In chapter 2 we reviewed a wide range of issues touching on the nature of work in manufacturing and the challenges that firms face in obtaining the workforce that they need. That chapter drew on a nationally representative survey we conducted of manufacturers, a survey that focused heavily on skill and hiring issues as well as the human resource practices of establishments. Even if there were no problems, it is important to understand the skills that employees will need in the future so that educational and training institutions can better prepare young people and adults looking to obtain manufacturing employment. That said, the national dialogue goes beyond this and has centered on a widespread perception of shortfalls in labor supply and skill gaps among available employees. The analysis in chapter 2 provided a more skeptical and nuanced view of these issues but also identified some concerns. The goal of this chapter is to draw on our fieldwork and data analysis (both of which were described in more detail in chapter 2) to suggest constructive policy responses to these concerns.

We showed in chapter 2 that the concern regarding a shortfall of appropriately skilled workers is not a general issue affecting all manufacturing but nonetheless is a real problem in specific circumstances. About 16 percent of establishments have a significant number of long-term vacancies, and about a quarter have some difficulties obtaining the workforce they require. The firms that are experiencing higher levels of difficulties tend to be smaller, to have demands for skills that are unique in their geographic area, to require relatively more advanced math and reading skills, and to engage in more frequent product innovation. These firms often find themselves cut off from a supply of trained labor that used to flow out of large firms in their region and from local institutions that could help address their needs. Larger firms that have lower levels of internal training and promotion
also experience long-term vacancies, although the vacancies represent a smaller and more manageable percentage of their production workforces. The forthcoming wave of retirements will exacerbate these challenges. In this chapter we propose a number of specific policies that address problems relating to the development and employment of a skilled workforce in the U.S. manufacturing sector. We will also provide an overarching rationale why these particular policies are likely to pass the cost-benefit test.

For manufacturers to ensure access to the workforce they need, all parties involved in the system must commit themselves to a set of actions that move them beyond where they are now. It is very important to be clear about the double-edged character of this message. We will argue for an active public policy response to the needs of firms, and we will also describe steps aimed at improving the performance of educational institutions.

At the heart of our public policy recommendations is an analysis of how a new skill production system has emerged in the United States. In order to ensure that this system meets the skill demands of manufacturers, it is essential to strengthen labor market intermediaries, improve the performance of community colleges and high schools, and reduce the risks associated with manufacturing employment in order to stimulate the flow of young people into the field. To make these steps effective, employers for their part need to commit to work with local schools, be willing to engage with other firms in their area on labor market issues, increase the level of training that they offer to their employees, and rethink a wage policy that has suppressed starting wages to the point where they often compare unfavorably to less skilled service sector employment.

The analysis we present here is based on extensive fieldwork and interviews with firms, public officials, and school systems across the country, and also on a large representative survey of manufacturing establishments that offers the most detailed available evidence on workforce issues and relationships with educational institutions, especially community colleges. (See appendix 2.1 in chapter 2 for details.)

Background

The system by which the United States produces a skilled workforce has changed dramatically since the 1970s and 1980s. This is particularly true for the manufacturing sector. During this time period, American
manufacturing shifted from a regime in which skills were produced in a context of larger plants, long job tenure, thick internal labor markets, and internal corporate training to a context of smaller establishments, shorter job tenure, reduced job ladders, and external training conducted by various institutions and intermediaries.

The average size of manufacturing establishments has declined significantly over time and the number of very large plants located in the United States has fallen precipitously (Henly and Sanchez 2009; Holmes 2011). This decline in size has changed the economics of internal company training. Smaller establishments realize fewer economies of scale in training and consequently have more difficulty in providing both formal and informal training.

Another critical factor that has shaped changes in training and skill development in manufacturing is the rise in uncertainty and volatility in employment. In an environment of higher turnover and less job security, firms have less time to recoup their internal training investments, whereas workers are more cautious about up-front investments in new skills (e.g., financing apprenticeship training via lower initial wages).

