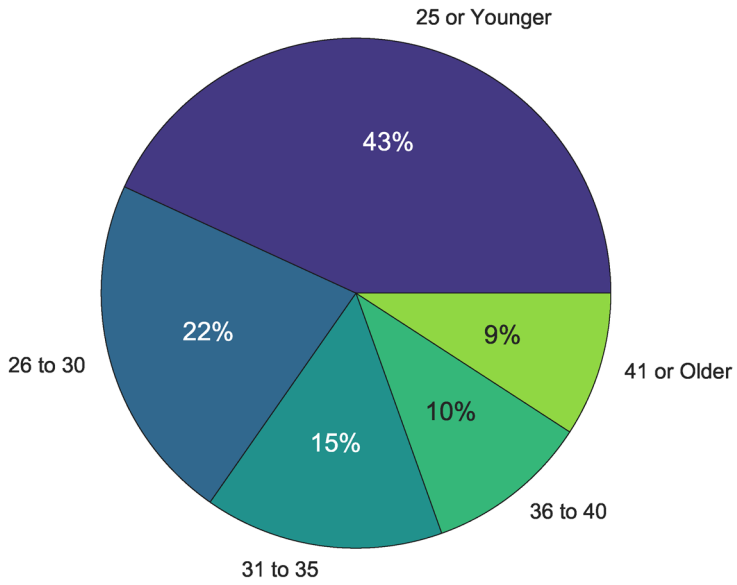

FIGURE 5-3 Age of uniformed active duty personnel in fiscal year 2014.
NOTE: Percentages may not sum to 100 because of rounding.
SOURCE: DoD, 2015. DMDC Active Duty Military Personnel Master File.

Military–Civilian Transition Issues

In 2014, 184,444 enlisted members and 20,112 officers left active military duty and returned to civilian life (DoD, 2015). The most common reason for leaving for enlisted members was voluntary separation/early release, while the most common reason for officers was non-disability-related retirement (DoD, 2015).[19] These workers have received excellent technical education and training, and they have developed the "soft skills" required to work well with others. Even though they receive comprehensive transition services, however, the Department of Veterans Affairs reports that, compared with civilians with similar demographics, veterans have an 8 percent higher total unemployment rate, and their median income is slightly below the nonveteran median of $42,317 (VA, 2015). Veterans participating in the GI Bill program complete

[19]The Pew Research Center (2011) estimated that the average length of service for enlisted personnel was 6.7 years.

programs at a rate comparable to that of traditional postsecondary students; however, they take longer to do so.

Veteran unemployment rates, earnings rates, and completion rates can vary across the services and base locations, as well as across skills, age, reason for separation, and other demographic factors. For example, the Department of Veterans Affairs reports that over the period 2005-2013, veterans aged 18-34 had a 20 percent higher unemployment rate than nonveterans, but median earnings for the same veteran age cohort were about 8 percent higher than those for nonveterans. Moreover, veterans under the age of 30 who used the GI Bill had 8 percent higher completion rates than traditional students in the general population. However, it is possible that these statistics misestimate the veteran–nonveteran difference for a wide range of reasons, including the way in which the experience of mobilized Reservists is treated.[20]

A 2014 U.S. Congressional Joint Economic Committee staff analysis indicates that more than 50 percent of veterans work in industries, such as transportation and utilities, manufacturing, construction, information, wholesale trade, and professional and business trades, that employ skilled technical workers (U.S. Congress Joint Economic Committee Democratic Staff, 2014). However, the analysis suggests that veterans are underrepresented in the fast-growing sectors of the economy, including two of the three industries that have fared the best during the past several years (in terms of job gains as a percentage of employment in the industry): the education and health services industry and the leisure and hospitality industry.[21]

To develop a better understanding of the contradictions in veteran transitions, the committee asked Susan Payne Carter and Brian J. Miller of the U.S. Military Academy to investigate the transitions of U.S. Army soldiers, who

[20]For example, the rates for the 18- to 24-year-old cohort likely reflect the experience of those who enlisted in their early 20s and left the military relatively early because it was not a good fit for them. Those who enlist at a young age and leave early are atypical because most enlistments are for 3 years or more. The proportion of those who leave early in older age cohorts may be much smaller. Additionally, the period 2005-2013 saw relatively high Reserve mobilization. Once demobilized, Reservists will appear in the data as "veterans." However, Reservists, particularly younger Reservists, may have a weaker connection to the labor force before mobilization (e.g., they may have been students or new to the workforce). Similarly, veteran–nonveteran comparative per capita income statistics may be misleading. For example, veterans who retire with an annuity or have other financial resources or support or who have fewer financial responsibilities may choose lower-paying jobs than veterans and nonveterans who have fewer financial resources or less financial support or greater financial responsibilities.

[21]The report notes that veterans represent only 4.3 percent and 3.3 percent of employees in these industries, respectively. Since December 2007, employment in the education and health services industry has expanded by 14.7 percent and in the leisure and hospitality industry by 8.9 percent.

represent the largest uniformed workforce in the Armed Services (Carter and Miller, 2015). Unlike civilian workers, departing military personnel may collect unemployment benefits even if they leave the service voluntarily. In many states, moreover, veterans may collect both GI Bill and unemployment benefits. Carter and Miller report that in 2013, DoD spent $829 million on Unemployment Compensation for Ex-servicemembers (UCX), more than one-half ($463 million) of which went to Army veterans. In 2010 and 2011, 53 percent of all transitioning veterans applied for benefits. On average, veterans drew benefits for 20 weeks during this time; 95 percent did not exhaust their benefits.

Between 2011 and 2013, 59 percent of departing Army soldiers who were eligible for UCX benefits applied, and most who did so ended up using the benefits. When data on soldiers are disaggregated across demographic and military service dimensions, however, average rates vary considerably. Surprisingly, soldiers with seemingly transferable skills, such as logisticians, apply for UCX at the highest rates, a result that holds when Carter and Miller control for education, cognitive ability, and other demographic differences. The authors speculate that some individuals in this population do not, do not wish to, or cannot directly transfer their Army skills to civilian jobs.

Similarly, Frogner and Skillman (2015) observe that military personnel have a unique career transition in health care. They point out that military skills and experience may not translate to the competencies needed or follow the path required by accreditation or licensing bodies in the civilian sector. Preparing and sitting for exams to obtain licenses despite years of experience can take more time than veterans can afford to be out of the workforce.

To explain differences in UCX application rates among demographic groups, Carter and Miller (2015) look at a wide range of demographic factors. They document evidence suggesting that a complex set of life factors can affect Army soldiers' UCX application rates (see Box 5-1). Groups more likely to apply include soldiers with 2 to 3 years of service upon separation and lower pay grades; female, black, and Hispanic soldiers relative to white male soldiers; divorced soldiers and soldiers with children relative to single soldiers; and soldiers with lower levels of educational attainment and lower cognitive ability scores on their qualification test.

Carter and Miller note further that the highest Army UCX application rates are associated primarily with service and support specialties. Veterans in the following specialties (listed in descending order) apply at higher rates: quartermaster, finance, chemical, adjutant general, air defense, and transportation. Although 62 percent of soldiers who separate because of satisfactory completion of their service contract apply for benefits, those who

BOX 5-1
Factors Affecting Unemployment Compensation for Ex-servicemembers (UCX) Applications

- Years of service
- Pay grade
- Gender and race
- Family structure
- Education and intelligence
- Military occupation
- Disability status
- Reason for leaving
- Location

separate for other reasons are more likely to apply.[22] Finally, application rates vary across base locations, suggesting differences in transition assistance programs.

Actions to Improve Veterans' Transitions

Several programs, including federal and state government programs, private-sector initiatives, and public–private partnerships, have been implemented to improve transitions for returning veterans (U.S. Congress Joint Economic Committee Democratic Staff, 2014). The United Services Military Apprenticeship Program (USMAP), for example, is a formal military training program implemented by the Center for Personal and Professional Development that gives active duty Coast Guard, Marine Corps, and Navy service members the opportunity to improve their job skills and complete their civilian apprenticeship requirements while they are on active duty. The objective of the National Apprenticeship Standards for USMAP is to provide registered certification of the training of individual service members and to achieve recognition for them equal to that of their civilian counterparts.[23] Lerman and his colleagues at the Urban Institute report that currently, about 1 in 4 enlisted

[22]The data show that soldiers with disability ratings are more likely to apply for UCX benefits. However, soldiers who have 100 percent disability ratings and are discharged for medical reasons are less likely to apply.

[23]DOL provides the nationally recognized "Certificate of Completion" upon program completion. Originally established in 1976 as a Navy program, USMAP became a single program registered with DOL (N-93063) for the three Sea Services in April 2000. USMAP allows active duty service members to complete a DOL apprenticeship program while serving their country (see DOL, 2012).

Sailors and 1 in 14 Marines participate in USMAP (Lerman et al., 2015). In their opinion, one of the program's major accomplishments is that it has registered about 100 occupations with DOL's Office of Apprenticeship that are related to civilian fields.

The VOW to Hire Heroes (VOW) Act (P.L. 112-56) strengthened and expanded tax credits for employers who hire unemployed veterans, increasing the tax credits for hiring veterans who have been seeking a job for more than 6 months, as well as those eligible for disability compensation from the Department of Veterans Affairs. Through the Hiring Our Heroes program, the U.S. Chamber of Commerce Foundation is working with businesses to obtain commitments to hire veterans and military spouses (Eversole, 2016).

Additional action is needed, however. Suggestions solicited by the Joint Economic Committee include streamlining credentialing and providing better-targeted transition assistance (U.S. Congress Joint Economic Committee Democratic Staff, 2014). Streamlining state occupational licensing, for example, helps veterans with equivalent military skills and abilities meet credentialing requirements for training and education. Veterans in jobs in health care and transportation occupations, such as emergency medical technicians, licensed practical nurses, and bus and truck drivers, often have skills that overlap with civilian occupational requirements. In addition, spouses of returning veterans often move with them across state lines and may need to obtain a certification or license in their new state. Today all 50 states and the District of Columbia allow veterans with relevant experience to receive waivers of the skills test to obtain a commercial driver's license, and dozens of states have acted in other ways to facilitate credentialing and licensing for military veterans transitioning to civilian employment and their spouses (U.S. Congress Joint Economic Committee Democratic Staff, 2014). Further legislation could facilitate the transition of additional veterans with specific skill sets into in-demand civilian occupations.

As Carter and Miller (2015) report, challenges in moving from active duty to civilian life often extend beyond simply having the right skills for available jobs. Veterans also may need assistance with more general skills that are helpful in the workplace and throughout the job search process (U.S. Congress Joint Economic Committee Democratic Staff, 2014). The VOW Act requires transitioning service members to participate in the Transition Assistance Program, which teaches them how to approach a job search, write a resume, and apply their military skills to civilian jobs (Orvis, 2016). The Veterans Employment Center, which lists private- and public-sector jobs, also helps veterans build profiles and translate their military skills into plain language. Carter and Miller argue that the Army should collect more data on soldiers' transition experiences, better analyze the efficacy of transition assistance classes, and tailor the classes to better address the challenges of transitioning from a military to a civilian career.

Other Actions

The information presented above suggests that DoD and the Department of Veterans Affairs could do a better job of assessing the transition risks for military personnel and of designing and delivering services to effectively mitigate these risks, including ensuring that the military culture encourages service members to transition without drawing UCX assistance. In addition, it appears to the committee that DoD could coordinate better with civilian policy makers, regulators, and educators to improve the transferability of military education, training, and certification.[24] A reevaluation of the Post-9/11 Veterans Educational Assistance Act may also be required.

Efforts to improve veterans' transitions into the civilian workforce have focused on actions taken immediately prior to their leaving the military at the point of transition into the civilian workforce. A seamless transition may require that planning begin earlier in—perhaps even at the start of—service members' military careers. Doing so would help ensure that service members are trained in fields in which they wish to continue after leaving the military and that these skills will be valued in both the military and civilian workforces. As discussed at a workshop convened by the committee on "The Military as a Pathway to Skilled Technical Jobs," DoD is seeking to pursue more fluid employment models that meet its workforce needs while allowing for easier transitions between the civilian and military workforces (see Box 5-2).

Given the sheer number of former service members transitioning out of the military each year (about 200,000) and the costs of UCX benefits (nearly $1 billion annually), better information on these transitions is needed, including return to military service after voluntary separation. For example, information on how often transitioning service members switch occupations and how they make occupation decisions is needed to help inform efforts of policy makers and DoD leadership to improve these transitions.

5.4 CONCLUSIONS

Policy makers, educators, employers, and workers need to better integrate economic development and workforce development objectives, undertake initiatives across and within industry sectors to align incentives, and invest in education and training. They also need to design and deliver relevant programs that meet the changing requirements of workers and employers at the local level. Addressing quality issues in skilled technical workforce development requires

[24]Many of these points are echoed in a recent study of USMAP. For an analysis of this program and recommendations, see Lerman et al. (2015).

BOX 5-2
Workshop on "The Military as a Pathway to Skilled Technical Jobs"

The committee convened a workshop to explore how the Department of Defense (DoD) can better integrate skills transition into military training rather than treating it as a separate component at the end of the service member's career. Participants considered how DoD can better coordinate with civilian employers, educators, and regulators to improve the transferability of military education, training, and certification to the civilian workforce. The meeting's agenda is reproduced in Appendix A.

In his keynote address, Under Secretary of Defense Peter Levine noted that education and training are at the heart of DoD's strategy both for recruiting service members and for transitioning them to civilian life. Karen Orvis of the DoD Transitions to Veterans Program Office described the Military Life Cycle (MLC) Transition Model, which starts preparation for service members' transitions early in their military careers. Service members are made aware of the Career Readiness Standards (CRS) they must meet throughout their military careers in mapping and refining their individual development to achieve their professional goals while in service and their postmilitary goals for employment, education, career technical training, or self-employment. DoD is in the process of implementing an evidence-based assessment of the Transition Assistance Program.

In his remarks, Ryan McDermott of the DoD Office for Manufacturing and Industrial Base Policy described the Skills Bridge Program, which offers service members an opportunity to participate in civilian job and employment training activities, including apprenticeships and internships. This program, he noted, also addresses the workforce needs of the manufacturing and industrial base that supports DoD's missions.

In their roundtable remarks, Debra S. Wada, Assistant Secretary of the Army (Manpower & Reserve Affairs); Brigadier General Kathleen Cook, Director of U.S. Air Force Services; and Anish Goel, Senate Armed Services Committee noted that a shift to a more integrated approach to selecting, training, and transitioning service members with technical skills is needed to facilitate the accomplishment of DoD objectives and enable workers to move back and forth between the military and civilian workforces. However, achieving this shift will require a change in DoD's mindset, authorities, and personnel management policies and procedures, which are currently focused on the more short-term goal of winning wars.

better coordination at the local, state, and federal levels and within and across economic sectors.

This chapter has considered a variety of current challenges to identifying and better aligning returns on investment in education and training on the part of students, workers, and employers. The next chapter reviews experiments under way across the United States to address many of the challenges identified in this and preceding chapters.

6

Key Lessons for Programs and Policies

Although, as discussed in the preceding chapter, significant challenges are entailed in developing and sustaining a skilled technical workforce, there is evidence for a variety of solutions that work by encouraging and facilitating collaborative partnerships across local employers; community colleges; high schools; universities; and local, state, and federal government agencies. These initiatives also can create the right incentives for employers and workers to remain engaged and vested in their local market for skilled technical work. This chapter reviews some leading programs and policies focused on achieving these ends.

Section 6.1 looks at how better to link students to skilled technical education and training opportunities and improve success rates, recognizing that students face substantial challenges in navigating, paying for, and completing such programs. Section 6.2 considers strategies for better linking secondary and postsecondary education and training, including early college schools, career academies, and dual-enrollment programs. Section 6.3 examines the links between postsecondary educational organizations and employers; the discussion encompasses strategic centers of excellence at community and technical colleges and sector-specific training programs. Section 6.4 looks at employer training programs, including the role of employers in developing apprenticeships, as well as efforts by labor unions to foster joint labor–management programs. Section 6.5 considers efforts to improve the collection, analysis, dissemination, and widespread use of data that can be used to improve the linkages discussed in the preceding section. Section 6.6 examines other policy initiatives aimed at improving career and technical education (CTE), including those focused on portable credentials and licenses, standardized credentials, licensing reforms, and competency models. Finally, Section 6.7 provides conclusions.

The polycentric nature of the skilled technical workforce development system in the United States provides the opportunity for many simultaneous policy and partnership experiments. This, in turn, makes it possible for civic

leaders to examine the needs of their communities, study the experiences of others, and develop initiatives that address the identified needs.[1] Assessing these initiatives remains a challenge, however. While this report cites research pertaining to the variety of initiatives under way across the United States, the large size and complexity of the U.S. workforce development system makes it difficult to survey, evaluate, and monitor these initiatives comprehensively. The effectiveness of any particular strategy can depend not only on the validity of its concept and the rigor of its implementation but also on the presence of complementary linkages with other components of the system. Thus while this chapter highlights an array of noteworthy initiatives to develop and sustain a skilled technical workforce and presents evidence (where available) of their impacts, it is important to note that in many cases, research on these initiatives has not yet been conducted, and therefore their relative value and potential impacts have not yet been assessed.

6.1 LINKING STUDENTS TO SKILLED TECHNICAL EDUCATION AND TRAINING OPPORTUNITIES AND IMPROVING SUCCESS RATES

As discussed in Chapter 5, evidence shows high economic and social benefits of completing postsecondary education and training, but a number of factors inhibit students from either choosing or completing this course of preparation. This section reviews the evidence on the effectiveness of policy measures aimed at encouraging enrollment in skilled technical education and training and improving completion rates. These policy measures include those focused on improved counseling services, financing strategies, wraparound services, improved remediation, improved outcomes for adult learners, leveraging of online learning, and improved incentives for completion at the community college level.

Although this chapter focuses on public 2-year institutions (community colleges), many private for-profit institutions offer similar education and training programs (see Chapter 4). While for-profit institutions can help meet the demand for skilled technical education and training, the evidence suggests that completion rates, default rates, and labor market outcomes are worse for for-profit than for public 2-year institutions (Deming et al., 2013).

[1]The National Center on Education and the Economy and the National Conference on State Legislatures have formed a study group to investigate top-performing education jurisdictions. For information, see NCEE (2017).

6.1.1 Improved Counseling Services

There appears to be widespread consensus among education experts that policy makers, educators, and employers need to do a better job of helping students and adult workers understand the link between education and training programs and employment. The Accelerated Study in Associate Programs (ASAP) at the City University of New York (CUNY), discussed further below, provides evidence that advising, career services, and tutoring play an important role in improving completion rates (Scrivener et al., 2015).[2] Career guidance is particularly important for skilled technical workforce development to counter the common perception that the only path to lifelong occupational success is through immediate entry into a 4-year college and advanced degree programs (see Chapter 5).

Some analysts believe that without career counseling and reliable occupational information, students pay insufficient attention to labor market trends when choosing a field of study (Long et al., 2014). When industries and occupations are changing, it is particularly challenging for students and job seekers to identify viable career options and the associated education and training requirements. At the same time, data suggest that K-12 schools, postsecondary schools, and worker assistance agencies have reduced support for counselors and advisors because of budget pressures and changing priorities (Good and Strong, 2015). Inadequate occupational guidance potentially increases the costs of education and training, creates imbalances in labor markets, and reduces returns on investment in skilled technical workforce development.

Research suggests that One Stop Career Centers often provide the type of career advising that is lacking in many educational institutions, and a variety of collaborations can be encouraged, depending upon local requirements (Holzer, 2015b). Under new provisions in the Workforce Innovation and Opportunity Act (WIOA), states can rethink and expand the reach of these job centers to better serve a broad range of clients. For example, some states have purchased online job databases such as Help Wanted OnLine® to help their One Stop Career Centers better match job seekers with jobs. Nearly a quarter of One Stop Career Centers are now located on college campuses, and even more are deploying staff

[2]Scrivener and colleagues (2015) used randomized controlled trials to evaluate the impact of ASAP over a 3-year period compared with the usual services and courses provided at CUNY, finding that graduation rates within 3 years nearly doubled. Along with these student services, students were required to be full-time students and were provided additional financial support, such as tuition waiver, free use of textbooks, and cards for free public transportation. The ASAP program has student-advisor ratios between 60:1 and 80:1. A study of two colleges in northern Ohio found that enhanced academic counseling with an average of a 160:1 student-adviser ratio had only modest short-term effects (Scrivener and Coghlan, 2011).

to campuses on a part-time basis. States also can take steps to reform job center metrics to better reflect the quality of advising activities rather than the number of referrals.

In addition to improving completion rates, counseling and career services can increase enrollment in skilled technical education and training where the returns are higher. As discussed in Chapter 5, however, many parents, students, and workers perceive career preparation programs such as CTE to be associated with lower socioeconomic status and lower career ambitions (see, e.g., Herian, 2010). If the challenges of skilled technical workforce development are to be addressed effectively, this perception must be changed so that programs to provide job skills and training are no longer viewed as a substitute for college but as a robust way to contextualize academic learning.

The best education and training programs prepare students to enter the workforce and pursue lifelong learning by encouraging the development of general technical skills, occupational skills, and "soft skills" that make for reliable and collegial employees (Bronson, 2007). However, the current overemphasis on 4-year college-preparatory curricula may inhibit students from receiving the workplace training necessary to acquire soft skills and from learning enough technical content to become skilled workers (see Bolli and Hof, 2014; Bolli and Renold, 2015). Thus, students may need to receive counseling even before entering community college so that they realize the potential gains from pursuing this training.