American communities, industries, and workers are in the process of adapting to this new world. A new skill production system is emerging that relies heavily on training provided by external actors such as community colleges or job training programs. It is not uncommon for multiple companies to work with local two-year colleges, nonprofit training providers, and government agencies to design and implement training for incumbent and potential workers. The financing for this training comes from myriad sources, including firms, colleges, government at all levels, foundations, and workers themselves. In some areas of the country, this system is very advanced and has been in place for many years. In other regions the new system remains stunted and has thus far failed to fill the gaps left by the dissolution of the old training regime.

The key observation about this new training regime from a public policy standpoint is that it vastly increases the number of independent actors who must collaborate to produce a skilled workforce. Because the new system has so many moving parts, it is much more subject to market failures than the old system. The first problem is one of coordination. Individual actors respond to different incentives and are free to pursue their own objectives and strategies. If the actors all pursue conflicting strategies, the new system will fail to efficiently produce
skilled workers. The second problem relates to the level of investment (or effort). No one actor in the new regime can completely internalize the benefits of contributing to an efficient skill production system. This is a classic public goods externality that will lead to underinvestment in skill production by key actors in the system. To use a metaphor: the first problem is to get everyone rowing in the same direction (coordination), and the second is to get everyone rowing with compatible strength and intensity (public goods production).

The principle that underlies all of the policy recommendations we offer in this chapter is that these recommendations are specifically designed to remedy one or both of the two market failures that disproportionately characterize the operation of the new skill training regime. Furthermore, these policies are likely to be ones in which benefits exceed costs because they apply not only to places that have failed to develop a viable new external training system. Even in the areas where this new system is more advanced, it requires much more maintenance than the old system. It is like a garden that requires constant tending lest one key element in the environment deteriorate. Unlike an internal corporate training system in which training incentives are more aligned by default, the new system contains the constant possibility that wedges will emerge among the needs of employers, the content of training curricula, and the goals of students. Thus the recommendations we make in this chapter are as relevant for regions with advanced external training as they are for areas that lag in this regard.

**Making connections**

A core explanation of why some firms face challenges in obtaining skilled workers is that they lack effective connections to an ecosystem of what might be termed *skill suppliers*. The consequence is a recurrent pattern of poaching employees from one another or else engaging in suboptimal work organization and production because of labor supply issues.

The best example of an effective ecosystem is perhaps the German dual apprenticeship system. As is well known in Germany, employer associations, unions, and the government work together to establish a national curriculum in vocational skill training, and a majority of German youth spend the latter part of their high school years in a mixture of classroom and on-the-job apprenticeship training. All observers agree that the training is high quality and that the skills that
it produces are an important source of German competitive advantage. It is notable in this regard that when German firms, accustomed to being deeply embedded in a well-developed skill-providing environment, come to the United States, they often seek to replicate the German environment as much as possible given local constraints (Furmans 2012).

Having said this, it is not realistic to attempt to replicate the German model here. The United States lacks strong employer associations and strong unions. In addition, there exists no national consensus that would enable such a uniform system, not least because no consensus exists that such a system is even desirable. Nevertheless, as we will describe shortly, the United States is not without resources, and the community college system is an important source of potentially high-quality skill training. However, there remains a significant issue of how to better connect firms to each other and to educational institutions in order to stimulate the supply of skilled labor. We believe that there is a central role to be played by labor market intermediaries and that encouraging and diffusing the intermediary model would be a very positive step forward.

In general terms, a labor market intermediary is an entity or organization that connects labor market actors to each other. In addition, the intermediary may undertake activities, ranging from collecting information to fundraising to policy advocacy, that are public goods and hence are not likely to be undertaken by any given organization operating on its own. Intermediaries are the glue that holds a disaggregated skill system together; they enable the type of feedback that overcomes coordination failures. As we will see shortly, intermediaries can range from employer trade associations to local government employer boards to private nonprofits devoted to economic growth or job creation.

It is instructive to examine what happens in the absence of intermediaries. As an example, we interviewed a wire cage manufacturer that had succeeded in securing high-margin aerospace contracts. This firm, however, had great difficulty hiring skilled production workers. Although the firm is located in a large metropolitan labor market with a substantial number of different types of educational institutions, it is not part of a cluster, and it does not have the size to draw the attention of regional community colleges.

The consequence of the firm’s isolation was an inability to hire, which, when combined with a fear that internal training would lead to
poaching by other firms, created a labor force crisis. The best solution for this employer would be to make common cause with firms in other area manufacturing industries that need somewhat similar skilled production workers. Together, these firms might have the combined aggregate demand to justify the creation of a targeted community college training program. The problem was that there was no institution or mechanism that could bring this about. Addressing this challenge is the reason that intermediaries need to be diffused, strengthened, and supported.

In our fieldwork we identified several best practice examples of intermediaries. What is striking about these cases is that although they share a good deal in common in terms of activities and impact, they differ in their organizational form and the auspices under which they are organized.

**An employer-driven intermediary: Rochester, New York**

Rochester, New York, is home to one of the premier optics clusters in the world. Kodak, Bausch and Lomb, and Xerox were all founded in Rochester, and during much of the twentieth century they, along with other optics and photonics firms such as Corning, were the regional employment leaders. At its height in the early 1980s, Kodak employed more than sixty thousand workers in Rochester. In the early 1960s, Kodak worked with Monroe Community College (MCC) to create a two-year associates program to produce optics technicians. The program provided training in physics and engineering topics related to optics, and it prepared individuals to perform jobs such as the operation of sophisticated lens grinding and polishing equipment. For decades, Kodak essentially underwrote the program, filling its classes with Kodak apprentices. There were spillover benefits as well. In addition to the students following a career path at big employers such as Kodak, some of the graduates of the program went on to lead innovative small optics companies in the area. However, because of industry shifts and poor business decisions, Kodak’s fortunes declined. Employment fell consistently during the 1990s, and today the company employs only a little more than five thousand workers in Rochester. As Kodak experienced these shocks, it pulled back from the relationship with MCC and the apprenticeship program. By the mid-2000s, the program had only a handful of students, and MCC was considering shutting it down. The University of Rochester had already closed its optics
manufacturing center, despite the fact that the program had launched a number of successful optics companies. The irony was that, despite Kodak’s decline, the Rochester optics cluster was actually doing well. Many small firms had grown up over the years and were thriving. These include companies that produce lenses for 3D movies, components for the semiconductor lithography process, and sophisticated glass grinding and polishing equipment. These firms wanted to hire skilled optics technicians, and they were alarmed at the decline of the MCC program and the possibility that the program would be permanently shuttered. However, no individual firm had enough capital or volume of hires to be a “market maker” for the MCC program. Furthermore, individual firms had idiosyncratic needs. Building the curriculum too closely around any one of these firms would have excluded others. Ultimately, the firms were not able to speak clearly with one voice, to aggregate their demand, or to provide coherent feedback to the community college system. Lack of coordination rather than lack of market demand was on the verge of killing a key element of Rochester’s skill production system.

The outcome of this story points to one type of solution to coordination failures in skill production systems. Around the time that MCC was thinking about closing the optics program, a dynamic individual took over the leadership of an industry group called the Rochester Regional Photonics Cluster (RRPC). This individual realized that unless the small- and medium-sized enterprises that now characterize Rochester’s optics industry joined together, the industry would lose an important element in the skill production system, one that could not easily be replaced. The RRPC joined together with an energetic leader of one of the local optics firms and convinced MCC to give the program another chance. A new advisory board composed of leaders of small- and medium-sized optics firms was established. The RRPC and executives from small optics firms also began working with local high schools to ensure a flow of students into the new program. Over the years, high school guidance counselors had lost knowledge of viable optics careers as the locus of the industry shifted from visible corporate giants such as Kodak to small specialty firms such as Optimax or OptiPro. RRPC also helped convince Corning to make a $500,000 donation to the program for new facilities and equipment. One of the small firms, Sydor Optics, followed this with an additional $250,000 donation. In short, various firms in the area had demand for MCC graduates, interest in the program, and even willingness to donate funds, but they
lacked coordination. What was required was an intermediary—in this case the RRPC—that could overcome the disaggregation of the various actors.¹