Instead of offering a program solely designed to prepare students for 4-year college programs, then, another option is to prepare them by developing technical skills and then help them prepare for and choose among postsecondary education and training and career alternatives. This emphasis on a strong technical foundation can improve public perceptions of career preparation programs, enhance the employment prospects of graduates, and develop a better workforce.

6.1.2 Financing Strategies

As discussed in Chapter 5, the rising costs of community college and inadequate financial aid can be a barrier to completion for many low-income students. Some federal aid, such as Pell Grants, is limited to undergraduate students in for-credit programs and is not available for students taking continuing education classes, even when they are earning a certificate (Greenhouse, 2013). An evaluation of two colleges in New Orleans found that providing financial aid tied to academic benchmarks to supplement other financial aid increased the likelihood that students enrolled full-time and earned more credits (Scrivener and Coghlan, 2011). Although only a small fraction of students in the ASAP program received tuition waivers, it may be that the availability of such financial support increased full-time enrollment in CUNY colleges by reducing worry about future financial aid (Scrivener et al., 2015). In

addition to the direct costs of community college, students have to weigh foregone earnings when in school and the need to balance college and work for many parents.

Braiding Strategies

Some states are seeking to combine public resources to support postsecondary education and training programs using "braiding strategies," which merge public dollars for a common purpose while keeping categorical funds distinct. For example, Oregon's Career Pathways Statewide Initiative braids Perkins Act, Temporary Assistance for Needy Families, Workforce Investment Act (WIA), and state general funds to finance career pathways programs in the postsecondary education system. In Arkansas, the Career Pathways Initiative (CPI) has partnered with the local division of child care and early childhood education offices to connect students to state subsidies for child care (Hoffman and Reindl, 2011). In addition, CPI students are assigned a tutor and a counselor to help them address any issues and obtain other services.

Lifelong Learning

Some states also are experimenting with strategies for ensuring that U.S. workers and employers continue to invest in education and training throughout the career span. Maine, for example, is experimenting with portable, employee-owned Lifelong Learning Accounts (LILAs) that permit employees, employers, and the state to pool funds for continual worker education and training (Hoffman and Reindl, 2011). LILAs, which are managed by the Maine Finance Authority, can be used for postsecondary education and training courses as well as books and supplies. In addition, LILA holders have access to career counselors.[3]

6.1.3 Wraparound Services

Providing education, training, and opportunity often is insufficient to ensure success for many youth and adult learners, many of whom are unfamiliar with school processes and policies or need help meeting family, work, and financial responsibilities. "Wraparound" student support services at the postsecondary level, such as those described in Box 6-1, can be particularly beneficial for low-income and first-generation students, who may not have the resources or social networks to navigate the higher education system and to persist to complete their degree programs. A recent study of the ASAP program

[3]For information about Maine's LILAs, see www.bos.frb.org/commdev/c&b/index.htm (accessed March 21, 2017).

BOX 6-1
Key Features of Wraparound Services

Purnell and Black (2004) identify the following key features of wraparound services:

- Academic guidance and counseling, through which students gain information on educational and course planning and graduation requirements;
- Academic supports, such as tutoring, through which students receive additional help in meeting their academic goals;
- Personal guidance and counseling, such as mental health counseling or crisis intervention;
- Career counseling, through which students receive information on careers; and
- Supplemental services, such as child care or transportation assistance.

SOURCE: Excerpted from Purnell and Blank (2004, p. 7).

at CUNY, discussed earlier, suggests that focusing on wraparound services can improve returns on investment in skilled technical education and training. The program offers full-time students intensive advising and tutoring, priority in registering for oversubscribed courses, free transportation, free textbooks, and a waiver that covers any shortfall between schooling costs and financial aid. A randomized controlled trial of the program showed significant positive outcomes. The program nearly doubled the share of students graduating within 3 years, increased the share enrolling in a 4-year college, and provided a satisfactory return on investment. The program was estimated to have increased per-student costs by 60 percent, or about $5,400 a year. However, the near doubling of graduation rates means that CUNY actually spent more than 10 percent less per college degree (Dynarski, 2015).[4]

Wraparound services may be standard and comprehensive or operate on a piecemeal or smaller scale, depending on local requirements. An example of a small-scale program is Massachusetts Bunker Hill Community College's (BHCC) emergency assistance fund.[5] This fund provides small one-time grants

[4]Some experts argue that wraparound services are important at the secondary as well as the postsecondary level. The committee believes this is an important issue; however, a detailed examination of secondary education is beyond the scope of this study.

[5]For information about the fund, see http://www.bhcc.mass.edu/emergencyassistancefund (accessed March 21, 2017).

to students for emergencies that occur during the semester and may cause them to drop out of college, such as a lost or stolen laptop, a medical emergency, or a car accident. Students who document such a need may receive up to $1,000 to help them get back on their feet and stay in school. In fiscal year 2012, the fund assisted 147 students and disbursed more than $100,000; the average grant was about $700. BHCC reports that the retention rate for students receiving assistance through the fund is 31 percent higher than that for the entire student population.

6.1.4 Improved Remediation

As discussed in Chapter 5, students who need to take remedial courses relative to those who do not are more likely to drop out of a postsecondary program. Nearly two-thirds of students entering community college are asked to take either remedial English or math classes (NCES, 2016a). Students who need to take two or three remedial classes in a subject are unlikely ever to complete a college-level class in that subject (Bailey and Jaggars, 2016). In addition, there is some evidence that the remediation is not effective: one study found that the vast majority (72 percent) of students who ignored the referral to a remedial class ended up completing the college-level class, compared with only 27 percent of students who complied with the referral (Bailey et al., 2010).

Reducing the Need for Remediation

As discussed in Chapter 5, many students entering college are assigned to noncredit developmental courses that increase the costs and lengthen the time for obtaining a degree. Some analysts are questioning the way students' readiness is assessed and whether the need for developmental coursework is as prevalent as some have assumed.[6] Improving readiness assessments could be a low-cost, high-benefit intervention to increase college access for many students. For example, using high school transcript information—either instead of or in addition to test scores—could significantly reduce the prevalence of assignment errors (Scott-Clayton et al., 2012).

[6] Many public colleges and universities use a computerized test, known as ACCUPLACER, to assess students' skills in mathematics, writing, and reading. However, recent research has found that under current test-based policies, about one in four test takers in mathematics and one in three test takers in English are assigned improperly to developmental courses. In addition to inaccurate assessments, the value of the developmental coursework has been challenged. For example, many community colleges require students to pass Algebra I before taking for-credit classes even in fields in which this mathematics track is not required.

The following subsections review evidence that integrating remediation into skills training classes, as well as using accelerated remedial coursework, can improve completion rates. Methods of reducing the need for remedial classes, including improving elementary and secondary education and better integrating secondary and postsecondary education, are then discussed.

Integrating Remediation

Schools can do a better job of assessing student readiness for postsecondary education and training and of designing more appropriate and cost-effective prerequisite requirements. Moreover, several studies indicate that it is possible to integrate academic preparation for postsecondary education and training with technical training to motivate students and to hasten readiness for skilled technical occupations (see, e.g., Hoffman and Reindl, 2011; Howington et al., 2015; Wachen et al., 2012).

Readiness can be improved by integrating developmental content into courses that are offered for credit instead of delivering it as a stand-alone course (see Bettinger et al., 2013).[7] The state of Washington's Integrated Basic Education and Skills Training (I-BEST) program, for example, offers academic instruction in the context of technical education (Hoffman and Reindl, 2011). Adult literacy and career-technical instructors co-teach courses that provide students with developmental support while they earn credit toward a certificate or degree. A multiyear evaluation of I-BEST found that when developmental instruction was combined with for-credit classes, students developed basic skills more closely tied to their field of study, were more likely to persist in their coursework, and did not waste financial resources on noncredit coursework (Wachen et al., 2012, using outcomes of I-BEST students matched to those of students with similar characteristics). The evidence also indicates that I-BEST students earn nearly twice as many college credits as non-I-BEST students and are more likely to earn occupational certifications. Moreover, the program's benefits and costs have been estimated to be approximately equal, suggesting that such programs can be designed so that no additional resources are needed to achieve better results (Wachen et al., 2012).

Several other states have launched integrated programs to help students develop more quickly the skills they need to obtain postsecondary credentials. The Minnesota Training, Resources and Credentialing for Pathways to Sustainable Employment program (FastTRAC), for example, uses a modular approach to attaining credentials that is modeled on the Washington I-BEST program (Hoffman and Reindl, 2011).

[7]Some of the approaches discussed in this section also serve as examples of articulating career pathways, which is discussed in more detail in a later section of this chapter.

Similarly, the state of Illinois created a plan to help adults quickly obtain a postsecondary degree valued by employers through "bridge" programs in community colleges located across the state (Hoffman and Reindl, 2011). These programs help students bridge the gap between their secondary education and the academic skills needed to succeed in postsecondary training. Students enrolled in bridge programs simultaneously receive academic and occupational instruction, which provides important context for learning.

The Florida College and Career Readiness Initiative (FCCRI) is another statewide program that assesses the college readiness of high school juniors and for those assessed as not ready for college, provides them with instruction as high school seniors (Mokher et al., 2014). A similar bridge program launched by LaGuardia Community College targets high school dropouts. This adult education program provides a bridge to a General Educational Development (GED) credential and continued postsecondary training. An evaluation by researchers at MDRC showed that bridge students at LaGuardia Community College were more likely to have passed the GED exam and enrolled in college relative to students in traditional GED preparation courses (Martin and Broadus, 2013).

Accelerating Remediation

In addition to integrating remedial classes with skills training and linking it to the students' fields of interest, providing accelerated remedial courses or co-requisite classes may reduce the incidence of students dropping out before completing required remedial courses. Acceleration strategies can include tailoring the curriculum to eliminate unnecessary topics, accelerating the pace of the remedial classes to reduce the number of dropout points, or linking college-level enrollment to a companion remedial class. Evidence from the Community College of Baltimore's Accelerated Learning Program revealed that students taking co-requisite and sequential remedial classes had the same pass rates for the college-level classes, but that students taking the co-requisite classes were able to accrue college-level credits more quickly. And Tennessee's co-requisite program showed a much higher rate of passing the college-level math and writing sequences (Bailey and Jaggars, 2016).

6.1.5 Improved Outcomes for Adult Learners

Community colleges serve adult learners in addition to students who enter immediately after graduating from high school. As discussed in Chapter 4, a significant portion of community college students are aged 30 and older. Career pathways, described below, focus on these adult learners. They entail linking two or more systems to improve education and training outcomes in a process known as "articulation" (King and Prince, 2015). There is some evidence that career pathway programs have significant impacts on employment and earnings

that tend to be longer-lasting than those of typical workforce programs, including higher wages and increased employment (Smith and King, 2011). While these results are not based on rigorous experimental evidence, randomized controlled trials of these programs are ongoing.

Career pathways are "roadmaps" of the education and training required to attain credentials associated with success in specific industries, often used to guide linked learning, sector strategies, talent management, and career pipeline initiatives. This approach has been adopted in several states.

Career pathways are typically targeted to meet the demands of local labor markets. The programs and resources of local community colleges, workforce development agencies, and social service providers are integrated to create structured sequences of education, training, and on-the-job learning in strategically important occupational areas (Alssid et al., 2002). Ideally, career pathways offer "a series of connected education and training programs and support services that enable individuals to secure employment within a specific industry or occupational sector, and to advance over time to successively higher levels of education and employment in that sector" (Jenkins and Spence, 2006, p. 2). They also often involve bridge programs to address the skill deficiencies of participants and the challenge of moving them along an accelerated pathway.

Several states, including Arkansas, Montana, Oregon, Virginia, and Washington, have developed statewide career pathways initiatives that are relevant for secondary and postsecondary education (Hoffman and Reindl, 2011). One often-cited example is that of Shifting Gears, launched in 2007 with the support of the Joyce Foundation and matching funds in six states (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin). This initiative prioritized industry and occupational sectors that offer skilled technical jobs; broke down longer diploma and degree requirements into shorter certificate models; and offered classes at a wider variety of places, days, and times (Strawn, 2010). In Minnesota, the Shifting Gears program evolved into the FastTRAC Adult Career Pathway partnership, which combined multiple federal, state, and philanthropic funds to serve 3,385 individuals between 2009 and 2012.[8]

Similar programs, created through the Center for Law and Social Policy (CLASP)-led Alliance for Quality Career Pathways (AQCP) Framework 1.0, focus on connecting adult learners with needed remediation and then getting them into training programs. To develop AQCP Framework 1.0, CLASP worked jointly with 10 states—Arkansas, California, Illinois, Kentucky, Massachusetts,

[8] Self-reported data indicate that 88 percent of these individuals completed industry-recognized credentials and/or credits. Among those exiting the program, 57 percent entered employment, and of those, 84.8 percent retained employment for at least 6 months. Among those with wages over the entire year, exiters earned on average $21,080 annually, a 33 percent increase over their annual earnings in the year prior to enrollment (Choitz et al., 2015).

Minnesota, Oregon, Virginia, Washington, and Wisconsin—thereby establishing a common understanding of quality career pathways and systems.[9] The framework provides criteria, indicators, and metrics for use in evaluating and creating state and local career pathways (CLASP, 2014).

6.1.6 Leveraging of Online Learning

Technology developments that support online learning make it possible for educators to create flexible learning environments that accelerate education and training, as well as facilitate the development of knowledge and practice communities that can be sustained over time using social media.

Distance education goes back decades, and many postsecondary programs are now delivering courses online. The Center for Adult Learning in Louisiana (CALL), for example, offers 13 online programs in accelerated formats for adult learners. Operated jointly by the Louisiana Board of Regents and the Southern Regional Education Board, CALL specifically targets adults and is provided exclusively online to accommodate the schedules of working students. Courses are taught in 4- and 8-week formats. Time to degree completion is accelerated through prior learning assessments, which offer students college credit for work, volunteer, or life experiences (Hoffman and Reindl, 2011). All CALL students are eligible for financial aid and are provided a range of support services. Similarly, a pilot training program funded by the Defense Advanced Research Projects Agency (DARPA) trained Navy recruits and unemployed veterans with no previous technical experience to perform at or above the competency level of a 10-year information technology (IT) expert with only 16 weeks of intensive online training (The White House, 2014). Still another example is a cross-state experiment in creating a virtual university that enrolls students from 50 states in the Western Governors University (WGU), a nonprofit online university (The White House, 2014). WGU, which costs approximately $6,000 per year and is nationally and regionally accredited, offers a competency-based curriculum that enables progress toward a degree based on demonstrated skills rather than number of credit hours.[10]

The rise of online education, particularly the recent growth of massive open online courses (MOOCs), makes it possible to increase the scale, interactivity, sophistication, and personalization of distance learning, as well as to enhance the learning experience. For example, Coursera and edX, two

[9]For information on the CLASP initiative, see CLASP (2014).

[10] Competency-based learning, which focuses on helping students master content, awarding credit, and permitting progress based on competency, can be considered a strategy for K-16 reform. For a definition of competency-based learning and an overview of issues and contemporary debates, see the entry on competency-based learning in *The Glossary of Education Reform* (Great Schools Partnership, 2014).

popular MOOC platforms, have more than 15 million enrollees from nearly 200 countries (Willcox et al., 2016). However, education research historically has focused on learning in the classroom and is only just beginning to consider the role and impact of online learning. A recent study by researchers affiliated with the Massachusetts Institute of Technology (MIT) Online Education Policy Initiative argues that if the proliferation of online learning is properly understood and leveraged, it can serve as a catalyst for reform in postsecondary education and training, although it cannot and should not replace teachers (Willcox et al., 2016) (see Box 6-2).

6.1.7 Improved Incentives for Completion at the Community College Level

Some states are already strengthening incentives for community colleges to respond to the skills needed in the labor market and to improve completion

BOX 6-2
Massachusetts Institute of Technology (MIT) Report on Online Learning

The committee convened a workshop to discuss online and blended learning opportunities and how they can be used to improve educational pathways. At the workshop, the authors of the 2016 report of MIT's Online Education Policy Initiative (OEPI), *Online Education: A Catalyst for Higher Education Reforms* (Wilcox et al., 2016), briefed the committee (see Appendix A).

The OEPI report provides a detailed history of online and blended education from the rise of educational games to massive open online courses (MOOCs). It highlights the use of online tools in remedial education and in reskilling of adult learners. In particular, catch-up courses offered online can help students overcome education deficiencies before starting a college program. In this way, online courses can help address some of the root causes of low community college completion rates.

The OEPI report concludes that digital technologies can play a significant role as an education enabler. However, teachers serve an essential role in learning by providing context, mentoring, and fostering reflection and discussion. Recommendations in the report include that new technologies be used to support teachers and allow them to focus on in-person interactions rather than content delivery. In the authors' opinion, "blended learning," whereby teachers and technologies cooperate across online and in-person spaces, can enhance learning but requires reorganizing the learning experience to apply the different strengths of the two modalities.

Finally, the OEPI report highlights the usefulness of learning simulators as a key online component of education. Flight simulators, for example, have transformed the training of pilots, and the report notes that training for selected skilled technical tasks can be similarly transformed using online simulation modules.

rates. Community colleges traditionally have received state-level funding based on the number of enrolled students. As of July 2015, however, 32 states had implemented funding formulas that allocate a portion of a college's funding based on such indicators as course completion, time to degree, transfer rates, the number of degrees awarded, and the number of low-income and minority graduates (NCSL, 2015). Yet it may be that reliance on these academic performance-based funding requirements will lead to more selective admissions criteria (Kelchen and Stedrak, 2016) or lowered standards for completion (Courty and Marschke, 2011). State policy makers thus might do better to attempt to create better incentives for improved completion rates by linking funding to employment metrics, such as earnings of students after graduation, or to metrics focused on increasing enrollment and completion for students who obtain credentials that are in high demand among employers or offer higher returns on investment (Holzer, 2015a).

6.2 LINKING SECONDARY AND POSTSECONDARY EDUCATION AND TRAINING

Better integration of academic and technical education and training can improve the quality of postsecondary education and training and increase the return on investment in education and training for skilled technical occupations (DOL et al., 2014). As discussed in Chapter 5, inadequate preparation in primary and secondary school may be a large part of the reason that students fail to complete their education. Strategies for reforming postsecondary education and training include creating flexible and integrated learning environments, particularly in community colleges and technical schools, and reassessing the readiness of students for postsecondary education and training and prerequisite requirements and programs.

In his paper commissioned for this study, Stern (2015) suggests that a better approach to secondary education is to prepare all high school students for both employment and a full range of postsecondary education and training options, and to avoid making assumptions about future education and training attainment or segregating students on this basis.[11] In his opinion, the coursework required for 4-year college admission can and should be available to all students willing to put in the effort. He argues that high school students should master a sequence of academic and CTE coursework that will help them earn a living

[11]This is not a new proposal. The School-to-Work Opportunities Act of 1994 (STWOA) embraced a similar philosophy and provided funds for activities classified as work-based learning, school-based learning, or connecting activities. For reviews of the challenges associated with implementing STWOA, see, for example, Hollenbeck (1997) and Neumark (2004).

regardless of whether they pursue or complete a 4-year college degree. He outlines several design principles to "make [secondary education] real and make it fair" (see Box 6-3).

Stern's findings also are relevant for state and federal policy makers. Citing a 2013 study by the National Association of State Directors of Career Technical Education Consortium and the Independent Advisory Panel for the 2014 National Assessment of Career and Technical Education, Stern calls for changing CTE standards (which now tend to be course-specific and geared toward preparing students for particular jobs) so they are aligned with a set of broader career clusters and pathways. He also makes the case that the pending reauthorization of the Perkins Act provides an opportunity for federal policy makers to eliminate bureaucratic rules that effectively maintain CTE as a silo of isolated activities and to better integrate CTE across several education reform efforts. In addition, a variety of programs, discussed in the next section, link secondary and postsecondary education and training with particular employers.

Clear linkages between secondary and postsecondary institutions can help students transition from secondary to postsecondary education and later, from education to employment. These linkages can improve student preparedness, reduce the costs of education and training, help students learn about college programs and processes, build critical social networks and supports, and improve returns on investments (Karp, 2015b). Programs designed to improve these linkages include early college schools, career academies, and dual- or concurrent-enrollment programs, discussed below.

BOX 6-3
Make It Real and Make It Fair

- Leave the choice up to the student.
- Provide support for students.
- Integrate academic and technical curriculum.
- Make the curriculum relevant with real-world linkages to jobs.
- Develop employer partnerships and work-based learning.
- Collaborate with postsecondary institutions.
- Get district support.
- Set high standards, create accountability, and let data drive decision making.
- Expand the number of career and technical education (CTE) teachers.
- Leverage the support of intermediaries.

SOURCE: Adapted from Stern (2015, p. 17).

6.2.1 Early College Schools

Early college schools integrate high school and college education and training in a rigorous yet supportive environment.[12] Each such school requires a collaborative partnership between a school district and a 2- or 4-year postsecondary school. One example is the P-Tech model, described in Box 6-4.

Most early college schools enroll a higher percentage of minority students relative to their corresponding school district and state, with an average of 60 percent of students coming from low-income families. Over the past decade, early college schools have produced significant outcomes for low-income youth, first-generation college students, and minority students. Based on a study of 100 representative early college high schools, for example, about 90 percent of early college students graduated high school, a figure 12 percentage points higher than the national average of 78 percent. Of the 2,600 early college

BOX 6-4
IBM's P-Tech Model

One of the most widely reported examples of an early college school is the Pathways in Technology Early College High School (P-Tech 9-14), launched in Brooklyn, New York, in 2011 in a partnership among the New York City Department of Education, the City University of New York, the New York College of Technology, and IBM. IBM helped develop the curriculum, which focuses on science, technology, and mathematics. P-Tech offers traditional classes, including English and history, but students also learn coding. IBM provides mentors and paid internships. Students earn their high school diploma and an associate's degree in applied science, and often have an opportunity to work for IBM.

Recently, six students from P-Tech graduated with associate's degrees in applied science and computer information systems in just 4 years instead of the expected 6 years. The students were able to finish both degrees in 4 years of secondary education because the school integrates high school and college coursework, but also includes an extended school day and academic year.

The P-Tech model has been replicated across the United States. *The Economist* (2015) reports that more than 70 small and large companies, including Microsoft, Verizon, and Lockheed Martin, have adopted or are working with schools to adopt the model. Consortia of advanced manufacturing firms and some hospitals also have partnered with school districts to replicate the model. IBM expects that more than 100 schools with 100,000 students will be operational in 2016.

[12]The committee's definition of early college programs embraces both 2- and 4-year postsecondary educational programs, which include "middle college" programs.

graduates who enrolled in postsecondary education and training, only 14 percent enrolled in coursework to prepare them for college-level work, compared with 23 percent nationwide. In addition, the majority of early college students earned college credit in high school, and 30 percent earned an associate's degree with their diploma. Early college school graduates thus were able to start their careers without college debt or with less debt than is typical (Webb and Gerwin, 2014).

The states of Michigan and New York have been at the forefront of the early college movement; however, a variety of programmatic models for early college schools have emerged.[13] With the help of more than $130 million in private start-up funds, the number of early college schools has grown from 3 in 2002 to 280 in 2014, serving more than 80,000 students and producing more than 5,000 graduates. Start-up costs range from $125,000 to establish an early college program within an existing high school, to $500,000 to establish a program on a college campus, to more than $3.5 million to establish a separate stand-alone early college charter school. Early college schools receive anywhere from $90,000 to $400,000 in grants from the coalition of funders that sponsors the national Early College High School Initiative. For programs established within existing high schools, these grants cover about 70 to 80 percent of start-up costs. Public school districts provide the ongoing operating budget for each early college school as they do for traditional high schools.

The Pathways to Prosperity program is another example of an initiative that links high school CTE with postsecondary education and training. In 2012, the Harvard Graduate School of Education and Jobs for the Future created the Pathways to Prosperity Network to help state, regional, and local educators, employers, and intermediary organizations build and scale up career pathways initiatives that span grades 9-14. The network's 2014 report indicates that at that time, the network included 10 states: Arizona, California, Delaware, Georgia, Illinois, Massachusetts, Missouri, New York, Ohio, and Tennessee (Jobs for the Future, 2014).

6.2.2 Career Academies

Career academies are small learning communities within schools that provide a college-preparatory curriculum with a career-related theme.[14] In some

[13]Examples of other models include middle college programs such as the Secondary Technical Education Program (STEP) in the Anoka-Hennepin School District in Minnesota and Washtenaw Technical Middle College (WTMC) in Washtenaw, Michigan. For information on the STEP program, see http://www.anoka.k12.mn.us/domain/2247 (accessed March 22, 2017). For information on WTMC, see http://www.themiddlecollege.org (accessed March 22, 2017). For an overview of early college models and student experience, see Barnett et al. (2015).

[14]See, for example, Kemple (2008) and Castellano et al. (2012). Some analysts argue that evidence of the benefits of career academies may be overstated because of bias

cases, these academies can generate large improvements in earnings for students for many years beyond graduation. In addition, many of these academies have demonstrated the ability to maintain mathematics and science instruction at high levels (Castellano et al., 2012).

Initiated in 1969 in Philadelphia with the Electric Academy at Edison High School, career academies in the United States now number more than 7,000 and cover a wide range of career areas (see, e.g., Stern et al., 2010).[15] One model is the National Academy Foundation (NAF), described in Box 6-5, which partners with educators at existing high schools, businesses, and civic leaders in high-need communities across the United States (see Orr et al., 2004, for a review of NAF's work). Other models for career academies include the Southern Regional Education Board (SREB) High Schools That Work; High Tech High; and regional technical centers in such states as Ohio, Massachusetts, and Washington.[16]

6.2.3 Dual- or Concurrent-Enrollment Programs

Dual- or concurrent-enrollment programs, also known as dual-credit technical programs, provide opportunities for high school students to take college-level courses free of charge and simultaneously earn credit toward high school completion and a college degree. Emerging from local practice in the 1980s, these programs have evolved without guidelines, regulation, or a policy framework, which has resulted in wide variation in state practices.[17] Recent years have seen a movement to learn from, accredit, and provide practice guidelines for these programs. As of the 2015-2016 school year, there were 97 accredited concurrent-enrollment programs nationwide: 59 at 2-year public colleges, 29 at 4-year public universities, and 9 at 4-year private colleges and universities (Scheffel, 2016).

One advantage of dual- or concurrent-enrollment programs is that they respond to local and state education and training needs (Scheffel, 2016). For example, if community leaders and elected officials in a specific location launch

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introduced by self-selection, which is difficult to control for in research studies. For example, effects may be stronger for boys than for girls and for those in certain types of programs, such as information and communication technologies.

[15]For additional background and resources, see Coalition for Evidence-Based Policy (n.d.).

[16]For more information, see SREB High Schools That Work, http://www.sreb.org/about-hstw and High Tech High, http://www.hightechhigh.org/about.

[17]For a report that explores how states regulate and ensure the quality of dual-credit programs, see Taylor et al. (2015). The authors indicate that programs in Minnesota are an exception: the state was an early adopter of dual-credit programs in the 1980s and provided educators with a policy framework to guide their efforts.

BOX 6-5
A National Academy Foundation (NAF) Academy: The Academy of Finance, Northeast High School, Florida

Created in 2003, the Academy of Finance gives high school students an opportunity to learn about and prepare for college careers in business and finance. Emphasis is placed on a college preparatory curriculum that prepares students for careers in business and finance with instruction in accounting, insurance, banking and credit, financial computing, international investments, financial planning, and securities. Students are given opportunities to enter into paid internships with local financial service companies during the summer of their senior year and receive offers of part-time employment during the school year.

In academic year 2014-2015, NAF supported 667 career academies that educated 82,000 students in 38 states and the District of Columbia (NAF, 2015). NAF career academies prepare students for skilled technical jobs in finance, hospitality and tourism, information technology, engineering, and the health sciences.

an economic development initiative related to a particular industry, concurrent-enrollment courses can be designed and offered to help students learn technical skills and prepare them for a certificate or degree program that will meet the demands of local employers. Concurrent-enrollment courses also can be adapted to new programs and fields at the 4-year college level.

Of course, this localized approach also brings variation in quality. Even so, the evidence to date suggests that concurrent-enrollment programs have positive impacts for both students and society (Krueger, 2006). In her paper commissioned for this study, Karp (2015b) points out that when properly leveraged, these programs can help the United States achieve its postsecondary education goals by strategically linking high schools and colleges, stimulating educators to rethink how education is structured and delivered, and forcing operational change at the organizational level.

6.3 LINKING TRAINING AND WORK

Many employers are seeking to partner more closely with community or technical colleges. Similarly, many educators are seeking to partner with employers to develop more relevant education and training programs. These educational institution–employer partnerships have the potential to create better-integrated learning environments and meet local employers' skill requirements. The idea is that employers will provide input on courses and curricula and will contribute to ensuring that students acquire skills that will lead directly to a job upon graduation.

Flexible and integrated learning environments for skilled technical occupations involve the alignment of community and technical college education and training with economic development objectives and opportunities, as well as the creation of modular, short-term programs that can be stacked over time; delivered in a variety of ways; and integrated with skills, academic, and occupational certification programs (see Box 6-6). Effecting these types of changes requires that community and technical colleges build effective partnerships with employers, industry and trade associations, and labor unions.

These partnerships are modestly supported by the federal government. For example, the U.S. Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program provides 256 grants totaling $1.9 billion over 4 years, authorized under the 2010 Health Care and Education Reconciliation Act. TAACCCT helps community colleges and other eligible institutions of higher education expand and improve their education and career training programs. The Department of Labor implements the TAACCCT program in partnership with the U.S. Department of Education.[18]

There is evidence that certain of these programs raise earnings for at-risk students, often in technical fields, when they integrate classroom training with workplace experience in a particular sector or employer. Examples of these programs include strategic centers of excellence at community and technical colleges and sector-specific training programs involving partnerships between training providers, often community colleges, and employers and trade associations in a single industry.

BOX 6-6
Community and Technical College–Employer Partnerships

Community and technical college–employer partnerships take a variety of forms:

- corporate partnerships with multiple colleges;
- college–employer partnerships facilitated by a regional workforce intermediary;
- sectoral partnerships across multiple colleges and employees;
- individual college–employer partnerships with deep employer engagement;
- career pathways partnerships that may also involve high schools; and
- partnerships facilitated by other intermediaries, including community-based organizations and vocational rehabilitation.

SOURCE: Heidkamp and Hilliard, 2014.

[18]For an overview of the evidence on federally funded education and training programs, see DOL et al. (2014).

6.3.1 Strategic Centers of Excellence at Community and Technical Colleges

Centers of excellence at community and technical colleges are designed to foster flexible and integrative learning in strategically important local industries. In 2004-2005, for example, the Washington State Board for Community and Technical Colleges created 10 centers of excellence to serve as integrators and catalysts for economic and workforce development in the state's leading industries.[19] The centers were placed on college campuses through a competitive application process and codified into state statute in 2008 (WA HB1323). They are intended to serve as a point of contact and resource hub for industry trends, best practices, innovative curriculum, and professional development. (See Box 6-7 for details on one of the centers.) Core foci of these centers include the following:

- **Economic Development Focus.** Serve as partners with various state and local agencies and regional, national, and global organizations to support economic vitality and competitiveness in Washington's driver industries.
- **Industry-Sector Strategy Focus.** Collaboratively build, expand, and leverage industry, labor, and community and technical college partnerships to support and promote responsive, rigorous, and relevant workforce education and training.
- **Education, Innovation, and Efficiency Focus.** Leverage resources and educational partnerships to create efficiencies and support development of curriculum and innovative delivery of educational strategies to build a diverse and competitive workforce.
- **Workforce Supply and Demand Focus.** Research, analyze, and disseminate information related to training capacity, skill gaps, trends, and best practices within each industry sector to support a viable new and incumbent workforce. (Washington State Centers of Excellence, 2017)

[19] These industries include aerospace and advanced manufacturing, agriculture, allied health, education, construction, clean energy, global trade, homeland security, information technology, and marine manufacturing. For more information, see Washington State Board for Community and Technical Colleges' (2017).

BOX 6-7
The Pacific Northwest Center of Excellence for Clean Energy

The Pacific Northwest Center of Excellence for Clean Energy (PNCECE) provides regional strategic coordination for workforce development in the energy industry. Integrating state, federal, and private resources, the partnership includes regional consumer- and investor-owned utilities, a federal power-marketing administration (the Bonneville Power Administration), organized labor, a national laboratory (Pacific Northwest National Laboratory), community and technical colleges and universities, and workforce and economic development councils. The center's extensive coordination has increased the number of energy programs in Washington's community and technical colleges roughly fivefold from just 5 in 2005 to 23 today, and each college has a specific technology/trade focus.

The center regularly convenes a statewide Power Generation Skill Panel that identifies, verifies, and documents precise skills, knowledge, competencies, and work functions in critical occupations in the industry. Employers use these standards to adjust job descriptions and promotion requirements. Educators and apprenticeship programs use the standards to offer training that evolves with the industry. In addition, the center offers occupational summaries, education resource guides, labor market data, white papers on topical issues, and career awareness events.

SOURCE: http://cleanenergyexcellence.org (accessed March 22, 2017).

6.3.2 Sector-Specific Strategies

Sector initiatives or partnerships (also known as sector employment programs) are regional partnerships in which a training provider agrees to prepare individuals to work in a specific industry with the expectation that the employers in that industry will hire them. In this way, sector-based strategies integrate the interests of employers, educational institutions, industries, labor, and community organizations to focus on the workforce needs of a strategically important industry within a regional labor market (see Figure 6-1). The training provider is sometimes a community college (e.g., AMTECH) and sometimes a stand-alone training institution (e.g., Per Scholas, described below).

Proponents, which include the National Governors Association (NGA) and the National Skills Coalition, argue that sector strategies can address current and emerging skill gaps; facilitate coordination across city, county, and state lines; and better align programs and resources to improve effectiveness and return on investment (NGA, 2013). Local, state, and federal government agencies that function as champions and conveners of sector-based partnerships can play a constructive role in facilitating skilled technical workforce development.

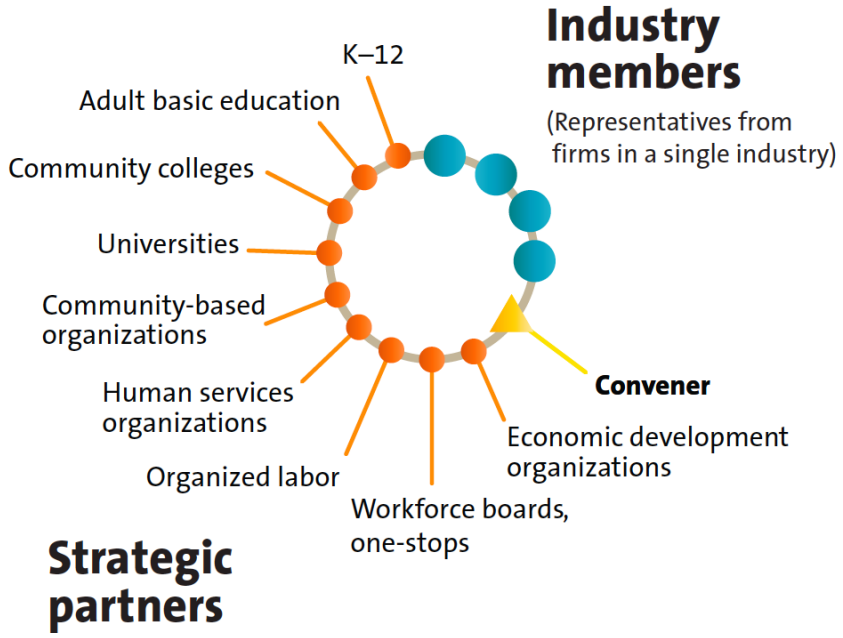

FIGURE 6-1 Sector strategy concept.
SOURCE: NGA, 2013.

Evaluations of sector partnerships suggest they have the potential to produce positive outcomes for youth and adults (Maguire et al., 2010; Roder and Elliott, 2014). Using randomized controlled trials, Maguire and colleagues (2010) found that 2 years after the sector-focused training programs they examined (Wisconsin Regional Training Partnership, JVS-Boston, and Per Scholas) ended, workers were earning about $4,500 more than those who did not participate in the sector-specific training (Maguire et al., 2010). One example, Per Scholas in the Bronx, New York, offers on-site training in IT in a 15-week program. An evaluation of Per Scholas showed large and consistent impacts on employment and earnings more than 2 years following the training (Hendra et al., 2016). However, little is known about the long-term impacts of these programs, particularly as workers change jobs and industries restructure, or what is required to build and sustain such partnerships over time. One recent study did use randomized controlled trials to track the long-term outcomes of Project

QUEST, which provides training in several in-demand occupations in San Antonio, with results to be released shortly.[20]

The NGA's Center for Best Practices estimates that 1,000 sector partnerships currently are operating across the country and that more than half the nation's states are exploring or implementing sector strategies (Maguire et al., 2010; Roder and Elliott, 2014). The center traces the origin of the concept to community-based efforts to connect workers to jobs in local industries in the 1980s. In 2010, at the conclusion of a 4-year state sector strategy project led by the NGA, the Corporation for a Skilled Workforce (CSW), and the National Network of Sector Partners (discussed below), more than 25 states were at various stages of implementing sector strategies and funding local initiatives.

In addition, over the past 10 years, the U.S. Department of Labor has funded several initiatives that are consistent with sector strategy principles, including the Sectoral Demonstration Project; the High Growth Training Initiative; the Community Based Job Training Initiative; WIRED; and several American Recovery and Reinvestment Act grants, such as State Energy Sector Partnerships, Energy Training Partnerships, Pathways out of Poverty, and other High Growth and Emerging Industry grants. And under WIOA, local workforce boards are required to use industry sector strategies to carry out training strategies.

Local and national foundations also are supporting the sector strategy concept. The National Fund for Workforce Solutions initiative, for example, involves 22 regional workforce funder collaborations, more than 80 workforce partnerships, and 200 funders. A national association, the National Network of Sector Partners, provides a way for partnerships across the country to connect and learn from each other. In June 2015, the Joyce Foundation announced that it will invest in the Business Leaders United Commitment to Action, which aims to expand the number of sector partnerships by more than 30 percent across all 50 states and to facilitate conversations between local business leaders and federal policy makers about how private, philanthropic, and public dollars can be leveraged to replicate and sustain these partnerships nationally (see Joyce Foundation, 2011).

The NGA, the CSW, and the National Skills Coalition maintain a clearinghouse for state-level sector strategy information.[21] Although all state sector strategies are based on the same basic principles, they each reflect local preferences and priorities. One way in which these differences are expressed is in who convenes the partnerships and how. In some states, for example, sector partnerships have been convened by civic leaders in business, community

[20]For a recent review of sector-based training strategies, see Holzer (2015b). See also Elliott and Roder (forthcoming).

[21]See http://www.sectorstrategies.org (accessed March 22, 2017).

service, or government, while in others, they have been convened by community colleges or economic development authorities.

6.4 EMPLOYER-BASED TRAINING PROGRAMS

This section reviews training provided by employers to workers through apprenticeship and joint labor–management programs. In many cases, this employer-sponsored training includes coursework at community colleges. American labor unions also have in many instances encouraged their members to support workplace education and training programs as a way to improve workers' employment security and help them adjust to changing workplace conditions. Connections between employers and workers can be improved as well through better communication of information about the value of credentials and licenses.

6.4.1 Apprenticeship Programs

As discussed in Chapter 4, apprenticeships combine occupational education and training with paid on-the-job work experience. Apprenticeships can be either registered or unregistered; approximately 400,000 active apprentices currently are registered with the Department of Labor. Some analysts assert that apprenticeship programs are an underutilized workforce development strategy in the United States (see, e.g., Ayres and Gurwitz, 2014). As Figure 6-2 shows, for example, the number of apprenticeship starts in the United States in 2012 was low relative to the numbers in other developed countries with well-developed apprenticeship programs, such as England, Switzerland, Germany, France, and Scotland.

A number of states have developed apprenticeship programs over the past 10 years, although the impact of such programs has not been rigorously evaluated (see, e.g., Lerman, 2010; Reed et al., 2012). In an effort to close skilled workforce gaps, for example, several programs, such as the Michigan Advanced Technician Training Program (MAT2), the Kentucky Federation for Advanced Manufacturing Education (KY FAME), and Apprenticeship Carolina in South Carolina, have created incentives to expand apprenticeships in their state's strategically important industries (see the description of Apprenticeship Carolina in Box 6-8).[22] The most interesting of these state models move beyond

[22] For information about these programs, see MAT2, http://www.mitalent.org/mat2; KY FAME, http://kyfame.com; and Apprenticeship Carolina, http://www.apprenticeshipcarolina.com.

FIGURE 6-2 Apprenticeship starts by country in 2012.
SOURCE: Adapted from material published by the Center for American Progress. See Ayres, S., and E. Gurwitz. 2014. *The underuse of apprenticeships in America*. Washington, DC: The Center for American Progress (www.americanprogress.org).

BOX 6-8
Apprenticeship Carolina

This initiative expands apprenticeships in the state of South Carolina to targeted industry clusters in advanced manufacturing; construction technologies; energy; health care; information technology; tourism and service industries; and transportation, distribution, and logistics. The state increased its budget for apprenticeships to $1 million a year and offered companies a tax credit of $1,000 a year per apprentice for 4 years. The number of apprenticeship sponsors increased from 90 in 2007 to more than 600 in 2014, and the number of apprentices increased from 777 to nearly 11,000 over the same period.

time-based workplace training to integrate dual-learning principles whereby academic courses are linked to workplace training and standardized competency-based certifications.

Many newer forms of apprenticeship in the United States include coursework at a local community college, which leads to an associate's degree. Employer sponsors provide at least 2,000 hours of paid work per year in the relevant occupation and arrange for their apprentices to receive approximately 150 hours of related instruction. The average apprenticeship lasts 4 years, and

apprentices earn an average of $161,000 during the course of their apprenticeship.

Given the benefits of apprenticeship and the underutilization of these programs noted above, some analysts have suggested that complementary policies and processes that make it convenient and cost-effective for employers to design and implement such programs may be necessary. Currently, it can take as long as 2 years to obtain approval for a new apprenticeship program in some states. Some have suggested offering tax subsidies to employers as a way to offset the costs of developing a new apprenticeship program (Lerman, 2010).