A workforce board intermediary: Springfield, Massachusetts

Springfield, Massachusetts, is a region with a long and rich history of manufacturing, particularly in the machine tool industry. In 2011 the region was home to forty-two precision manufacturing firms with just under four thousand employees (Regional Employment Board of Hampden County 2012). Up until recently the smaller firms in the area were able to obtain a skilled workforce by taking advantage of the apprenticeship training provided by larger companies such as Lennox and United Technology as well as the Springfield Armory. In the past, a sufficient number of employees who received this training went to work at smaller manufacturers due to a preference for a smaller environment or the hope of eventually striking out on their own. The firms we interviewed all reported that although this system worked well for some time, it eroded as the larger firms cut back on internal training and also became, in the words of our interviewees, “design and assembly” operations with less emphasis on actual production. The consequence, much as in the Rochester case, was a shortfall in skilled labor.

For a period of time this shortfall was addressed via a training institution established by the local chapter of the National Tooling and Machining Association (NTMA). The training school was funded by a grant from the U.S. Department of Labor, and when that grant was not renewed, firms found themselves at sea. For reasons laid out previously very few firms were willing or able to mount their own internal training and instead, according to our interviews, reverted to what was termed the “standard” behavior of trying to steal recruits from each other.

Faced with this situation the NTMA approached the Hampden County Regional Employment Board (REB). The REB is a public intermediary and is mandated by federal job training legislation to represent firms, government, and educational institutions in the operation of the Workforce Investment Act of 1998. The actual performance of these REBs is very uneven across the country, with many acting as mere funding conduits with little proactive behavior (Barnow and King 2003). The Hampden County REB had a quite different attitude. In 2005 it began the complex process of connecting firms to local educational
institutions and of encouraging these institutions to build up their offerings in relevant curriculum tracks. Just as the firms were disconnected from the educational institutions, the schools themselves were passive in their relationships with employers. In some schools individual staff members in particular departments had relationships with firms, but schoolwide commitments and connections were weak. REB staff met with all NTMA member firms as well as with five vocational-tech high schools and two community colleges. These meetings were aimed at collecting data about needs of firms and the curriculum, actual and potential, in the schools. The result of this process was a memorandum of understanding crafted by the REB and signed by all of the firms and schools. REB staff personally traveled to all firms and schools to get the signatures on the memorandum of understanding to ensure commitment.

As a result of this process the Springfield REB has built a substantial set of programs and activities aimed at meeting workforce needs in the precision manufacturing sector. One set of actions involve data collection: surveys of firms on hiring needs and data collection on enrollment in high school and community-college manufacturing programs. Until the board undertook these, there was no information available on the balance, or lack thereof, between supply and demand of relevant skills. The board has also connected employers directly to schools in order to improve curriculum and to assist in job placements. This has taken the form of encouraging meetings and also of creating a more formal process that strengthened school advisory councils and placed employers as the chairs. In addition, the board organized a training program for supervisors in member firms, funded and managed a dislocated worker training program in machining skills, and organized career fairs and firm visits in order to increase the interest of high school students in manufacturing careers. Due to the actions of the REB, manufacturing firms in the region are now organized, cooperative with each other, and proactive in their stance toward schools and their own workforce needs. The REB has thus helped solve a fundamental coordination problem in the Springfield skill production system.

A community nonprofit intermediary: Cincinnati, Ohio

Partners for a Competitive Workforce is an intermediary that was initiated by the Greater Cincinnati Foundation in 2008 and is, as of 2013, housed and managed by the Cincinnati United Way. It is supported
locally by various funders and nationally by the National Fund for Workforce Solutions. The organization works on labor supply issues in a tristate area of southwest Ohio, northern Kentucky, and southeast Indiana. Manufacturing is one of several industry foci, along with health care, construction, IT, and finance.

The organization supports manufacturing curriculum and certifications at local community colleges, as well as at other sites such as community-based organizations. Partners has arranged for local firms to promise a modest hourly pay supplement for new hires and incumbent workers who obtain these certificates. Second, Partners has worked with several firms to start internal apprenticeship programs and has provided subsidies to the firms that have launched these. Finally, just as is true in Springfield and Rochester, Partners is working with local schools on career exploration programs aimed at increasing the flow of young people interested in manufacturing careers.

Despite these successes, Partners does face challenges that reflect the issues confronting manufacturing workforce development throughout the country. Starting wages in local manufacturing establishments are low and fairly stagnant, and this fact, along with the sometimes negative image of manufacturing, discourages new entrants to the workforce. Employers become engaged in activities of Partners only when they themselves feel under immediate pressure, and, as a consequence, it is hard work to develop forward-looking proactive programs. Asked whether they could double their activities if their budget were magically increased, Partners staff expressed doubt largely because of the difficulty of obtaining broad employer engagement.

With these examples in mind we can see that there is no single model of an effective intermediary, and they vary by auspices as well as by sources of support. Indeed there are more models than we have described here (Hunt 2012). What all effective intermediaries do have in common is that they solve problems involving coordination or public goods production. However, the market will not automatically produce intermediaries that solve these market failures. As a result, there is a role for public policy in terms of either launching the intermediary or providing at least some of the necessary resources, or both.

Intermediaries typically do not directly provide training but rather connect employers to the educational institutions in their regions. For this process to be effective there need to be institutions whose curricula and educational capacities can meet the requirements of local manufacturers. In other words, in order to create a viable skill production
system, communities not only need mechanisms that can overcome the market failures that characterize the new skill training regime but they also need the raw material of the skill production system: high-quality and flexible educational institutions. Community colleges are one of the best examples of these necessary institutions, and it to these that we now turn.

Community colleges

Community colleges have emerged as one of the most central institutions for training the new manufacturing workforce. They are, of course, not the only institutions devoted to developing skills. In parts of the country technical high schools remain strong, and in some communities nonprofits and community-based organizations directly provide training. However, community colleges tend to be the dominant players in the design and delivery of industry-focused, high-skill training for several reasons. First, community colleges have much greater scale and resources than nonprofit training providers or other training institutions. Second, community colleges often have a culture of openness to multiple stakeholders. Many community colleges strive to include employers in their course designs and to solicit employer feedback concerning the quality of their graduates’ training. At the same time, community colleges take seriously the demands and concerns of local officials and parents. This institutional openness means that individuals and organizations that seek to adapt worker training for a new economic environment are frequently able to interact with the community college system in a way that is not possible with, for example, the local high school system.

There are over 1,100 U.S. community colleges that enroll over seven million students in credit-bearing courses (National Center for Education Statistics 2008). Among students who are enrolled for credit, most are in degree programs, but a substantial minority seeks certificates. We are not sure how many students are enrolled in noncredit community college courses, on topics ranging from the directly vocational to the recreational, because not all states keep data on these enrollments. However, experts agree that the numbers are close to those in credit courses. Hence, roughly twelve million people are enrolled in U.S. community colleges (Osterman 2011).

In two-year degree programs over half of enrollment is in occupational fields, and virtually all certificate programs, either of the credit
or the noncredit variety, are occupational (Bailey et al. 2004). Returns to community college education, either for obtaining a two-year degree or for earning a shorter certificate in a specific field, are substantial. For AA degrees, the returns range from 13 to 38 percent, depending on the population in question and the field of study.³ The research on the rates of return to community college certificates is thinner but still leads to impressive conclusions. According to a recent report by the Center on Education and the Workforce, 12 percent of adults hold certificates, and the rates of return to certificate holders are as high as 20 percent for high school graduates. In these data, individuals who hold certificates in metalworking earn about the median among all certificate holders (Carnevale, Rose, and Hanson 2012).