Yet while there is considerable enthusiasm for expanding the apprenticeship concept in the United States, including its extension to a wider range of occupations, some experts caution against directly importing apprenticeship programs from other countries into the United States at a national level.[23] They argue that significant institutional differences between the United States and other developed countries make it difficult to replicate other countries' policies and programs. In addition to the much larger size of the U.S. economy relative to those of European nations, they note the differences in national governance structures and workforce development traditions.[24] Countries such as Germany and Switzerland, for example, have stronger traditions as well as formal organizations in place that support employer involvement in education and training. Also in contrast with the policies of many other developed countries, U.S. federal and state-level policies require that most students and workers bear a significant portion of the cost of postsecondary education.

Even so, it may be that the structures of education and workforce policies and programs in some U.S. states are similar in some respects to those found in other developed countries. In such instances, there may be opportunities for state-level policy makers to learn from such countries as Denmark, Germany, Sweden, and Switzerland. Based on the review by Messing-Mathie (2015) commissioned for this study, Box 6-9 lists some key lessons that can be learned from the experience of foreign apprenticeship programs. Further comparative studies, based on a robust methodology, would increase understanding of apprenticeships, the contexts within which they are effective, and the current barriers to their expansion.

[23] Panel 6 at the committee's 2015 symposium covered the topic of apprenticeships. Presentations, Andrea Messing-Mathie's paper on apprenticeships, and a webcast of discussions can be found at http://nas.edu/SkilledTechnicalWorkforce.

[24] For an overview of the issues, see the section on apprenticeship in Chapter 4. For a comprehensive review of theories, evidence, and comparative issues, see Wolter and Ryan (2011).

BOX 6-9
Key Lessons from Foreign Apprenticeship Systems

- **Establish a flexible framework.** Apprenticeships "operate within the wider context of cultural traditions and aspirations of individuals and the complexity of labor market regulation" (Steedman, 2012, p. 10). Successful apprenticeships allow for flexibility within a guiding framework.
- **Set clear rights and responsibilities.** A legal framework should establish clear rights and responsibilities for all partners. In particular, legislation should secure the rights of an apprentice as an employee, but with provisions that address separate wage structures.
- **Balance incentives for employers and apprentices.** Carefully targeted tax credits and subsidies can encourage investment in the apprentice as a member of the firm and allow the apprentice to develop valuable relationships beyond his or her academic institution. These tax credits and subsidies also can encourage the apprentice to complete the program.
- **Make apprentices "employees."** The workplace, not the school, should be considered the center of the apprentice's experience. Community colleges and other educational organizations serve to complement this relationship with academic instruction.
- **Create strong intermediaries.** As Bailey (1993, p. 7) points out, "There needs to be some overarching institution trusted by employers and workers (and unions where they exist) that can coordinate individual employers' participation and that can help schools work with business."
- **Set standards and signal accomplishment.** Companies need agreement on industry standards and the competencies that apprentices should acquire in order to meet those standards. Upon graduation from their program, apprentices should receive an associate's degree or other certification that is widely recognized.

SOURCE: Messing-Mathie, 2015.

6.4.2 Joint Labor–Management Programs

Unions have a prescribed role in job training programs under WIOA, and they have a long history of designing and implementing innovative and effective education and job training programs that potentially can benefit workers, businesses, and local communities. From the earliest days of American trade unions, workers have organized to advocate for local public school systems, and they have been instrumental in the passage of federal vocational education legislation (Stacey and Charner, 1982). Craft unions developed in the 19th century and masters- and journey-level workers created apprenticeship systems that set minimum time periods for training, wage levels, and education requirements (Rorabaugh, 1986). As production and service delivery were expanded and restructured in the 20th century, distinct spheres of influence for managers and workers emerged. Enterprise owners and their professional managers sought to control strategic decision making on

investments, the use of technology, the organization of work, and requirements for technical skills. Workers organized into industrial and service unions to negotiate wage and benefit levels, personnel management practices, and other procedural and process issues salient to the economic interests of their members, including education and training (Thomas and Kochan, 1992).

As the nature and organization of work have continued to evolve, the AFL-CIO, a federation of American labor unions, has encouraged its members to directly sponsor workplace education and training programs as a way of improving workers' employment security and helping them advance on the job and adjust to changing workplace conditions. In a recent report on these issues, the AFL-CIO argues that many U.S. unions have embraced this challenge and are increasingly collaborating with management to create joint programs and workplace education and training systems, and then institutionalizing these changes through collective bargaining (AFL-CIO, 2016). Box 6-10 describes one example—the Wisconsin AFL-CIO Regional Training Partnership.

More research is needed on joint labor–management strategies for establishing workplace learning systems and on community-based workforce and

BOX 6-10
Wisconsin AFL-CIO Regional Training Partnership

The Wisconsin Regional Training Partnership (WRTP) was formed by Milwaukee area business and labor leaders in 1992 in response to skill shortages created by the recovery of manufacturing, retirement of an aging workforce, and diversification of the regional economy. It is one of the largest sectoral training programs in the country, working with more than 300 firms, including small and medium-sized employers, training 1,700 workers in machining, electronics, plastics, and related sectors in 2012 alone. The WRTP has developed successful models for implementing new technologies and work processes and educating and training a diverse skilled technical workforce.

The WRTP recently collaborated with BIG STEP, an initiative led by Building Trades, and with employers and community groups to increase participation by minorities and women in the trades through training. It also launched an Industrial Manufacturing Technician apprenticeship program in partnership with the AFL-CIO Working for America Institute. The program is state certified and sponsored by the Department of Labor under its H-1B program. The program is being piloted in Milwaukee and is on pace to enroll 80 incumbent manufacturing workers. It will expand statewide as well as include Michigan and Minnesota in 2014.

The collaboration between WRTP and BIG STEP began during the Department of Labor grant term, when construction was one of the industry sectors selected for replication. With their own highly successful histories, WRTP and BIG STEP partnered to facilitate more effective coordination of employer-driven worker readiness to best ensure that individuals preparing for employment gained the skills and experiences that employers need.

SOURCE: Excerpted from AFL-CIO, 2016.

economic development initiatives. However, several innovative programs could provide inspiration for skilled technical workforce development in a wide range of areas, including health care, manufacturing, construction, and transportation, and could be adapted to meet the requirements of the nation's regions (see AFL-CIO, 2016, for an overview of some of these programs). Box 6-11 describes one example of such an innovative technical workforce development program.

BOX 6-11
The Bison Gear Example

Demonstrating that a company does not have to be large to engage in skilled technical workforce development, the Bison Gear & Engineering Corporation in St. Charles, Illinois, makes education an essential part of its work culture. According to the Aspen Institute, which has recognized Bison Gear as a model of success in its Skills for America's Future program, more than one-third of employees are involved in some type of continuing education, and Bison employees average 7.2 hours of on-the-job training per year.

The Skilled Workforce Initiative at Bison Gear provides opportunities for production-floor workers to become trained and certified and encourages all employees to attain at least an associate's degree. New and incumbent employees have the opportunity to earn a National Career Readiness Certificate (NCRC) credential, a portable credential that demonstrates achievement and a level of workplace employability skills in applied mathematics, location information, and reading for information. Bison Gear uses the NCRC as a preassessment tool: upon completion, workers become a certified production technician (CPT), which is a prerequisite for entering Bison Gear's Manufacturing Skills Standard Council (MSSC) Fast Track program.

Bison Gear's MSSC Fast Track program encourages CPT employees to attain an MSSC certificate. MSSC is a national industry-led training, assessment, and certification system that focuses on the core skills and knowledge needed in production and material handling. Interested workers complete 15-18 hours of training in modules, scheduled on their own time. The firm covers the cost of registration fees and assessments, and awards a $100 bonus to participants when they pass a module.

To encourage employees to pursue higher education degrees, Bison Gear has designed a tuition reimbursement program, Growth Education and Results (GEAR). Under GEAR, the firm has relationships with community college partners, which directly bill the company for the cost of an employee's education. Bison Gear also provides education benefits for employees' children through the Bullock Family Bison Cares Scholarship.

Bison Gear staff also contribute to workforce development efforts by working directly with local community college partners to provide information on skill requirements, project long-term hiring needs, and support the development of curriculum. They engage students through structured mentorships and host summer job training internships. Bison Gear staff regularly attend community college recruitment meetings to identify prospective job candidates, and they post job openings on each school's website.

SOURCE: Colborn and Jenkins, 2016.

6.4.3 The Push for Talent Pipelines

Complementing efforts by labor groups, the U.S. Chamber of Commerce Foundation—through its affiliation with the U.S. Chamber of Commerce and its federation of more than 3 million employers nationwide—has called upon the business community to play a leadership role in developing a workforce that will meet its strategic business needs (see Box 6-12) (U.S. Chamber of Commerce Foundation, 2014). Working with large employers such as IBM, the U.S. Chamber of Commerce Foundation promotes the use of supply chain management principles to create "talent pipelines." This approach involves linking workforce development requirements to business strategy, as well as reconceptualizing and reorganizing workforce development to nurture and sustain talent, enabling it to evolve to meet business needs over time.

Seeking to address the challenges of skilled technical workforce development, some employers have signed up to participate in the Skills for America's Future program, a federal initiative designed to foster partnerships between employers and community colleges. In addition, some employers recognize that their employees need support services to improve their skills and pursue education and training opportunities. These employers are fostering a culture that supports continual learning and are adjusting work schedules and assisting employees with child care, transportation, tuition, and other types of expenses. As discussed above and in Chapter 4, data on the extent and effectiveness of these initiatives are scarce, and more research is needed in this area.

BOX 6-12
U.S. Chamber of Commerce Foundation's Talent Management Principles

1. Link talent management to business strategy by identifying core capabilities.
2. Develop customized solutions to address core capability requirements.
3. Create shared ownership and accountability for talent management across the organization and develop sourcing strategies around the positions and capabilities that are most essential to competitiveness.
4. Establish networks of preferred providers to source and develop core capabilities.
5. Develop competency, credentialing, and other performance indicators.
6. Create balanced scorecards to align performance measures and incentives.
7. Use dashboards and predictive analytics to monitor performance.

SOURCE: Excerpted from U.S. Chamber of Commerce Foundation, 2014.

6.5 IMPROVING LINKAGES THROUGH BETTER DATA

Better data and better analyses of data are needed to make progress in understanding and addressing the challenges of skilled technical workforce development. Nearly all of the strategies discussed in this report have the potential to improve the flow of information indirectly. Efforts to improve the quality and delivery of skills education and training, for example, will inherently expose students to more information about careers and the education and training required to pursue them. Similarly, better integration across different parts of the workforce development system through dual-enrollment programs, early college schools, sector-based strategies, and career pathways will necessarily involve the sharing of information across educational institutions and employers.

6.5.1 Data Challenges

Extensive gaps exist in the data on technical workforce education and training, as pointed out by Rebecca Rust of the U.S. Bureau of Labor Statistics at the committee's 2015 symposium. Speaking at the same event, John Dorrer of Jobs for the Future argued that analysts need to improve their ability to mine newly emerging digital jobs databases, as well as existing databases, and called for additional investment in research, particularly policy-relevant research. Courtney Brown of Lumina stated that more data and analyses are needed to understand credentials, career pathways, and supply and demand dynamics in labor markets. Other participants expressed related concerns about the challenges associated with improving labor market data and research, such as privacy laws that can inhibit data sharing, the time and costs associated with information management, and the potential for false or misleading associations that can arise from poorly designed big data repositories and analyses. An additional challenge is ensuring that training programs and educational institutions can use the data collected to keep programs up to date and enable them to evolve with the changing skills required by employers.

Given the complex coordination challenges faced by policy makers, individuals, educators, employers, industry and trade associations, labor unions, and other civic organizations, improvements in the flow of information in skilled technical labor markets are clearly needed. The remainder of this section provides examples of different types of experiments currently under way to improve technical workforce development by identifying and addressing existing information deficits.

6.5.2 Using Big Data

Advances in mathematics, statistics, and the computational sciences make it possible to capture, augment, and analyze data from a broad range of very

different sources. Several contributors to this study argued that applying these developments to policy analysis and research on skilled technical workforce development can provide policy makers with a stronger factual basis for decision making (see Reamer, 2015, for an overview of the issues and findings). In addition, advances in data analytics and information technologies can be used to help consumers make better decisions and create incentives to improve the quality of education and training options.

In the era of big data and new digital tools for collecting information, private firms have learned to mine the web to aggregate or crowdsource data from existing sources. Online job posting and searching, for example, which began in the early 1990s, provides a rich source of data for analysts, researchers, and labor market participants. Software and analytic tools can be designed to crawl through these data, analyze the content, and generate aggregate statistics on job vacancies more often and at finer occupational and geographic scales relative to traditional employer surveys such as the Job Opening and Labor Turnover Survey (JOLTS).[25]

Researchers at Georgetown University estimate that 60 to 70 percent of job postings are now posted online (Carnevale et al., 2014, 2015). However, they state that online job ads may not capture all job openings in all locations. Their analyses suggest that online job ads tend to be biased toward industries and occupations that seek high-skilled workers and workers with 4-year degrees. In their view, data on online job ads are useful in measuring labor demand and honing in on previously inaccessible variables, but these data have limitations. They urge users to exercise caution and utilize this tool in conjunction with traditional data sources. While noting these concerns, contributors to this study highlighted the need for researchers to use a broader set of analytic tools and develop new methodologies to take advantage of the proliferation of online databases.[26]

6.5.3 Crowdsourcing Information

A primary example of crowdsourced labor market data is the data collected by Burning Glass Technologies (BGT), one of the leading vendors of data on

[25] JOLTS is a monthly survey of employers that was developed to provide information on job openings, hires, and separations. Each month the JOLTS sample consists of approximately 16,000 businesses drawn from 8 million establishments represented in the Quarterly Census of Employment and Wages. The publicly available data provide a measure of labor demand across broad industry classifications at the national level or overall aggregate labor demand for four quadrants of the nation.

[26] See, for example, the paper by Reamer (2015) commissioned for this study, presentations and discussion in Panel 10 of the committee's 2015 symposium, and presentations made to the committee in February 2016 at http://nas.edu/SkilledTechnicalWorkforce.

online job ads.[27] These data include detailed information on current online job openings updated daily from such sources as job boards, newspapers, government agencies, and employer sites (Burning Glass, 2017). The data provided by BGT allow geographic analysis of occupation-level labor demand by education level and experience level over time. Moreover, the data collection process used by BGT yields a robust representation of hiring in real time.

Such crowdsourcing databases provide valuable information that can be used by educational institutions and workforce development boards. Colleges and technical schools, for example, can use these data to examine the labor market in real time and align their programs with the marketplace, giving students crucial information as they seek jobs. Similarly, labor exchanges in 14 states currently use BGT data to connect workers and employers more efficiently while providing pathways and tools that help workers identify viable careers.

These tools are valuable and increasingly used, but as discussed in the previous section, online data and analytic tools have limitations. For-profit companies own some analytic strategies, such as those offered by BGT, and their data and tools are proprietary. Therefore, maintaining publicly available data and analytic tools, which is encouraged under WIOA and requires federal, state, and local coordination, remains important.

6.5.4 Recent Initiatives

Web-Based Tools

Other web-based tools have enabled private firms to collect data from participants in a variety of markets, including the labor market. For example, Glassdoor, an online jobs and recruiting site with a crowdsourced database, has launched a new open-source map that enables job seekers to see where there are open jobs county by county across the country (The White House, 2014).[28] Workers provide information about their experience in interviewing with and working for employer organizations, and registered employers promote job opportunities to potential workers. The database is available online and via mobile applications to registered users.

Public Data Warehouses

The U.S. Department of Labor has supported state efforts to develop the data infrastructures needed to create or improve longitudinal data systems that

[27]Similar data are also collected by Conference Board via its Help Wanted OnLine series.
[28]For information about Glassdoor, see http://www.glassdoor.com/index.htm (accessed March 22, 2017).

link employment and earnings data with education, employment service, and training data over time (Davis et al., 2014). Integrating data from K-20 and workforce experience and then warehousing these data allows for the creation of consumer applications that estimate return on investments in education and training. In November 2010, the U.S. Department of Labor launched the Workforce Data Quality Initiative (WDQI), which has provided more than $30 million in grants to 29 states.

Consumer Report Cards

Recently, U.S. Department of Labor grants have focused on creating consumer report card systems (CRCSs).[29] As of this writing, five WDQI states—Florida, Minnesota, New Jersey, Virginia, and Washington—had existing CRCSs. Among these states, the structure of the state website and how it is used are generally similar, with each system displaying outcome data for individual programs (Davis et al., 2014).

For example, the New Jersey Department of Labor and Workforce Development partnered with the State University of New Jersey John J. Heldrich Center for Workforce Development at Rutgers to create a consumer report card website that provides information on occupational training programs in the state (Davis et al., 2014).[30] State laws require "training programs at for-profit, public 2-year, and some public 4-year schools that receive state or federal workforce funding to submit records to the state for all of their students" (The White House, 2014). The website makes it possible for students to search by occupation, location, or key word for schools and organizations that provide job training. Students can compare training providers by location, cost, outcomes, and length of training. A results section displays information about former program participants, such as employment rates, retention rates, and average earnings over time.

As another example, Florida continues to expand the longitudinal administrative data infrastructure it developed in the 1970s to integrate K-20 education and workforce data. This infrastructure supports the Florida CRCS—Smart College Choices—which makes it possible to assess and analyze participation in and outcomes of all education and training programs in the state.

[29]WIOA requires eligible training providers, including community colleges, to provide similar consumer/outcome data in the form of a "report card" at the program level.

[30] For additional information about the New Jersey Consumer Report Card, see http://www.nj.gov/education/cte/ppcs/students/OnliConRC.shtml. WIOA requires local workforce systems to create career pathways for in-demand industries in the local workforce area. The Department of Labor, Department of Education, and Department of Health and Human Services have agreed upon a framework for career pathways to facilitate meeting this requirement.

Florida's CRCS provides basic information about education and training programs at the state's 28 community colleges and 11 public universities. The state is currently preparing to expand the system to include additional institutions and provide more detail about existing options. Consumers can compare such institutional outcomes as completion, continuance, and employment rates and estimated earnings.

6.6 OTHER POLICY INITIATIVES

In addition to linking the key actors in the workforce training and education ecosystem, some policy initiatives help improve the portability and wider recognition of acquired technical skills. Roadmaps that link selected competencies also can help guide students and workers through the education and training they need to address the needs of local industries.

6.6.1 Portable Credentials and Licenses

The NGA's Center for Best Practices observes that up to 40 percent of community college students enroll in multiple institutions within a 6-year period (The White House, 2014). Efforts to transfer education and training accomplishments and licenses across education and training programs, employers, industries, and geographic boundaries can improve the quality of postsecondary education and training, reduce costs, and improve returns on investment (The White House, 2015, Chapter 2).

To improve the portability of credentials, some states are crafting credit-transfer agreements across their postsecondary systems. The state of Tennessee, for example, "expanded its credit-transfer agreement between 2-year colleges and the public university system. The agreement covers 100 percent of general education requirements and 75 percent of majors at the associate level" (The White House, 2015, Chapter 2). Other initiatives, discussed below, involve standardizing credentials and reducing the burden of licensing requirements.

6.6.2 Standardized Credentials

The past decade has witnessed explosive growth in the number and variety of college degrees, education certificates, industry certifications, occupational licenses, and online badges awarded by various entities and subsequently presented to employers as evidence of specific competencies.[31] This pro-

[31]Some experts observe that there is also no national standard for a high school diploma. While the committee believes this is an important issue, a detailed examination of secondary school standards is beyond the scope of this study.

liferation of credentials has created confusion on both sides of the labor market: individuals are unsure which credentials are worth investing in, and employers are questioning the quality and value of the credentials individuals present.

Efforts to standardize credentials focus on harmonizing key features related to quality, portability, and labor market value. For example, a recent partnership between The George Washington University's Institute of Public Policy and the American National Standards Institute, which is funded by the Lumina Foundation, is reviewing the credentialing activities of more than 48 major credentialing stakeholders, such as business associations; higher education associations; and federal agencies such as the U.S. Departments of Commerce, Education, Labor, Defense, Energy, and Health and Human Services. The partnership has developed definitions, coding schemes, plans for an open metadata registry for posting comparable credentialing information, and pilot projects for testing several registry applications. The implementation plan includes a public–private collaboration of stakeholders that will decide whether and how to take the system to scale and make it sustainable (Crawford and Sheets, 2015).

6.6.3 Licensing Reforms

As discussed in more detail in Chapter 3, a recent study of U.S. occupational licensing patterns and trends reveals significant growth in the number of workers holding an occupational license. When carefully designed and implemented, licensing can offer important health and safety protections to consumers, as well as benefits to workers. However, the current licensing regime in the United States also involves substantial costs, and the requirements for obtaining a license frequently do not align with the skills needed for the job. "Too often, state policy makers do not carefully weigh these costs and benefits when making decisions about whether or how to regulate a profession through licensing" (The White House, 2015, Chapter 2).

The 2015 White House study on occupational licensing argues that standards for certification and licensing are related and mutually reinforcing (The White House, 2015, Chapter 2). [32] Guidelines for occupational certifications can help reduce the need for such licensing, make it easier to transfer credentials across state lines, and improve the efficiency and effectiveness of both certification and licensing activities. The White House study includes several recommendations that are consistent with its findings:

- Limit licensing requirements to those occupations that address legitimate public health and safety concerns.
- Conduct comprehensive cost/benefit assessments of licensing laws,

[32]For related analyses in this study, see http://nas.edu/SkilledTechnicalWorkforce.

and reduce the number of licenses that are not justified by these assessments.