To get an idea of the role played by community colleges it is helpful to take a look at best-practice cases. In choosing these cases, we focus not simply on individual community colleges but rather on community colleges that have effective institutional relationships that extend beyond the walls of the community college itself. Specifically, we highlight McComb Community College in Michigan and its relationship with the federal Advanced Technical Education (ATE) program, as well as the BioNetwork in North Carolina.

McComb is a community college located just north of Detroit. Over the years, the college has been hit hard by the shocks that have affected Detroit’s auto industry. The number of apprentices from Chrysler taking courses at McComb declined from one thousand to ninety since the early 2000s. The college has demonstrated its flexibility in filling niches in the skill gap system by shifting its focus to producing more workers for small- and medium-sized enterprises. McComb has also continued to bring knowledge of advanced technical processes into the region. Through the federal ATE program, McComb learned about a high-tech auto curriculum in California and now partners with California institutions to implement it.

The ATE program is important not only for McComb but also for other community colleges seeking to improve their relationships with manufacturing firms. It began in 1992 and supports manufacturing curriculum development in more than thirty community college–based centers throughout the country. We interviewed centers in Michigan, South Carolina, and Connecticut. It was clear from these interviews that the program is effective in improving the quality of curriculum materials in area community colleges. In addition, by using ATE support, schools are able to experiment with new delivery methods
such as providing internships during the academic year and summer break. McComb is effectively using the program to adapt to changing needs and gaps in the region’s skill production system. More extensive assessments of the program also support its efficacy (Lloyd 2013).

The Research Triangle Park (RTP) area in Durham, North Carolina, is home to a world-class biopharma cluster. Unlike some other biotech and pharmaceutical clusters, however, RTP combines a substantial amount of manufacturing alongside cutting edge research. It is in this context that the story of North Carolina’s BioNetwork is instructive. BioNetwork is a program that links North Carolina’s community colleges by providing shared biotech workforce training services. As the director of the BioNetwork noted, BioNetwork exists because there are fifty-eight community colleges in North Carolina that “need it but cannot individually support it.” In 2011, the BioNetwork trained more than 4,300 students in short classes. More than 80 percent of these students were incumbent industry workers. In many cases, the training is branded by the local community college and delivered by one of BioNetwork’s contract instructors. BioNetwork also conducted outreach to thousands of middle and high school students regarding the biopharma industry and potential career paths. Ultimately, BioNetwork is an “efficiency enhancing measure” that “saves duplication and provides resources to smaller colleges.”

One of the BioNetwork’s latest initiatives is a mobile unit—essentially a big recreational vehicle—that contains lab equipment and fume hoods for biotech skill training. By deploying this unit, BioNetwork can serve North Carolina firms on-site without disrupting production. The net result is that North Carolina’s community colleges and their associated institutions—such as BioNetwork—are able to fill a wider range of gaps in the new disaggregated skill production system than in states that lack such a diverse group of flexible institutions.4

Challenges facing community colleges: Findings from the survey

The rates of return to achieving a community college degree or certificate are high but the community college system as a whole faces significant challenges (Belfield and Bailey 2011, 46). The community colleges are themselves subject to coordination failures. There often exists no coherent community college “system.” In fact that the use of the term system is misleading in that community colleges are governed at the state, not national, level. Moreover, within some states
community colleges are often fairly autonomous within their own funding districts. The fact that one innovative or responsive community college exists in a given region is no guarantee that the other community colleges that serve the region will have high-quality or complementary offerings. In addition to inconsistency, community colleges suffer from very high student dropout rates, a challenge that concerns all community college programs, not just those in manufacturing (Integrated Postsecondary Education Data System).5

Despite the importance of community colleges, there has been little data on the relationship between manufacturing firms and community colleges. The MIT Production in the Innovation Economy (PIE) manufacturing survey of nearly nine hundred nationally representative manufacturing establishments includes a rich set of questions on this relationship in order to determine the nature of the role that community colleges are currently playing with regard to the training of manufacturing production workers (the survey is described in detail in chapter 2).