- Harmonize regulatory requirements across states to the extent possible, and where appropriate, enter into interstate compacts that recognize licenses from other states.
- Allow practitioners to offer services to the full extent of their current competency to ensure that all qualified workers can find services. (The White House, 2015, Chapter 2)

6.6.4 Competency Models

The Department of Labor's Employment Training Administration has developed a structured approach to articulating the competencies required for occupations in an industry or sector, from foundational competencies, to industry-wide competencies, to technical competencies within a specific subsector.[33] This competency strategy is used to identify specific employer skill requirements, define career pathways and credentials, develop competency-based curricula and training models, and create industry-defined performance indicators and certifications. It also includes the development of resources for career exploration and guidance, and is being used to encourage employers to make hiring decisions based on work-related competencies rather than credentials.[34]

Competencies can serve as a better basis for education, training, and employment decisions relative to credentials, which are imperfect proxies for occupational capacity and competency. Those who are engaged in integrated learning, sector strategies, talent management, career pathways, and career pipeline initiatives can use the competency model framework to guide their work.

6.7 CONCLUSIONS

Educators, workers, employers, industry and trade associations, labor unions, and other civic leaders face several challenges in developing a skilled technical workforce that meets local economic development requirements. Although there are no panaceas, and the available evidence has limitations, the

[33]For more information on competency modeling, see http://www.careeronestop.org/competencymodel (accessed March 33, 2017).

[34]See, for example, the work of the Business Roundtable (http://businessroundtable.org/issues/education-workforce) and the National Network of Business and Industry Associations (http://actfdn.org/category/national-network-of-business-and-industry-associations).

committee has identified examples of initiatives currently under way that could be instructive for policy making.

Evidence indicates that reform of secondary and postsecondary education to better integrate academic education, technical training, and hands-on work experience produces better outcomes and return on investment for all students in high school, postsecondary education, and careers (DOL et al., 2014). These approaches—which include creating flexible and integrated learning environments to meet the needs of a highly diverse student body, revising remedial programs and prerequisite requirements, creating portable credentials and licenses, and providing wraparound services—are compatible with a wide range of education and training models, including career academies, charter schools, small-themed schools, internships, and summer job programs for youth. In addition, some apprenticeship programs offer positive benefits for both participants and society as a whole.

Lifelong learning is essential for the U.S. workforce to remain globally competitive, and some policy makers, employers, industry and trade associations, and labor unions are experimenting with strategies for ensuring that U.S. workers will continue to invest in education and training throughout their work lives. In addition, they are experimenting with a number of enabling initiatives aimed at improving the flow of information, braiding financial sources, articulating career pathways, building competency models, and implementing sector strategies. Although these experiments provide ideas for policy makers who wish to innovate and implement reforms, there are no blueprints for success. Rather, experiments must be based on analyses of local requirements, and programs must be designed with these requirements in mind. Further research is needed both to support these analyses and to understand the dynamics of these highly complex social systems.

7

Findings and Recommendations

The United States needs a skilled technical workforce to remain competitive in the global economy and to ensure that its workers participate in the nation's economic growth. There are significant opportunities as well as major challenges in this regard. Notably, rigorous evidence indicates that the returns on investments in technical skills in the labor market are strong when students successfully complete their training and gain credentials sought by employers. At the same time, the committee found that in many instances, workers either are not taking advantage of these opportunities or are failing to complete their training programs.

To understand why, it is necessary to recognize that in the United States, the responsibility for developing and sustaining a skilled technical workforce is fragmented across many groups, including educators; students; workers; employers; the federal, state, and local governments; labor organizations; and civic associations. For the system to work well, these groups need to be able to coordinate and cooperate successfully with each other.

Unlike most other advanced economies, the United States lacks formal mechanisms that require governments, educators, labor representatives, and employers to coordinate on workforce development policies and practices at the national level. In fact, workforce development in the United States is polycentric in nature, driven by a variety of private and public investments in workforce education and training. Workers often pay for on-the-job training through lower wages. Although employers and governments share an interest in developing and maintaining a robust skilled technical workforce, their respective investments often are uncoordinated. At the same time, public investments are guided by a complex and similarly uncoordinated set of policies associated with achieving similarly divergent goals related to economic development, education, employment, health and human services, and veterans' affairs. In this polycentric system, making better use of available resources and generating better outcomes requires improving coordination between students and educational or training institutions, between secondary and postsecondary

institutions, and especially between training institutions and employers through a variety of public, private, and hybrid mechanisms.

The good news is that promising experiments currently under way across the United States can provide guidance for innovation and reform, although the scalability of some of these experiments has not yet been tested. As detailed in Chapter 6, evidence suggests that integration of academic education, technical training, and hands-on work experience improves outcomes and return on investment for students in secondary and postsecondary education and for skilled technical workers in different career stages.

The findings and recommendations presented in this chapter are designed to help overcome some of the barriers identified within the current framework of federal governance, state implementation, and market incentives. They address the key elements of the statement of task for this study.[1] To the extent possible, the recommendations call for specific actions by Congress, federal agencies, state governments, employers, and civic organizations to improve the American system of workforce development.[2]

FINDINGS

TASK: Define the skilled technical workforce.

Finding 1: The skilled technical workforce includes a range of occupations that require a high level of knowledge in a technical domain, but many of these occupations do not require a bachelor's degree for entry.[3]

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[1]The statement of task is presented in Box 1-2 in Chapter 1. The findings and recommendations in this chapter are cross-indexed to the tasks undertaken by the committee as follows:

- Define the skilled technical workforce: Findings 1 and 2, and Recommendation 2.
- Consider gaps and market failures: Findings 3, 4, 5, and 6, and Recommendations 3, 4, and 5.
- Consider the current public- and private-sector roles in financing and providing employment training and skills certification: Finding 7.
- Consider policy-making challenges and experiments that affect incentives and information to improve work skills: Findings 8, 9, 10, 11, and 12, and Recommendations 1 and 6.
- Consider selected employment preparation practices in other countries: Finding 13 and Recommendation 7.

[2]A summary list of selected appropriate actions for stakeholders is presented at the end of this chapter.

[3]See also the summary in Box 1-1 in Chapter 1.

a. Estimates of the number of skilled technical workers range from 11.9 percent to 23.1 percent of the total U.S. workforce, depending on how the workforce is defined.
b. Nonroutine, interpersonal, and analytic skills are becoming increasingly important for skilled technical work. It has been estimated that as of 2009, more than 60 percent of all work tasks required these skills. Competencies associated with skilled technical workers include the following:
    - **Personal skills.** These include interpersonal skills, integrity, initiative, dependability and reliability, adaptability and flexibility, and lifelong learning.
    - **Academic competencies.** These include basic academic skills such as reading, writing, and mathematics; advanced knowledge and skills in science and technology relevant to the technical occupation; and critical and analytical thinking.
    - **Workplace competencies.** These include teamwork and collaboration; customer focus; planning and organizing; problem solving and decision making; working with tools and technologies; scheduling and coordination; and checking, examining, and recording.
    - **Industry-wide technical competencies.** These are the knowledge, skills, and abilities associated with a particular industry such as health care or manufacturing. They are "cross-cutting" competencies common to most occupations within the industry. These competencies usually deal with comprehension, awareness, or analysis.
    - **Occupation-specific technical competencies.** These are the knowledge, skills, and abilities associated with specific occupations such as emergency medicine or automotive manufacturing technicians.

Finding 2: Although widely used to describe this segment of the workforce, the term "middle skills" fails to capture the high value and dynamism of this segment of the U.S. workforce and is seen by some as having pejorative connotations. This label can deter students and workers from these occupations at every stage of their career. [4]

a. **Social Perspectives.** Students, parents, and workers often fail to appreciate the value of many skilled technical occupations and wrongly believe that skilled technical jobs do not offer adequate wages, working

[4]See Section 1.4 of Chapter 1 on "Defining the Workforce."

conditions, employment security, social prestige, opportunities for advancement, or other important benefits.[5] Consequently, many students and workers overlook occupations and career opportunities that have high social value and potentially good returns to education and training, or they do not properly prepare themselves for these opportunities.

b. **High-value jobs.** In fact, the data show that skilled technical occupations are well-paying jobs with high social value and multiple points of entry that require academic preparation combined with postsecondary technical education and training and experience on the job to achieve competency.[6]
c. **Multiple pathways.** Workers in skilled technical occupations may hold any one of several different types of credentials, including associate's, bachelor's, and master's degrees; certificates; certifications; and occupational licenses.[7]

TASK: Consider gaps and market failures.

Finding 3: To remain competitive in the global economy, foster greater innovation, and provide a foundation for shared prosperity, the United States needs a workforce with the right mix of skills to meet the diverse needs of the economy. Conversely, an insufficiently skilled workforce imposes significant burdens on the U.S. economy, including higher costs to workers and employers and lower economic productivity.[8]

a. **Higher costs.** An insufficiently skilled workforce imposes costs on employers who struggle to find skilled workers, and also hurts workers who could otherwise have higher skills and earnings, thus exacerbating inequality.
b. **Lower employment and productivity.** Some economists are concerned that an insufficient number of skilled workers can limit growth rates in employment, output, and productivity. If employers cannot hire workers with the right skills locally, they cannot produce enough of the higher-value products and services that are associated with sustained innovation and growth in their location. This in turn creates pressure to relocate either within the United States or abroad. In

[5]See Section 1.4 of Chapter 1 on "Defining the Workforce."
[6]See Section 1.4 of Chapter 1 on "Defining the Workforce."
[7]See Section 1.5 of Chapter 1 on "Structure of the System for U.S. Skilled Technical Workforce Development."
[8]See Section 2.1 of Chapter 2 on "The Supply of and Demand for Skilled Technical Workers."

a global economy, employers often offset the lack of qualified labor in one country by seeking qualified labor in another (offshoring).

c. **Other impacts.** Citizens with lower skill proficiency tend to report poorer health, lower civic engagement, and less trust. Lower skills also make it difficult for workers to attain more education or training when structural changes require adapting to new methods and processes.

Finding 4: The evidence suggests that as a nation, the United States is not adequately developing and sustaining a workforce with the skills needed to compete in the 21st century.[9]

a. Americans perform poorly on a large international assessment of adult skills compared with citizens of other leading economies. For example:
   - Compared with the working-age population in 24 Organisation for Economic Co-operation and Development (OECD) countries, Americans rank 16th in literacy skills, 21st in numeracy skills, and 14th in problem solving in a technology-rich environment.
   - U.S. average mathematics and science literacy scores are below the average scores for all developed countries, and Americans have substantially fewer high scores and more low scores than citizens of other developed countries.

b. Americans perform poorly on U.S.-based assessments of skills:
   - Only 46 percent of Americans can demonstrate an understanding of scientific inquiry.
   - On average, American students are not proficient in mathematics, reading, or writing as measured by the National Assessment of Educational Progress (NAEP).

c. Americans are concerned about the nation's ability to develop and sustain a skilled workforce:
   - According to the National Science Board (NSB), most Americans think other countries are doing a better job of providing technical education and supporting lifelong education and training.
   - Spurred by concerns about the need for a skilled technical workforce, public officials at the federal, state, and local levels have undertaken numerous initiatives related to improving the skill of the workforce.[10]
   - Employers, industry associations, and labor unions share these

[9]See Section 3.6 of Chapter 3 on "Current Policy Issues Related to Developing a Skilled Technical Workforce."

[10]See Section 3.3 of Chapter 3 on "Federal-Level Policies and Programs" and Section 3.5 of Chapter 3 on "State-Level Policies."

concerns. Industry surveys and policy reports find evidence of current and long-term skill gaps in technical occupations.

- The available evidence suggests that efforts to create stackable credentials and career pipelines and pathways may not in themselves lead to an increase in the supply of technical workers. A recent report of the NSB cites decades of data showing that in the United States, "degree is not destiny" and that there is only a very loose association between degrees and jobs at all education levels and in all degree fields.[11]

Finding 5: It is difficult to find rigorous evidence on how well skilled technical labor markets are functioning at aggregate levels of analysis across the nation.[12]

a. Evidence indicates labor market imbalances in certain skilled technical occupations, industry sectors, and locations; however, analysts disagree as to whether there are gaps or failures in the aggregate in skilled technical labor markets, with some arguing that there is no overall evidence of market failures.
b. Labor supply and demand for skilled technical occupations vary across sectors and locations, and it is difficult to disentangle these two factors using traditional analytical methods.[13]
c. By definition, an innovative economy is likely to experience some lag in producing workers with the latest skills.[14] The ability to measure skill shortages is hampered by the dynamic nature of the labor market in that it is difficult to know whether an imbalance will be permanent or temporary. The measurement challenge arises because it is difficult to consistently identify levels of supply and demand in multiple sectors, at varying levels of aggregation, and in changing markets for skilled labor.

Finding 6: The nation is experiencing, and will continue to experience, imbalances in the supply of and demand for skilled technical workers in certain occupations, industry sectors, and locations. The nature of the

[11]See Section 2.1.1 of Chapter 2 on "National Trends in the Demand for and Supply of Skilled Technical Workers."
[12]See Section 2.1 of Chapter 2 on "The Supply of and Demand for Skilled Technical Workers."
[13]See Section 2.1 of Chapter 2 on "The Supply of and Demand for Skilled Technical Workers."
[14]See Section 1.2 of Chapter 1 on "The Importance of Skills."

problem differs across sectors and locations. These imbalances arise from multiple sources:

a. **Sectoral gaps.** Gaps are particularly evident in health care and manufacturing, industries that have undergone a shift from high-volume, low-tech jobs to dynamic, high-tech jobs and that encompass several occupations that require proficiency in science, technology, engineering, and mathematics (STEM) skills, as well as other foundational skills.[15]
b. **Demographic factors.** Changes related to population growth and the retirement of the baby boom generation create the potential for gaps and imbalances in skilled labor markets.
c. **Structural changes.** The functioning of skilled labor markets is affected by structural changes related to technological advances, changing business models, global competition, and sectoral changes associated with price movements.[16]
d. **Outmoded or misaligned policies and regulations.** Examples of misaligned policies include lengthy training requirements or licensing laws that constrain the supply of skilled technical labor for long periods of time in certain occupations, such as health care.[17]
e. **Advances in science and technology.** New technologies will impact the demand for applied technical skills: requirements will evolve over time, and continual education and training will be needed.[18]
f. **Poor incentives facing the nation's institutions.** Federal and state funding formulas can distort educators' incentives by emphasizing the volume of enrollment in institutions and programs rather than the quality of the institutions and programs or outcomes.[19] Funding formulas also can divert resources from programs that actually add value in skilled technical workforce development.

TASK: Consider current public- and private-sector roles in financing and providing employment training and skills certification.

Finding 7: In the United States, educators, students, workers, employers, the federal government, state and local governments, labor unions, industry and

[15]See Section 2.1 of Chapter 2 on "The Supply of and Demand for Skilled Technical Workers."
[16]See Section 2.1.2 of Chapter 2 on "Exploring Imbalances across the Skilled Technical Workforce in the United States."
[17]See Section 2.3 of Chapter 2 on "Trends in Supply and Demand in Health Care."
[18]See Section 2.3 of Chapter 2 on "Trends in Supply and Demand in Health Care."
[19]See Section 5.2 of Chapter 5 on "Impediments to Better Training Outcomes."

trade associations, and other civic associations all play a role in skilled technical workforce development.

a. **Educators** are responsible for designing and delivering education and training that will meet current and future skilled technical workforce requirements. The current education system works well to prepare some students for some skilled technical occupations.
   - **Elementary and secondary education,** which is intended to provide the foundation for qualifying for jobs in skilled occupations, is provided both publicly and privately. Public education is funded primarily with local tax revenues. Career and technical education (CTE) of varying quality and scope is provided in 9,500 comprehensive high schools, about 1,000 vocational high schools that also offer academic subjects, and about 800 area regional vocational schools that offer mainly CTE courses.
   - **Postsecondary education**, which is increasingly necessary to qualify for jobs in skilled technical occupations, is typically subsidized with state and federal funding provided to individuals and institutions. Depending on the location, options of varying quality, cost, and scope for postsecondary education and training for skilled technical jobs may include the following:
     - **Community and technical colleges** were created to provide affordable lifelong academic and technical education and training for all individuals in a local area. They offer associate's degrees that are transferrable to higher education degree programs, terminal associate's degrees, certifications, apprenticeships, and contract or custom training on a noncredit basis. Community colleges in the United States currently enroll nearly half of all students pursuing undergraduate education.
     - **Colleges and research universities** provide academic and technical education and training for skilled technical jobs for youth and adults on a competitive basis at a wide range of costs. They offer bachelor's degrees, clinical training, graduate degrees, and doctoral degrees in the arts; such vocations as business, education, government, and law; and science and technology. Slightly more than half of all students pursuing undergraduate education are currently enrolled in 4-year colleges and research universities.
     - **Apprenticeships** provide education and training in a wide range of skilled occupations and are expanding nationally. The registered apprenticeship network in the United States currently includes more than 1,000 occupations, although active programs may not exist in all of these occupations.

There are about 400,000 registered apprentices in the United States, and they are typically clustered in a few occupational sectors, such as construction, certain areas of manufacturing, and services.[20] However, there are numerous barriers to the wider adoption of apprenticeship programs, including confusion about what constitutes an apprenticeship; the high costs of starting a program; a lack of intermediating institutions needed to connect firms, workers, and educational organizations; and insufficient in-company training resources.[21]

- **Certifications** are offered by approximately 4,000 entities in the United States, including industry groups, professional organizations, and employers, often with little quality control through third-party review or accreditation.
- **Certificate programs**—typically lasting 1 year or less—are widely available at community colleges for many skilled technical fields. The limited research available suggests that the value of these certificates varies widely.

b. **Students and workers** are responsible for identifying education and training requirements, but may not be making informed choices. Higher education in public institutions in the United States is subsidized by the state governments. Even so, most postsecondary students are responsible for the up-front costs, including tuition, books, supplies, child care, and transportation.

c. **Employers** often provide on-the-job training, as well as tuition assistance for postsecondary education and training for employees. However, it is difficult to determine accurately the motivation for, the scale of, or the effectiveness of employer training because of limited independent data and analyses. The data that have been collected show wide variation across surveys. For example, estimates of the proportion of workers who participated in training in the years 2003 and 2004 vary from 22 to 57 percent. About 30 percent of employees use tuition reimbursement programs.[22]

d. **Civic organizations,** including labor unions, worker associations, industry and trade associations, religious organizations, and philanthropies, also support workforce development based on their specific missions and interests. However, there have been no

[20]See Section 4.3 of Chapter 4 on "Other Postsecondary Education and Training Programs."
[21]See Box 4-1 of Chapter 4 on "Apprenticeships: Challenges from Concept to Application."
[22]See Section 4.2 of Chapter 4 on "The Primary Components of Workforce Development."

comprehensive studies of the scale or effectiveness of the role of civic associations in skilled workforce development.[23]

TASK: Consider policy-making challenges and experiments that affect incentives and information to improve work skills.

Finding 8: Skilled technical workforce development in the United States is guided and supported by a complex and often uncoordinated set of policies and funds at the local, state, and federal government levels associated with achieving goals related to economic development, education, labor and employment, health and human services, and veterans' affairs. Most resources are allocated by formulas based on demographic factors, which serve as a proxy for need, rather than on performance, outcomes, or evidence of what works best in workforce development.

a. **Federal policy frameworks** include the 2015 Every Student Succeeds Act, the 2014 Workforce Innovation and Opportunity Act (WIOA), the Perkins Act, the Higher Education Act (HEA), and the Post-9/11 Veterans Educational Assistance Act of 2008.[24]
   - The majority of federal workforce training funding is distributed by formula grant programs that allocate funds to state and local entities based on established noncompetitive criteria; the rest is distributed through competitive grant programs administered by federal agencies.
   - Of the $145 billion in federal education assistance provided in 2013, the vast majority ($130.7 billion) was governed by Title IV of HEA, while $10 billion was governed by the Post-9/11 Veterans Educational Assistance Act of 2008, $2.5 billion by WIOA, $1.1 billion by the Perkins Act, and $575 million by the Trade Adjustment Assistance Act (TAA).
   - Many federal programs support workforce development; however, 95 percent of this funding is managed by four federal agencies: the Department of Labor (45.2 percent), Department of Education (29.9 percent), Department of Health and Human Services (12.5 percent), and Department of Veterans Affairs (8 percent).
   - WIOA is intended to better align federal and state workforce development efforts. However, it has not yet been fully implemented; resource allocations are uncertain; and in the past,

[23]See Section 4.4 of Chapter 4 on "Funding for Skilled Technical Workforce Education and Training."
[24]See Section 3.3 of Chapter 3 on "Federal-Level Policies and Programs."

congressional oversight of performance against policy goals has been limited.

b. **State and local policy frameworks** include those related to K-16 education, CTE, labor, and veterans' assistance.[25]
   - The National Center for Education Statistics reports that state and local expenditures for public elementary and secondary schools alone are projected to be $634 billion for the 2015-2016 school year.
   - State and local government agencies are the primary source of funding for community colleges. In 2013-2014, expenditures for community colleges totaled $55.9 billion, nearly half (49.4 percent) of which came from state or local funding, 22.6 percent from federal funding, and the remainder from student tuition and fees (16.7 percent) and other sources (11.3 percent).
   - Some forms of education and training, such as CTE, apprenticeships, certificate programs, certification programs, licensing programs, and veterans' transition assistance programs, require systematic collaboration across educators, employers, labor unions, industry and trade associations, and policy makers at the local level.
   - Although there are many examples of effective systematic coordination that prepares skilled technical workers to meet local employer needs, these models remain isolated. Many policy makers are concerned about the effectiveness of local coordination and resource allocation.

Finding 9: The incentives for students and employers to invest in skill development depend on the return on these investments.[26]

a. Overall, there is strong evidence of high positive returns to postsecondary education and training for skilled technical jobs. However, students face major hurdles in starting and completing their education and training. Students in public community colleges have lower completion rates relative to students in private technical colleges or 4-year colleges. Key factors affecting the initiation and completion of postsecondary education and training programs include
   - the rising cost of tuition;

[25]See Section 3.5 of Chapter 3 on "State-Level Policies."
[26]See Section 5.1 of Chapter 5 on "The Return-on-Investment Calculus."

- inadequate preparation in elementary and secondary education and the high costs of remedial programs needed to overcome this lack of preparation;
- a lack of support services to address challenges faced by many students in establishing their household, raising their children, and caring for aging family members;
- limited career guidance, which makes it difficult for students to identify appropriate courses of study; and
- the perceived low social prestige of CTE among some students and parents.

Finding 11 addresses effective strategies for improving completion rates for programs in skill training.

b. Evidence on employer investments in education and training and the return on these investments is mixed, in large part because data are missing or incomplete.
   - Some employers may look to public resources for education and training for students and workers because they fear that other employers may free-ride on their investments.
   - With the growth of contingent work arrangements, which shorten the timeframe within which employers can recoup investments in training, some employers may have insufficient motivation to invest in some types of skilled technical workforce development.

c. Investments in certification programs by students, workers, and employers depend on the perceived value of these programs. The value of certain programs may be difficult to measure or may be lower when alignment is lacking among credentialing institutions, states, or employers within an industry.
   - The available research on certificates and certifications indicates that outcomes are highly context-dependent. Certifications appear to have more labor market value in some sectors than in others, and some degree of quality control is exercised through third-party review or accreditation. Certificates that require long periods of study and are aligned with industry certifications provide more benefits to holders relative to those that require short periods of study.
   - State and local credentialing and licensing requirements can increase the costs of preparing for and entering skilled technical jobs, and make it more difficult and costly to move from one job to another or from one location to another.

Finding 10: Policy makers and participants in workforce development lack the information they need to adjust policies and make choices. User-friendly tools that provide direct access to information about options and performance can assist labor market participants in their decision-making processes.[27]

a. Limitations in data and analyses make it difficult to determine whether and how individuals, employers, and the public are investing in skilled technical education and training, and whether they are realizing a sufficient return to continue or increase their investments.[28]
b. To make adjustments that will improve workforce development outcomes, both policy makers and labor market participants need better data with which to analyze labor market dynamics, returns on investments in workforce development, and the effectiveness of alternative strategies.
    - Students and workers, guidance counselors, and educators need better information on skill requirements, career pathways, and potential returns on their investments in education and training.
    - Employers can benefit from better information on effective education and training resources and on viable pipelines for producing skilled workers.
c. Much of the data for the information system that supports U.S. labor market functions is funded and administered by the Department of Labor. However, this information system is less effective than it could be; funding has been stagnant over the past decade, and Congress has provided limited oversight.
d. Many analysts are using outdated and ineffective research methods. Investing in more research will not necessarily generate new knowledge if analysts continue to use outmoded analytical methods and tools. Advances in mathematics, statistics, and the computational sciences make it possible to capture and analyze data from a broad range of very different sources. The evidence suggests that more analysts need to apply these advances to improve workforce analysis tools and methods.
e. Local data warehouses and analytical applications, such as those funded by the Department of Labor's Workforce Data Quality Initiative, help policy makers better estimate returns on investments in education and training.

[27]See Section 5.2 of Chapter 5 on "Impediments to Better Training Outcomes," and Section 6.5 of Chapter 6 on "Improving Links through Better Data."
[28]See also Section 2.3 of Chapter 2 on "Trends in Supply and Demand in Health Care" and Section 5.2 of Chapter 5 on "Impediments to Better Training Outcomes."

Finding 11: Several strategies and initiatives show promising results by improving rates of successful completion of education and training and by coordinating education and training opportunities with employer needs. These experiments, which link the different parts of the ecosystem for workforce education and training, could be instructive for designing and enforcing policy and allocating resources within appropriate contexts.

a. The first set of policy measures is intended to link students to education and training and improve success rates.[29] They include the following:
   - **Counseling services.** Career guidance is particularly important to skilled technical workforce development because it can counter the common perception that the only path to lifelong occupational success is through immediate entry into a 4-year college and advanced degree programs. Without career counseling and reliable occupational information, students pay insufficient attention to labor market trends when choosing a field of study.
   - **Financial aid.** Some federal aid, such as Pell Grants, is limited to undergraduate students in for-credit programs and is not available to students taking continuing education classes, even when they earn a certificate. Evidence indicates that providing financial aid tied to academic benchmarks as a supplement to other financial aid increases the likelihood that students will enroll full-time and earn more credits.
   - **Braiding of financial sources.** Some states are finding effective ways to combine public resources to support postsecondary education and training programs by using "braiding strategies," which merge public dollars for a common purpose while keeping categorical funds distinct. More analyses of funding sources and financial flows are required to ensure that public funds can flow freely to meet changing workforce development needs.
   - **Continuing education and training.** Lifelong learning is essential for the U.S. workforce to remain globally competitive. Overall participation in all forms of adult education among Americans aged 16 and older is about 44 percent. Some states are experimenting with strategies for ensuring that U.S. workers will continue to invest in education and training throughout their work lives. Maine, for example, is experimenting with portable, employee-owned Lifelong Learning Accounts that permit employees, employers, and the state to pool funds for continual worker education and training.

[29]See Section 6.1 of Chapter 6 on "Linking Students to Skilled Technical Education and Training Opportunities and Improving Success Rates."

- **Wraparound services.** Providing a wide range of services, such as counseling, tutoring, child care, and transportation assistance, that support students in achieving education and training goals appears to improve student outcomes and returns on investment.
- **Remedial programs.** Students who need to take remedial classes in college are more likely to drop out. Although it has not been validated through randomized controlled trials, anecdotal evidence suggests that integrating remediation into skills training improves completion rates. Schools also can do a better job of assessing student readiness for education and training and designing more appropriate and cost-effective prerequisite requirements. Online education may be a key component of improved remediation, and the use of online simulation modules may be effective at improving training opportunities economically.
- **Career pathways.** Some evidence suggests that articulating career pathways improves education and training outcomes. Career pathways, which are roadmaps of the education and training required to attain credentials associated with success in specific industries, have been adopted in several states and often are used to guide linked learning, sector strategies, talent management, and career pipeline initiatives.
- **Online and blended learning.** New information technologies can supplement traditional educational methods. Although the use of online training has proven effective in certain professions, such as air transportation (e.g., flight simulators) and health care (e.g., surgical applications), it also offers the promise of aiding with remedial education, which may improve community college completion rates.
- **Incentives for community colleges.** Although many states have already implemented funding incentives based on such indicators as course completion and time to degree, these formulas may encourage community colleges to accept only the best students or to lower standards for completion. To boost completion rates, community colleges and other educational organizations will require incentives and funding to create more flexible and integrated programs and offer supportive services.

b. A second set of policy measures is intended to improve links between secondary and postsecondary education.[30] Better integration of academic and technical education and training can improve the quality

[30]See Section 6.2 of Chapter 6 on "Linking Secondary and Postsecondary Education and Training."

of postsecondary education and increase the return on investments in education and training for skilled technical occupations.

- **Dual-enrollment programs and early college high schools.** The existing evidence suggests that these programs, which involve formal linkages between secondary and postsecondary school credentialing programs, improve incentives for high school students to earn their high school diploma and an associate's degree in an applied science or technology and to obtain a job.
- **Career academies.** Evidence suggests that career academies, a type of small learning community within a school that provides a college preparatory curriculum with a career-related theme, improve outcomes for students during and after high school. First founded in 1969 in Philadelphia with the Electric Academy at Edison High School, career academies in the United States now number more than 7,000 and cover a wide range of career areas.

c. A third set of policy measures is intended to link training and work.[31] Many employers are seeking to partner more closely with community or technical colleges. Similarly, many educators are seeking to partner with employers to develop more relevant education and training programs. These educational institution–employer partnerships have the potential to create better-integrated learning environments and meet local employer skill requirements.

- **Strategic centers of excellence at community and technical colleges.** These centers are designed to foster flexible and integrative learning in strategically important local industries. They can serve as a point of contact and resource hub for industry trends, best practices, innovative curriculum, and professional development.
- **Sector strategies.** Evaluations of sector partnerships suggest that they have the potential to produce positive outcomes for youth and adults. Advocated by the National Governors Association (NGA), the Department of Labor, and civic associations, sector strategies are partnerships of employers within a single industry that focus on coordinating policies and resources to address the workforce needs of a strategically important industry, including through apprenticeship programs targeted to those sectors. NGA estimates that more than 1,000 sector partnerships now operate across about half of all U.S. states.

d. Apprenticeship and joint labor–management programs can serve to link employers and workers.[32]

[31]See Section 6.3 of Chapter 6 on "Linking Training and Work."
[32]See Section 6.4 of Chapter 6 on "Employer-Based Training Programs."

- **Apprenticeship programs.** As noted earlier, these programs combine occupational education and training with paid on-the-job work experience. A number of states have developed apprenticeship programs over the past 10 years, although the impact of such programs has not been rigorously evaluated. The most interesting of these models move beyond time-based workplace training to integrate dual-learning principles whereby academic courses are linked to workplace training and standardized competency-based certifications.
- **Joint labor–management strategies.** More evidence is needed on joint labor–management strategies for establishing workplace learning systems and community-based workforce and economic development initiatives.[33] Unions have a prescribed role in job training programs under the 2014 WIOA, and they have a long history of designing and implementing innovative and effective job training and apprenticeship programs that potentially benefit workers, businesses, and local communities.
- **Talent pipelines.** The use of supply chain management principles to create talent pipelines that link investments in workforce development with business strategy is being promoted by the U.S. Chamber of Commerce Foundation; the National Network of Business and Industry Associations; industry trade associations, such as the Precision Machined Products Association, the National Tooling and Machining Association, the Technology and Manufacturing Association, and the National Institute for Metalworking Skills; and major employers, such as IBM.

e. A final set of policy initiatives is intended to increase the portability and wider recognition of acquired technical skills.[34] Roadmaps that link selected competencies also can help guide students and workers through the education and training they need to address the needs of local industries.

- **Portable credentials and licenses.** Given the proliferation of training programs and types of credentials, standardizing credentials would provide certainty to employers and workers about the value of the credentials. The evidence suggests that efforts to ensure that education and training accomplishments and licenses transfer across education and training programs, employers, industries, and geographic boundaries can reduce the costs of education and training and improve returns on investment.

[33]See Section 6.4 of Chapter 6 on "Employer-Based Training Programs."
[34]See Section 6.6 of Chapter 6 on "Other Policy Initiatives."

- **Competency models.** The Department of Labor's Employment Training Administration has developed a structured approach to articulating the competencies required in occupations in an industry or sector, from foundational competencies, to industry-wide competencies, to technical competencies within a specific subsector. The competency strategy is used to identify specific employer skill requirements, define career pathways and credentials, introduce competency-based curricula and training models, create industry-defined performance indicators and certifications, and develop resources for career exploration and guidance. The evidence suggests that assessments against competencies are a better basis for education, training, and employment decisions than credentials, which are imperfect proxies for occupational capacity and competency. Those who are engaged in linked learning, sector strategies, talent management, career pathways, and career pipeline initiatives can use the competency model to guide their work.

Finding 12. The Armed Services, one of the largest employers in the United States, could do a better job of assessing employment transition risks for military personnel, and designing and delivering services to mitigate these risks. They also could coordinate better with civilian policy makers, regulators, and educators to improve the transferability of military education, training, and certification.[35]

- Many Americans join the uniformed Armed Services as a pathway to education, training, and preparation for life and careers: 43.2 percent of all uniformed active duty personnel are aged 25 or younger.[36] Military personnel receive training in the competencies associated with skilled technical work. As of the end of November 2015, about 1.3 million individuals were working in the Armed Services.
- Each year, tens of thousands of military personnel transition back into civilian life after serving in the armed forces for just under an average of 7 years. Veterans' transition assistance programs include federal and state government programs, private-sector initiatives, and public–private partnerships. However, additional action is needed to improve

[35]See Section 5.3 of Chapter 5 on "Challenges in Training and Transitioning the Skilled Technical Workforce."
[36]See Section 5.3 of Chapter 5 on "Challenges in Training and Transitioning the Skilled Technical Workforce."

the effectiveness of these programs. Data suggest that some veterans have more difficulty with transitions than others.

- The Department of Defense (DoD) spends approximately $1 billion per year on unemployment benefits for transitioning service members but does not track how long members claim unemployment benefits or other characteristics of these benefits. DoD tracks only information on the characteristics of those who initially file for the Unemployment Compensation for Ex-servicemembers (UCX) program, regardless of whether they actually use those benefits.

TASK: Consider selected employment practices in other countries.

Finding 13. Policies and governmental structures used to support education and training in such countries as Germany and Switzerland may not be directly applicable in the United States because of differences in political and economic structures. However, applicable lessons can be learned from specific programs or innovative educational techniques, and policy makers in the United States can benefit from more rigorous cross-country comparisons.

a. Unlike most other developed countries, the United States lacks formal mechanisms that require governments, educators, labor representatives, and employers to coordinate on workforce development policies and practices at the national level.[37] Also in contrast with many other developed countries, federal and state-level policy in the United States requires most students and workers to pay for most of the cost of postsecondary education.
b. Nevertheless, state policy makers may be able to learn from the experience of other developed countries that have more coordinated employer training programs and a tradition of technical invention and innovation.[38] With regard to establishing apprenticeship programs, for example, a key lesson is the need to set clear rights and responsibilities for employers, workers, and educational organizations. Also needed are strong intermediating institutions that can coordinate individual employers' participation and help schools work with business, as well as clear industry standards and the competencies that apprentices should acquire in order to meet those standards.[39]
c. Moreover, there is a growing interest in developing apprenticeship programs in the United States, particularly in high-growth industries

[37]See Section 4.2 of Chapter 4 on "The Primary Components of Workforce Development."
[38]See Section 6.4 of Chapter 6 on "Employer-Based Training Programs."
[39]See Box 6-9 of Chapter 6 on "Key Lessons from Foreign Apprenticeship Systems."

such as health care, advanced manufacturing, information technology, and biotechnology. These programs use various approaches that often differ from the European dual-education model, and therefore direct comparisons are difficult.[40]

RECOMMENDATIONS

TASK: Consider policy-making challenges and experiments that affect incentives and information to improve work skills.

Recommendation 1: State and federal policy makers should support and enhance strategies that help students successfully complete their training for the skilled technical workforce. In addition, public policies should ensure that stakeholders, including students, workers, employers, and educational organizations, have the right incentives to improve the quality of technical education and training, encourage experimentation and collaboration, and improve the collection and use of relevant information.

a. The Department of Education should collect and disseminate information on best practices at community colleges that facilitate timely completion and enhance employment of graduates who are being trained to be a part of the skilled technical workforce.

- The Department of Education should provide information to states and community colleges around the country to help them adapt and craft programs based on principles underlying successful programs.
- Based on this information, students should be encouraged to embark on and complete education and training programs for skills that are in demand, and educational institutions should be incentivized to support them in doing so. In this regard, mandatory counseling and better student support can improve completion rates. In addition, studies in several states have shown that integrating remediation into skill training is very helpful.

b. The Department of Labor should encourage employers to partner with industry and trade associations, labor unions, and other civic organizations; educators; workers; and policy makers to develop workforce skills. Employers are encouraged to

- consult regularly and partner with policy makers, educators, labor unions, industry and trade associations, and other civic associations on skilled technical workforce development issues;

[40]See Section 6.4 of Chapter 6 on "Employer-Based Training Programs."

- engage in workforce planning for future labor needs, and actively seek education and training partners to address those needs;
- create incentives and resources for employees to invest in continual technical education and training throughout their careers; and
- support programs, such as apprenticeships, that link work-based learning with contextualized coursework and competency-based standardized certifications.

c. The Department of Labor should develop and disseminate information on the return on student and worker investments in training for skilled technical jobs.

- **Support state initiatives.** Congress should prioritize the provision of resources to support the states in investigating the return on investment in education and training as part of local skilled technical workforce development.
- **Collect and disseminate information.** The Department of Labor should collect and disseminate information on investigations of return on investment, and provide technical assistance and resources for such investigations.
- **Request studies.** State legislatures also should request studies of return on investment. These studies should include efforts to develop a better understanding of how students make decisions about education and training.

d. The secretaries of education and labor should incentivize stakeholders to:

- **Develop context-based learning strategies.** Review and evaluate funding formulas and grant rules for education and training programs to ensure that they provide incentives and funding for all stakeholders to participate in the development of an equal-opportunity skilled technical workforce using integrated, work context–based learning strategies. For example, allow federal and state education and labor funds to be used for all postsecondary education and training programs at all ages and levels of career advancement.
- **Reduce the need for remediation.** Encourage community colleges to reduce the need for remediation, integrate remediation into skills training, and improve the readiness of high school students for postsecondary or adult education programs.
- **Reward program completion.** Implement funding formulas tied to employment metrics, such as earnings of students after graduation, or metrics focused on increasing rates of enrollment and completion for programs that are in high demand among local employers.

- **Enhance the portability of credentials.** Work with and encourage efforts of local workforce boards to harmonize key features related to the quality, portability, and labor market value of credentials.
- **Encourage participation.** Develop incentives for employers and industry and trade associations to contribute to workforce development and transition management.

The secretaries of education and labor should report to Congress or state legislatures on the results of these efforts.

e. Innovate, experiment, and assess. The secretaries of education and labor should encourage educators to innovate and experiment in their skilled technical education and training programs to improve the linkage between education and employment, the quality of programs, student services, information about programs, and return on investments in education and training. Examples are provided in Chapter 6.

- Specifically, states should provide competitive funding grants to community colleges to encourage such innovation, along with accountability structures that enable assessment of what works. Principles underlying successful interventions should be identified and applied statewide and across state lines.
- Regular internal and external assessments are essential to identify and learn the lessons of these experiments.

TASK: Define the skilled technical workforce.

Recommendation 2: An alliance of industry, trade, academic, and civic associations and labor unions, in cooperation with the U.S. Departments of Labor and Education, should organize a nationwide public–private communication campaign to raise awareness of the value of and demand for skilled technical workers and the return on investment for individuals preparing for these careers. This campaign should be customized to recognize local variations in skilled technical workforce education, training, and labor market requirements.

a. **Labor unions, industry trade associations, and other civic associations** can enhance this message by providing financial and in-kind support to the Department of Labor's communication campaign.
b. **Educational institutions** can participate by providing more transparent information about their programs and curricula that can be showcased in these campaign efforts.
c. **Employers** can help by providing salient examples of high-paying jobs and the education and training that can lead to these jobs.

TASK: Consider gaps and market failures.

Recommendation 3: Congress and state legislatures should improve oversight of public policies and resources, highlighting the implementation of reforms such as those called for in WIOA. Reforms should be accelerated through targeted incentives.

a. **Expand.** Given the gaps in data and the failure to measure important parts of the skilled workforce ecosystem, the Department of Labor should consider the need to revise and expand current data collection approaches to better monitor this ecosystem.
b. **Monitor.** The Department of Labor should continue to monitor the state of the workforce through oversight and produce data particularly relevant to the technical skill arena. These activities are important given that efforts to address the issues are spread across several stakeholders and arenas.
c. **Analyze.** Congress should require the secretaries of education and labor to prepare annual reports on progress in implementing reforms such as those called for in WIOA and on the allocation of resources and financial flows associated with implementation.
d. **Oversee.** Congress and state legislatures should conduct regular hearings on progress in implementing education reforms.
e. **Incentivize.** Community colleges and other educational organizations should be incentivized and provided the means to adopt policies and programs aimed at boosting degree or credential completion, including better integration of academic and technical education and training.

Recommendation 4: Congress, state legislatures, and agencies of the federal and state governments should improve the workforce labor market information system (WLMIS), labor market data, and research tools and methods, including by providing funding for such activities.

a. **Prepare a roadmap.** Congress should require the secretary of labor to prepare a roadmap for implementing WLMIS reforms required under WIOA and to submit an annual report on progress against this roadmap.
b. **Conduct hearings.** Congress and state legislatures should conduct regular hearings on WLMIS issues and reforms.
c. **Provide support.**
    - The Department of Labor should provide resources for improving and developing the WLMIS, as called for in WIOA.
    - Civic organizations and private industry also can provide financial and in-kind support for WLMIS initiatives.

d. **Analyze data.**
   - The National Science Foundation should develop a program to expose labor market analysts to innovations in data and information sciences, develop new user-friendly information tools and research methodologies, and train and incentivize analysts to apply these innovations in their work.
   - Labor market researchers should be required to learn about and apply advances in data science and such new tools as screen scraping, and to conduct investigations that produce useful insights for stakeholders.

e. **Disseminate results.** State departments of labor should develop an understanding of what data are required and how they are used, and provide information for students, workers, and employers that meet these requirements and help them calculate returns on investments in education and training.
   - To make well-informed decisions, high school and postsecondary students need more direct career counseling based on accurate information, as well as advice about the challenges and opportunities made available by various kinds of academic programs.
   - Educational institutions also need information about alternative pathways available to students and completion rates of various programs. For example, community college students often avoid technical fields because they plan to transfer to 4-year colleges and obtain bachelor's degrees, but most do not do so.
   - States need to include data on the labor market outcomes of students in their state student information systems so that school districts can use the data to evaluate and improve their career programs.

Recommendation 5: Federal and state agencies should remove barriers to worker mobility, such as licensing and certification requirements that are not related to public safety. They also should improve labor market information on the changing requirements for skilled technical workers to help reduce imbalances in labor markets and to align workforce development with advances in science and technology.

a. **Enforce fair employment standards.** Labor law enforcement agencies, employers, labor unions, industry and trade associations, and other civic associations should help ensure that, consistent with the laws in place, all qualified workers can participate in all occupations in the skilled technical workforce, have access to education and training

opportunities throughout their careers, and be paid the regular and overtime wages to which they are entitled.

b. **Disseminate labor market information.** The National Science Foundation should develop a program to rapidly disseminate useful information to K-20 faculty and students, employers, and policy makers about changing labor market requirements and job opportunities that may result from advances in science and technology.
c. **Remove barriers.** The Department of Education should consider ways to reform financial aid that is currently limited to undergraduate students in for-credit programs so that it includes students taking continuing education classes in certificate programs.
d. **Review licensing requirements.** States should review their licensing requirements and reduce the number of licensed occupations or the number of requirements that do not pertain to public health and safety.
e. **Align training programs.** The states should consider a collective agreement with DoD that would facilitate alignment of DoD training with their 50 separate sets of certification and licensure requirements, perhaps modeled on the Military Child Education Compact.

TASK: Consider policy-making challenges and experiments that affect incentives and information to improve work skills.

Recommendation 6: DoD should further integrate skills transition into military training rather than treating it as a separate component at the end of the service member's career.

To further develop military training as a major pathway to the acquisition of technical skills, DoD should

a. investigate career pathway and transition issues in each of the Armed Services, which are among the largest employers in the United States, and use data from these investigations to better coordinate with civilian policy makers, regulators, and educators to improve the transferability of military education, training, and certification;
b. assess transition risks for military personnel, and design and deliver services to mitigate these risks, including ensuring that the military culture encourages service members to do everything they can to transition without drawing UCX assistance; and
c. collect better information on the cost and duration of unemployment benefits used by transitioning military personnel, as well as the incentives these programs create to use benefits.

TASK: Consider selected employment practices in other countries.

Recommendation 7: While selected programs and policies from other countries have been adapted in the United States, federal agencies should further study the conditions under which particular attributes of apprenticeships or other programs can be effectively applied more broadly.

a. The National Science Foundation should commission a study of how countries with more proficient workers develop their skilled technical workforces. This study should utilize concepts and methods that are common in organizational and institutional analysis, and should include the development of a rigorous methodology for conducting comparative studies and the application of insights from these studies to policy analysis and design.
b. Similarly, the Department of Education should use data from comparative organizational and institutional studies to identify ways of strengthening relationships between employers and educational institutions to improve state employment rates of graduates.

Box 7-1 organizes the committee's recommendations according to the various stakeholders to which they are targeted.

BOX 7-1
Summary of Selected Recommended Actions for Stakeholders

Congress

- Prioritize the provision of resources to support the states in investigating the return on investment in education and training as part of local skilled technical workforce development. (Recommendation 1c)
- Require the secretaries of education and labor to prepare annual reports on progress in implementing reforms and on the allocation of resources and financial flows associated with implementation. (Recommendation 3c)
- Require the secretary of labor to prepare a roadmap for implementing WLMIS reforms required under WIOA and to submit an annual report on progress. (Recommendation 4a)

Congress and State Legislatures

- Improve oversight of public policies and resources, highlighting the implementation of reforms such as those called for in WIOA. (Recommendation 3)
- Conduct regular hearings on WLMIS issues and reforms. (Recommendation 4b)

State Legislatures

- Request studies of return on investment. (Recommendation 1c)

Federal and State Departments of Labor and Education

- Review and evaluate funding formulas and grant rules for education and training programs to ensure that they provide incentives and funding for all stakeholders to participate in skilled technical workforce development. (Recommendation 1d)
- Collect and disseminate to students, workers, educators, and employers information on investigations of return on investment, and provide technical assistance and resources for such investigations. (Recommendation 1c)
- Encourage educators to innovate and experiment in their skilled technical education and training programs to improve the linkage between education and employment, the quality of programs, student services, information about programs, and return on investments in education and training. (Recommendation 1e)
- Monitor the state of the workforce and produce relevant data for students, workers, and employers. (Recommendation 3b)
- Provide resources for improving and developing the WLMIS. (Recommendation 4c)

(Continued)

BOX 7-1
Continued

Department of Defense

- Further integrate skills transition into military training rather than treating it as a separate component at the end of the service member's career. (Recommendation 6)
- Investigate career pathway and transition issues, and use data from these investigations to improve the transferability of military education, training, and certification. (Recommendation 6a)
- Collect better information on the cost and duration of unemployment benefits used by transitioning military personnel, as well as the incentives these programs create to use benefits. (Recommendation 6c)

National Science Foundation

- Expose labor market analysts to innovations in data and information sciences, develop new user-friendly information tools and research methodologies, and train and incentivize analysts to apply these innovations in their work. (Recommendation 4d)
- Commission a study of how countries with more proficient workers develop their skilled technical workforces. This study should include the development of a rigorous methodology for conducting comparative studies and the application of insights from these studies to policy analysis and design. (Recommendation 7a)

Educators (with the encouragement of the Secretaries of Education and Labor)

- Innovate and experiment in their skilled technical education and training programs to improve the linkage between education and employment, the quality of programs, student services, information about programs, and return on investments. (Recommendation 1e)

Employers, Industry and Trade Associations, Labor Unions, and Allied Training Partners (with the encouragement of the Department of Labor)

- Consult regularly and partner with policy makers, educators, and other civic associations on skilled technical workforce development issues. (Recommendation 1b)
- Create incentives and resources for employees to invest in continual technical education and training throughout their careers. (Recommendation 1b)
- Support programs, such as apprenticeships, that link work-based learning with contextualized coursework and competency-based standardized certifications. (Recommendation 1b)
- Raise awareness of the value of and demand for skilled technical workers. (Recommendation 2)

BOX 7-1
Continued

Other Civic Associations

- Consult regularly and partner with policy makers, educators, and employers on skilled technical workforce development issues. (Recommendation 1b)
- Raise awareness of the value of and demand for technical skills. (Recommendation 2)
- Provide financial and in-kind support for a skilled technical workforce communication campaign. (Recommendation 2a)
- Provide financial and in-kind support for WLMIS initiatives. (Recommendation 4c)
- Help ensure that all qualified workers can participate in all occupations in the skilled technical workforce, have access to education and training opportunities throughout their careers, and be paid the wages to which they are entitled. (Recommendation 5a)

Researchers

- Learn about and apply advances in data science, and conduct investigations that produce useful insights for stakeholders. (Recommendation 4d)

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A

Agendas of Committee Meetings

JUNE 24-25, 2015
SYMPOSIUM ON THE SUPPLY CHAIN FOR MIDDLE-SKILL JOBS: EDUCATION, TRAINING, AND CERTIFICATION PATHWAYS

National Academy of Sciences
Room 120
2101 Constitution Avenue, NW
Washington, DC

Day 1: Wednesday, June 24, 2015

8:30 AM **Continental Breakfast**

9:00 AM **Introduction**
Sujai Shivakumar, *The National Academies*

9:10 AM **Setting the Stage**
Senator Jeff Bingaman, *Study Chair*

9:30 AM **Keynote**
Senator Tim Kaine, *U.S Senator for Virginia, co-chair of Senate CTE Caucus*

10:00 AM **Panel 1: Defining Middle-Skill Jobs**
Moderator: Harry Holzer, *Georgetown University*
Presenter: Jonathan Rothwell, *Brookings Institution*
Discussants:

- V. Celeste Carter, *National Science Foundation*
- Brendan Lind, *LaunchCode*
- Dan Marschall, *AFL-CIO*

10:45 AM **Break**

11:00 AM **Panel 2: Middle-Skill Workers and Today's Labor Market**
Moderator: Francine Lawrence, *American Federation of Teachers*
Presenter: Alicia Sasser-Modestino, *Northeastern University*
Discussants:
- William Spriggs, *Howard University and AFL-CIO*
- Peter Cappelli, *Wharton Business School*
- Manjari Raman, *Harvard Business School*

11:45 AM **Panel 3: High School Pathways (Career Technical Education)**
Moderator: Gary Hoachlander, *ConnectEd*
Presenter: David Stern, *UC-Berkeley*
Discussants:
- Tom Volk, *Ohio Belting and Transmission*
- Grace Suh, *IBM Corporation*
- Erin Ward Bibo, *DC Public Schools*

12:30 PM **Break**

12:45 PM **Panel 4: Community College Pathways (Advanced Technical Education)**
Moderator: Annette Parker, *South Central College*
Presenter: Melinda Karp, *Community College Research Center, Columbia University*
Discussants:
- Johan Uvin, *Department of Education*
- Darlene Miller, *PERMAC*
- Marilyn Barger, *Florida Advanced Technological Education Center of Excellence*

1:30 PM **Lunch Keynote**
John McKernan, *U.S. Chamber of Commerce Foundation*

2:30 PM **Panel 5: Employer-led Training**
Moderator: Katharine Frase, *IBM*
Presenter: Robert Lerman, *American University*
Discussants:
- Dale Allen, *Quinsigamond Community College*
- Scott Ellsworth, *Business Leaders United for Workforce Partnerships*

- James Redstone, *House Education and Workforce Committee*

3:15 PM **Panel 6: Apprenticeships: Learning from Other Countries**
Moderator: Mario Kratsch, *German-American Chambers of Commerce of the Midwest*
Presenter: Andrea Messing-Mathie, *Northern Illinois University*
Discussants:
- Eric Seleznow, *Department of Labor*
- Josh Benton, *Kentucky Cabinet for Economic Development*
- Stuart Rosenfeld, *Regional Strategies Inc.*

4:00 PM **Break**

4:15 PM **Panel 7: Federally-funded Workforce Development**
Moderator: Susan Sclafani, *Pearson Foundation*
Presenter: Carolyn Heinrich, *University of Texas – Austin*
Discussants:
- Yvette Chocolaad, *National Assn. of State Workforce Agencies*
- Maureen Conway, *Aspen Institute*
- Scott Cheney, *Senate HELP Committee*

5:00 PM **Adjourn (End of Day 1)**

Day 2: Thursday, June 25, 2015

8:00 AM **Breakfast**

8:30 AM **Opening Remarks**
Tom Bailey, *Columbia University, Study Co-Chair*

8:45 AM **Panel 8: Pathways to Careers in Allied Health**
Moderator: George Zangaro, *HRSA*
Presenter: Bianca Frogner, *University of Washington*
Discussants:
- Eleni Papadakis, *Washington State Workforce Training and Education*
- Carolyn O'Daniel, *Jefferson Community and Technical College*

9:45 AM **Panel 9: Pathways for Military Credentialing & Veterans' Transitions**
Moderator: David Chu, *Institute for Defense Analyses*
Presenters: Susan Carter & Major Brian Miller, *U.S. Military Academy*
Discussants:
- Phillip Carter, *Center for a New American Security*
- Matt Notowidigdo, *Northwestern University*
- Wayne Boswell, *DoD Transitions to Veterans' Program Office*

10:45 AM **Break**

11:00 AM **Panel 10: Data Resources to Support Middle-Skill Workforce Development**
Moderator: Jennifer McNelly, *Manufacturing Institute*
Presenter: Andrew Reamer, *George Washington University*
Discussants:
- Rebecca Rust, *Bureau for Labor Statistics*
- John Dorrer, *Jobs for the Future*

12:00 PM **Panel 11: Building the Middle-Skill Talent Pipeline and Innovation**
Moderator: Rita Colwell, *University of Maryland*
Presenter: Robert Sheets, *George Washington University, and Jason Tyszko, U.S. Chamber of Commerce Foundation*
Discussants:
- Mary Alice McCarthy, *New America Foundation*
- Kimberly Green, *National Association of State Directors of Career and Technical Education Consortium*
- Byron Zuidema, *Department of Labor*

1:00 PM **Closing Remarks**
Senator Jeff Bingaman**,** *Study Chair*

1:15 PM **Symposium Adjourns**

SEPTEMBER 10, 2015
MEETING OF THE COMMITTEE ON THE SUPPLY CHAIN FOR MIDDLE-SKILL JOBS

Keck Center of the National Academies
Room 101
500 5th Street, NW
Washington, DC

9:00 AM **Working Breakfast**
Welcome
- Senator Jeff Bingaman, *Committee Chair*

9:10 AM **Federal Legislation**
- Cassandria Dortch, *Congressional Research Service*
- Committee Discussion

9:55 AM **Break**

10:10 AM **Role of New Technologies in CTE Education**
- Dale Allen, *Quinsigamond Community College*
- Committee Discussion

10:55 AM **State Programs**
- Martin Simon, *National Governors Association*
- Kate Blosveren Kreamer, *NASDCTEc/NCTEF*
- Committee Discussion

11:40 AM **Military Credentials & Transition Issues**
- Phillip Carter, *Center for a New American Security*
- Committee Discussion

12:25 PM **Soft Skills: Briefing on *Education for Life and Work***
- Margaret Hilton, *Study Staff*
- Committee Discussion

1:00 PM **CLOSED SESSION BEGINS**

FEBRUARY 17, 2016
MEETING OF THE COMMITTEE ON THE SUPPLY CHAIN FOR MIDDLE-SKILL JOBS

Keck Center of the National Academies
Room 106
500 5th Street NW
Washington, DC

9:00 AM **Working Breakfast**
Welcome
- Senator Jeff Bingaman, *Committee Chair*

9:10 AM **Data, Labor Market Dynamics & the Middle-Skill Workforce**
- Moderator: Andrew Reamer, *George Washington University*
- Kimberly Vitelli, *Department of Labor*
- Michael Horrigan, *Bureau of Labor Statistics*
- Sharon Boivin, *National Center for Education Statistics*
- Emilda Rivers, *National Center for Science and Engineering Statistics*
- Arpita Chattopadhyay, *Health Resources Services Administration*

10:30 AM **Break**

10:45 AM **Committee Discussion**
- Tom Bailey, *Community College Research Center*

11:30 AM **CLOSED SESSION BEGINS**

APRIL 1, 2016
WORKSHOP ON THE MIT ONLINE EDUCATION REPORT

National Academy of Sciences
The Lecture Room
2101 Constitution Avenue, NW
Washington, DC

2:00 PM **Welcome**

- Dr. Katharine Frase, co-chair of the Committee on the Supply Chain for Middle-skill Jobs

2:15 PM **Panel 1: Major Findings in MIT Online Education Report**

- Sanjay Sarma, *MIT, Dean of Digital Learning*
- Karen Willcox, *MIT, Professor of Aeronautics and Astronautics, Co-Director, Center for Computational Engineering*
- Eric Klopfer, *MIT, Professor & Director, Scheller Teacher Education Program*

3:00 PM **Panel 2: The Educators' Point of View**

Moderator: Toby Smith, *Vice President for Policy, Association of American Universities*

- Marshall "Mike" Smith, *Visiting Scholar, Carnegie Foundation for the Advancement of Teaching*
- Andrea Nixon, *Director of Educational Research, Carleton College*
- Kacy Redd, *Director of Science and Mathematics Education Policy, Association of Public and Land-grant Universities*
- Bror Saxberg, *Chief Learning Officer, Kaplan, Inc.*

4:00 PM **Break**

4:15 PM **Panel 3: Views from the Government**

Moderator: David Soo, *Senior Policy Advisor, Office of the Under Secretary, U.S. Department of Education*

- Susan Singer, *Division Director for Undergraduate Education, National Science Foundation*
- Ryan Burke, *Senior Policy Advisor, National Economic Council, The White House*

- Roberto Rodríguez, *Deputy Assistant to the President for Education, Domestic Policy Council, The White House*
- Mark Mitsui, *Deputy Assistant Secretary for Community Colleges, Office of Career, Technical, and Adult Education, Department of Education*

5:15 PM **Wrap-Up**

5:30 PM **Adjourn**

DECEMBER 6, 2016
WORKSHOP ON "THE MILITARY AS A PATHWAY TO SKILLED TECHNICAL JOBS"

National Academy of Sciences
The Lecture Room
2101 Constitution Avenue, NW
Washington, DC

12:30 PM **Welcome**
David Chu, *Committee on the Supply Chain for Middle-Skill Jobs and IDA*

12:40 PM **Keynote: The Force of the Future and the Skilled Technical Workforce**
The Hon. Peter K. Levine, *Under Secretary of Defense*

1:15 PM **Panel I: Preparing Service members for their Post-military Civilian Careers**
Moderator: David Chu, *Institute for Defense Analyses*

The Transition Assistance Program and Reinventing the Military Life Cycle
Karin Orvis, *Department of Defense*

Signaling Skills: The DOD's Certification, Licensing, and Credentialing Efforts
Diana Banks, *Department of Defense*

Building the Skills Bridge to Post Military Success
Ryan McDermott, *Department of Defense*

2:30 PM **Panel II: Improving the Transferability of Military Training**
Moderator: Susan Sclafani, *Pearson (Ret.)*

Best Practices from a State Program for Veterans
Sean Murphy, *Pacific Mountain Workforce Development Council*

Supporting the Transition: The Federal Role
Teresa Gerton, *Department of Labor*

The Onward to Opportunity Program
Mike Haynie, *Syracuse University*

3:30 PM **Coffee Break**

3:45 PM **Panel III: Continuum of Service and Civilian Needs**
Moderator: Lieutenant General Jack Stultz, Jr., *U.S. Army Reserve (Ret.)*

Establishing the Continuum of Service
John Winkler, *RAND*

Hiring our Heroes: The Private Sector Role
Eric Eversole, *U.S. Chamber of Commerce*

JPMorgan Chase: A Commitment to Veterans
Ross Brown, *JPMorgan Chase Foundation*

4:45 PM **Panel IV: Policy Roundtable**

Moderator: Daniel Feehan, *Department of Defense*
Debra S. Wada, *Assistant Secretary of the Army (Manpower & Reserve Affairs)*
Brigadier General Kathleen Cook, *U.S. Air Force*
Anish Goel, *Senate Armed Services Committee*

5:30 PM **Adjourn**

B

Biographies of Committee Members

Jeff Bingaman (*Chair*) is a former U.S. senator from New Mexico, serving from 1983 to 2013. He served as chairman of the Committee on Outreach for the Senate Democratic Caucus. Senator Bingaman held several committee assignments during his tenure in the U.S. Senate, including the Committee on Energy and Natural Resources; Committee on Finance; Joint Economic Committee; Committee on Armed Services; and Committee on Health, Education, Labor, and Pensions. During much of his political career, he was involved in the immigration debate, and he has worked to protect wildlife and public lands. On the Senate Energy Committee, he contributed to every major piece of energy policy legislation in the last two decades. Prior to serving as a U.S. senator, he worked as a private practice attorney. He served as counsel to the New Mexico Constitutional Convention of 1969, and served as attorney general of New Mexico from 1979 to 1983. Senator Bingaman earned his B.A. from Harvard and his J.D. from Stanford University.

Tom Bailey (*Co-chair*) is George and Abby O'Neill professor of economics and education at Teachers College, Columbia University. He is also director of the Community College Research Center (CCRC) and two national centers funded by a grant from the Institute for Education Sciences (IES): the Center for Analysis of Postsecondary Education and Employment (CAPSEE), established in 2011, and the Center for the Analysis of Postsecondary Readiness (CAPR), established in 2014. From 2006 to 2012, Dr. Bailey directed another IES-funded center, the National Center for Postsecondary Research (NCPR). His areas of expertise include labor economics, community colleges, econometrics, education policy, developmental education, assessment, educational equity, higher education and workforce preparation, school-to-work transition, and online learning.

In 1996, with support from the Alfred P. Sloan Foundation, Dr. Bailey established the CCRC at Teachers College, where he has served since 1992 as director of the Institute on Education and the Economy (IEE). In June 2010,

U.S. Secretary of Education Arne Duncan appointed him chair of the Committee on Measures of Student Success, which developed recommendations for community colleges to comply with completion rate disclosure requirements under the Higher Education Opportunity Act. Dr. Bailey and the CCRC won the Terry O'Banion Prize for Teaching and Learning at the annual conference for the League for Innovation in the Community College in 2013 and was inducted as an American Educational Research Association (AERA) fellow in the same year. He has been a member of the National Academy of Education since 2012.

Dr. Bailey's papers have appeared in a wide variety of education, policy-oriented, and academic journals, and he has authored or co-authored several books on the employment and training of immigrants and the extent and effects of on-the-job training. Along with Shanna Smith Jaggars and Davis Jenkins, he wrote *Redesigning America's Community Colleges: A Clearer Path to Student Success*, published by Harvard University Press in 2015. Other books include *Defending the Community College Equity Agenda* (Johns Hopkins University Press, 2006), co-edited with Vanessa Morest; *Working Knowledge: Work-Based Learning and Education Reform* (Routledge, 2004), co-authored with Katherine Hughes and David Moore; *Manufacturing Advantage* (Cornell University Press, 2000), written with Eileen Appelbaum, Peter Berg, and Arne Kalleberg; and *The Double Helix of Education and the Economy* (IEE, 1992), co-authored with Sue Berryman. Dr. Bailey holds a Ph.D. in labor economics from the Massachusetts Institute of Technology (MIT).

Katharine Frase (*Co-chair*) retired from IBM after a 30-year career in 2016. Her career spanned positions in manufacturing, product and process development, strategy, research, and business development. Her most recent assignments were in support of IBM's clients and field teams in the government, cities, health care, and education industries, particularly the application of analytics and technologies such as Watson to provide actionable insights for some of the world's most important challenges. In 2006, she was elected a member of the National Academy of Engineering. Dr. Frase received an A.B. in chemistry from Bryn Mawr College and a Ph.D. in materials science and engineering from the University of Pennsylvania.

David Chu serves as president of the Institute for Defense Analyses (IDA), a nonprofit corporation operating in the public interest. Its three federally funded research and development centers provide objective analyses of national security issues and related national challenges, particularly those requiring extraordinary scientific and technical expertise. Dr. Chu served in the Department of Defense as under secretary of defense for personnel and readiness from 2001 to 2009, and earlier as assistant secretary of defense and director for program analysis and evaluation from 1981 to 1993. From 1978 to 1981 he was assistant director of the Congressional Budget Office for National Security and International

Affairs. Dr. Chu served in the U. S. Army from 1968 to 1970. He was an economist with the RAND Corporation from 1970 to 1978, director of RAND's Washington Office from 1994 to 1998, and vice president for its Army Research Division from 1998 to 2001. He earned his Ph.D. in economics, as well as a B.A. in economics and mathematics, from Yale University.

Rita Colwell is distinguished university professor at the University of Maryland, College Park and Johns Hopkins University Bloomberg School of Public Health, and chairman and chief science officer, CosmosID, Inc. Her interests are focused on genomics, biodiversity, and molecular microbial systematics and ecology. Dr. Colwell is an honorary member of the microbiological societies of the United Kingdom, Australia, France, Israel, Bangladesh, India, and the United States. She served as the 11th director of the National Science Foundation from 1998 to 2004. She has authored/co-authored 19 books and more than 800 scientific publications. She is a member of the National Academy of Sciences and has been awarded the Stockholm Water Prize; the Order of the Rising Sun, Japan; and the U.S. National Medal of Science.

Gary Hoachlander is president of ConnectEd: The California Center for College and Career. Recently established by the James Irvine Foundation, ConnectEd is dedicated to advancing practice, policy, and research designed to help young people prepare for college and career—both goals and not one or the other. ConnectEd's primary mission is supporting the development of multiple pathways by which young people can complete high school; enroll in postsecondary education; attain a formal credential; and embark on lasting success in work, community, and civic affairs.

Having begun his career in 1966 as a brakeman for the Western Maryland Railroad, Dr. Hoachlander has devoted most of his professional life to helping young people learn by doing—connecting education to the opportunities, challenges, and many different rewards to be found through work. Widely known for his expertise in career and technical education and many other aspects of elementary, secondary, and postsecondary education, Dr. Hoachlander has consulted extensively for the U.S. Department of Education, state departments of education, local school districts, foundations, and a variety of other clients. Dr. Hoachlander is also chairman of MPR Associates, Inc., an educational research and development organization closely affiliated with ConnectEd, and is also one of the country's leading policy analysts for the U.S. Department of Education, including the National Center for Education Statistics and the Office of Vocational and Adult Education. He earned a B.A. at Princeton University and holds master's and Ph.D. degrees from the Department of City and Regional Planning, University of California, Berkeley.

Harry Holzer is John LaFarge Jr. SJ Professor of Public Policy at Georgetown University. He has been at Georgetown since the fall of 2000. He served as associate dean from 2004 through 2006 and was acting dean in the fall of 2006. He is currently an institute fellow at the American Institutes for Research, a senior affiliate at the Urban Institute, a nonresident senior fellow at the Brookings Institution, and a research affiliate of the Institute for Research on Poverty at the University of Wisconsin at Madison. He has also been a faculty director of the Georgetown Center on Poverty, Inequality and Public Policy.

Prior to coming to Georgetown, Dr. Holzer served as chief economist for the U.S. Department of Labor and professor of economics at Michigan State University. He was a visiting scholar at the Russell Sage Foundation in 1995 and a faculty research fellow of the National Bureau of Economic Research.

Throughout most of Dr. Holzer's career, his research has focused primarily on the low-wage labor market, particularly the problems of minority workers in urban areas. In recent years, he has worked on the quality of jobs as well as workers in the labor market, and on how job quality affects the employment prospects of the disadvantaged, as well as worker inequality more broadly. He has also written extensively about the employment problems of disadvantaged men, advancement prospects for the working poor, welfare reform, and workforce policy. His current research focuses on disadvantaged students at college and how to improve their academic and employment outcomes. His latest book, *Making College Work* (with Sandy Baum), is forthcoming from Brookings Press in 2017.

Dr. Holzer teaches graduate courses in public policy and statistical methods for program and policy evaluation at the McCourt School, as well as courses on antipoverty policy and on labor market policy. He received his B.A. (1978) and Ph.D. (1983) from Harvard University.

Francine Lawrence was elected executive vice president of the American Federation of Teachers (AFT) by a unanimous vote of the AFT executive council and assumed the responsibilities of the office in September 2011. She ran for reelection in 2012 and served as executive vice president of AFT through July 2014. From 1997 to 2011, Ms. Lawrence was president of the 3,000-member Toledo (Ohio) Federation of Teachers, where she led contract negotiations that focused on what matters most: student achievement. She co-chaired the union and district's Intern Board of Review, which oversees Toledo's peer assistance and review plan; the Toledo plan serves as an example of school reform that works. As AFT executive vice president, she coordinated AFT's Program Policy Councils for Teachers, Healthcare, Higher Education, Paraprofessionals and School-related Personnel (PSRP), Public Employees, and Retirees. She guided the development of AFT's new LEAD initiative, focused

on leadership education and development. She also led AFT's Teacher Preparation Task Force and Small Local Union Task Force.

Ms. Lawrence was a member of the Albert Shanker Institute and AFT Innovation Fund governing boards. She served as treasurer of the AFL-CIO Department for Professional Employees. She served on the United Way USA Board of Trustees and also served on and chaired the Learning First Alliance—a partnership of 17 national education associations dedicated to improving student learning in America's public schools.

Jennifer McNelly serves as president of 180 Skills, LLC, an online technical education experience supporting the nation's manufacturers. 180 Skills offers the only industry-defined, competency-based, high-quality, low-cost solution to advance the manufacturing workforce. Ms. McNelly has extensive experience in workforce development, employer engagement, and business.

Prior to joining 180 Skills, Ms. McNelly was president and executive director of The Manufacturing Institute, the nonprofit affiliate of the National Association of Manufacturers (NAM), where she advanced a national agenda to close the manufacturing skills gap and make manufacturers in America globally competitive. She is a proven leader at the Institute as the chief architect of one of the organization's flagship initiatives, the NAM-Endorsed Manufacturing Skills Certification System. Ms. McNelly is a member of the Senior Executive Service (SES) and served as an administrator for the U.S. Department of Labor's (DOL) Employment and Training Administration. Her strong private-sector experience includes serving as senior vice president of Strategic Partnerships, LLC, an international consulting firm specializing in helping Fortune 500 corporations build strategic partnerships with government agencies in support of workforce development.

In 2012, Ms. McNelly was recognized as one of the 100 inaugural Women in STEM. She is the immediate past chair of the World Economic Forum's Global Agenda Council on Advanced Manufacturing. She previously served as a member of the American National Standards Institute (ANSI) Personnel Certification Accreditation Committee, the Precision Metalforming Association (PMA) Education Foundation, and the SME Education Foundation Board.

Elizabeth Mertz is an associate professor at the University of California, San Francisco, with a joint appointment in the Department of Preventive and Restorative Dental Sciences, School of Dentistry, and in the Department of Social and Behavioral Sciences, School of Nursing. She is affiliated with Healthforce Center, the Philip R. Lee Institute for Health Policy Studies, and the Center to Address Disparities in Children's Oral Health (CANDO).

Dr. Mertz has researched, published, and lectured on a broad range of health professions workforce policy and analysis issues, including supply and demand of providers, health care regulation, state and federal workforce policy, access to care, and evolving professional practice models. She has served on a number of advisory and planning committees for organizations such as the Health Resources and Services Administration, the California HealthCare Foundation, the San Francisco Foundation, and the Institute of Medicine. She is the principal investigator on multiple research grants, including a National Institutes of Health (NIH)-funded evaluation of standardized preventive care to reduce dental disparities in children, a set of studies on workforce diversity in dentistry, and a national center for Oral Health Workforce Research.

Dr. Mertz holds a B.A. from the University of Southern California, an M.A. from the Humphrey Institute of Public Affairs at the University of Minnesota, and a Ph.D. in medical sociology from the University of California, San Francisco.

Paul Osterman is Nanyang Technological University (NTU) professor of human resources and management at the Massachusetts Institute of Technology (MIT) Sloan School of Management, as well as a member of the Department of Urban Planning at MIT. From July 2003 to June 2007, he also served as deputy dean at the Sloan School. His research concerns changes in work organization within companies, career patterns and processes within firms, economic development, urban poverty, and public policy surrounding skills training and employment programs.

Dr. Osterman has been a senior administrator of job training programs for the Commonwealth of Massachusetts and has consulted widely for government agencies, foundations, community groups, firms, and public interest organizations. His most recent book is *Good Jobs America: Making Work Better for Everyone* (Russell Sage, 2011). Other recent books include *The Truth about Middle Managers: Who They Are, How They Work, How They Matter* (Harvard Business School Press, 2009); *Gathering Power: The Future of Progressive Politics in America* (Beacon Press, 2003); *Securing Prosperity: The American Labor Market: How It Has Changed and What to Do about It* (Princeton University Press, 1999); and *Working in America: A Blueprint for the New Labor Market* (MIT Press, 2001). Dr. Osterman is also the author of *Employment Futures: Reorganization, Dislocation, and Public Policy; Getting Started: The Youth Labor Market*; *The Mutual Gains Enterprise: Forging a Winning Partnership among Labor, Management, and Government*; and *Change at Work*. He is the editor of two books, *Internal Labor Markets* and *Broken Ladders: Managerial Careers in the New Economy*. In addition, he has written numerous academic journal articles and policy issue papers on such topics as

labor market policy, the organization of work within firms, careers, job training programs, economic development, and antipoverty programs.

Annette Parker is president of South Central College in North Mankato, Minnesota. In September 2013, she was selected to be on the President's Advanced Manufacturing Partnership Steering Committee. Dr. Parker was one of 19 industry, academia, and labor executives selected, including co-chairs Andrew Liveris, president, chairman, and CEO of Dow Chemical; and Rafael Reif, president of the Massachusetts Institute of Technology. Together, they were charged with identifying policies and initiatives that lead to the creation of high-quality manufacturing jobs.

Prior to moving to Minnesota, Dr. Parker worked for the Kentucky Community and Technical College System (KCTCS), where she served as system director for the National Center of Excellence in Advanced Automotive Manufacturing. The objective of this organization was to create a national, standardized curriculum that supported the needs of automotive manufacturers in 12 states. Dr. Parker brought colleges together with major automakers such as Toyota, Honda, Ford, GM, and BMW to form the standards. The Center later was recognized by the National Governors Association as a national best practice.

Prior to her position at KCTCS, Dr. Parker served as department chair of Manufacturing Engineering Technologies at Lansing Community College in Michigan, where skilled workers were in extremely high demand. GM had committed to building two new assembly plants in the area and needed workers in robotics and automation. The college responded by launching a $48 million campus dedicated to supporting advanced manufacturing.

Dr. Parker herself is a product of on-the-job training combined with higher education. After high school, she spent 11 years working at GM before pursuing an associate's degree in industrial drafting from Lansing Community College. She then continued her education, earning bachelor's and master's degrees in technical education from Ferris State University in Michigan and a Ph.D. in educational leadership from Western Kentucky University.

Susan Sclafani is retired from the Pearson Foundation, which she joined in January 2011 as vice president of programs. Previously, she served as director of state services at the National Center on Education and the Economy. Before that, she was with Chartwell Education Group, an international consulting group. She also served as assistant secretary of education for vocational and adult education from 2003 to 2005 in the U.S. Department of Education (ED). Earlier, Dr. Sclafani was counselor to U.S. Secretary of Education Rod Paige, serving as the U.S. representative to both the Organisation for Economic Co-operation and Development and Asia-Pacific Economic Cooperation.

Dr. Sclafani's passion for the task of promoting and ensuring the highest standards in education was well demonstrated during her tenure at ED. Among the highlights of her tenure there was the leadership role she played in the creation of the Mathematics and Science Initiative (MSI) to focus attention on the importance of mathematics and science in the education of all students. MSI emphasized the need for teachers knowledgeable in math and science at every level of schooling and the importance of further research in both areas.

Dr. Sclafani's international work led to her leadership of the joint E-Language Learning Project with the Chinese Ministry of Education. She also led ED's High School Redesign Initiative to better prepare students for 21st-century education and training and the workplace.

Prior to serving at ED, Dr. Sclafani was chief academic officer of the Houston Independent School District in Texas, one of the nation's largest urban school districts. In that capacity, she focused on a number of areas, including technology, curriculum development, mathematics and science initiatives, and construction management. She also has extensive state education and business experience.

Dr. Sclafani earned a bachelor's degree at Vassar College, a master's degree in Germanic languages and literature at the University of Chicago, and a master of education degree and Ph.D. in educational administration at the University of Texas, Austin.

Mark Tomkins is president and CEO of the German American Chamber of Commerce of the Midwest (GACC Midwest), where in addition to his roles in building bilateral trade and investment between the United States and Germany, he has led GACC Midwest's Skills Initiative to expand the German dual-education model of workforce development in the Midwest and throughout the United States. This has included supporting the creation and ongoing implementation of the Michigan Advanced Technician Training (MAT2) program and initiating the Industry Consortium for Advanced Technical Training (ICATT), which is currently operating in Illinois and Wisconsin. These are the first programs of their kind, where apprentices receive both an associates' degree and a German DIHK certification in various professions, such as mechatronics, industrial maintenance, and product design and visualization, while completing apprenticeships registered to U.S. Department of Labor (DOL) standards. GACC Midwest supports additional training programs at companies in more than 10 states. GACC Midwest's efforts have received recognition from the U.S. DOL, National Governors Association, *Wall Street Journal*, German Federal Government, and many others.

Mr. Tomkins is a frequent speaker in the United States and abroad on topics relating to workforce and economic development. Prior to joining GACC Midwest in 2006, he spent more than a decade in various roles of international trade and economic development.

C

Examples of Sector-Specific Strategies

MASSACHUSETTS: THE COMMONWEALTH CORPORATION

Massachusetts was the first state to formalize sector strategy work and now has more than three decades of experience. In 1981 civic leaders formed a public–private partnership, the Bay State Skills Corporation, to fund local workforce development initiatives across the state in important industries, requiring a 50 percent matching contribution from employers.

The mission of the Commonwealth Corporation is to strengthen the skills of Massachusetts' youth and adults by investing in innovative partnerships with industry, education, and workforce organizations (Commonwealth Corporation, 2014).[1] In partnership with 8 state government offices, 16 regional Workforce Investment Boards, and 10 corporate and foundation partners, it allocated $48.6 million in 2014 to addressing the workforce training needs of businesses, unemployed workers, and youth.

The corporation's Workforce Competitiveness Trust Fund (WCTF) is an example of its partnership model in practice. In an effort to build regional capacity to address the gap between the skills held by unemployed and underemployed workers and the skills needed by employers, the WCTF made grants to 15 partnerships across the state. These partnerships involved more than 100 businesses, as well as regional stakeholders from community colleges, vocational technical schools, community-based organizations, workforce investment boards, career centers, and organized labor.

[1]In 1996, BSSC merged with the Industrial Service Program to form the Commonwealth Corporation, which is a quasi-public corporation of the Commonwealth of Massachusetts.

AUTOMOTIVE MANUFACTURING TECHNICAL EDUCATION COLLABORATIVE (AMTEC)

AMTEC is an example of a large, cross-state sector partnership that integrates federal, state, and private investments in skilled technical workforce development. Established in 2005 with a grant from the National Science Foundation's (NSF) Advanced Technical Education (ATE) program to the Kentucky Community and Technical College System, AMTEC is a collaboration of community and technical colleges and industry partners that aims to prepare technicians and engineers for work in automobile manufacturing and technology. AMTEC is one of 42 NSF ATE centers.[2]

Today AMTEC has 13 active community college and technical education partners and 15 industry partners located across eight states.[3] Industry partners include American, Asian, and German automakers and suppliers and the United Auto Workers. The sector partnership identifies worker skill needs across critical job classifications. Using a career pathway approach, AMTEC develops standardized coursework that is modular, flexible, and relevant to local contexts, and it produces "stackable" credentials. Colleges and organized labor work with manufacturers in their local area to customize training consistent with standardized curricula and credentials.

ARIZONA COMMERCE AUTHORITY

The Arizona Commerce Authority, a statewide economic development organization overseen by a public–private board, established the Workforce Arizona Council (WAC) to strengthen the workforce system and address a variety of industry workforce needs using sector strategies. WAC provides customized, intensive technical assistance to local areas, embedding sector strategies into plans, grants, and guidance for workforce plans, apprenticeships, and career pathway programs.

In 2013, Arizona had active or emerging sector partnerships in 11 counties in a wide range of sectors that depend on skilled technical occupations (see Figure C-1). For example, the Cochise Utilities Sector Partnership was established after the Sulphur Springs Valley Electric Corporation reached out to six other local utilities struggling to fill needed line worker positions. In response, the Arizona Workforce Connection worked with Cochise Community College to develop new courses and a certificate program to prepare local candidates, improve the talent pipeline, and provide long-term jobs for the

[2]For information about the NSF ATE program, see NSF (n.d.).

[3]AMTEC currently has active partners in Alabama, Kentucky, Michigan, Ohio, South Caroline, Tennessee, Texas, and West Virginia. For information on AMTEC, see AMTEC (n.d.).

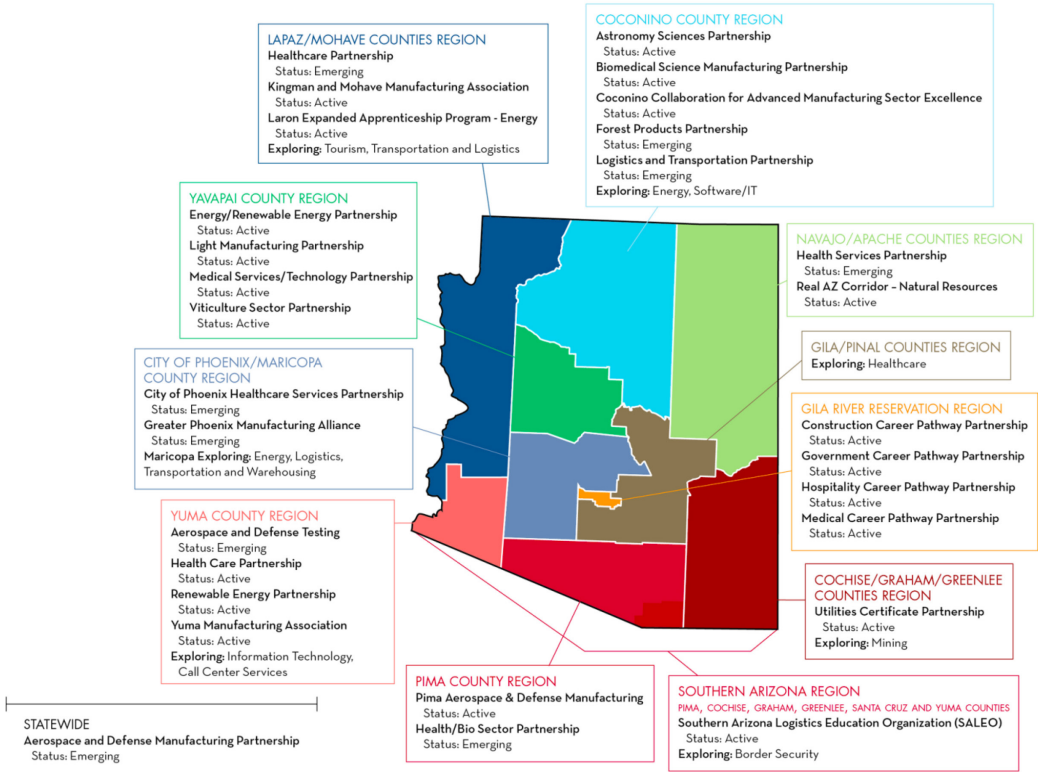

FIGURE C-1 Arizona sector partnerships in 2013.
SOURCE: Shedd, 2013.

community. Similarly, the Coconino Advanced Manufacturing Partnership is an association of 16 of the region's leading manufacturers that identified shared opportunities and requirements for growth in their sector. Working with regional partners to address workforce and training needs, the group has organized quarterly roundtables, developed incumbent worker training programs, and spearheaded a rebranding campaign to develop greater interest in careers in manufacturing (Arizona Commerce Authority, n.d.).