The coverage areas of community colleges are quite substantial. Eighty-eight percent of establishments in our survey reported that a community college served their area. However, actual contact between community colleges and manufacturers is somewhat less extensive. Among manufacturing establishments that had a community college in their area only 49 percent reported that they had had discussions with the community college regarding training or hiring core production employees. When we ask about an actual relationship the numbers fall further. Among the 49 percent reporting some type of contact, 43 percent report that they have had a community college deliver training for experienced core employees, and 18 percent report that they have had training delivered for new hires or potential recruits.

The net result of the survey is that only 21 percent of all establishments have ever had a community college deliver training to core production employees. Thus, although community colleges are regarded as critical institutions for the training of highly skilled workers, a substantial majority of U.S. manufacturers do not rely on community colleges for training.

The picture improves when we ask whether the establishments that do use community colleges are satisfied. Eighty-nine percent report that the community college was very or somewhat helpful. Thus manufacturing establishments that actually work with community colleges are overwhelmingly satisfied with the quality of services that they
receive. Another way of approaching these issues is to focus on the opinion of manufacturing establishments about community college-trained workers as opposed to opinions about the institutions themselves. Of those establishments with direct experience of community college applicants, 81 percent reported that they feel the general academic skills of community college applicants for core production positions were either good or very good, and 50 percent felt the same way about job-specific skills. Of course these findings must be set against the fact that 37 percent of respondents with a community college in their area said that they had no community college–trained applicants.

Responses about the quality of communication between firms and community colleges were concerning. Overall, 57 percent of respondents did not believe that the local community college did a good job of communicating with industry employers. This result points to the importance of the types of intermediaries discussed previously.

We can gain further insight into the dynamics of community college training by analyzing the relationship between the incidence of this training and establishment size. The probability that a manufacturing establishment will use a community college to train its employees rises substantially with the total size of the entity. Among establishments with fewer than fifty employees, only 14 percent have arranged for community college training. This compares with 44 percent of establishments with 100 to 499 employees and 59 percent of establishments with five hundred or more employees. Thus, any given small establishment is much less likely to access one of the key resources in the new skill production system: community colleges. To the extent that we have seen a decline in the average size of establishments over the past few decades, and to the extent that manufacturers have reduced the level of internal training they once provided, these results indicate that over time there may be a class of smaller manufacturing employers who will face significant challenges in accessing the new skill production system.

Taken as a whole, these results are very consistent with the themes that characterize the new skill production system. Employers tend to be favorably impressed with community colleges, particularly with regard to the general skills that these institutions impart. They have somewhat more reservations about the quality of job-specific skills, but half of manufacturing establishments still rate these skills as good or very good. What is more striking is the fact that many employers do
not have relationships with their local community college, and many do not receive any community college applicants for positions in their plants. These results point to the possibility that certain segments of the manufacturing industry experience information or coordination failures with regard to their participation in the skill production system. This possibility is reinforced by the fact that questions regarding communication elicited significantly more negative responses than questions regarding skills or quality. Ultimately, the challenges of managing a disaggregated skill production system may be even more important than the particular content of the training curriculum.

High schools

A great deal of energy at the national level has been directed toward school reform, and it probably fair to say that more attention has been paid to the lower grades than to high schools. Nonetheless high schools certainly merit attention. The quality of high school education and graduation rates include far broader challenges than issues concerning manufacturing, but they are relevant because many of the young people at risk are potential candidates to enter into manufacturing careers.

One of the findings of our research is that, even in areas with strong community college systems such as North Carolina and Ohio, there are many employers who are looking for workers with a skill level that is below that of a two-year college graduate but above that of a typical high school graduate. In some cases, community college certificate programs may fill this need, but in other cases it may be much more economical— and effective—to involve high schools in producing the required skills.

A broader discussion of the role of high school career and technical education is complicated by the need to take seriously the argument that, as the dismal average earnings of high school–only employees shows, postsecondary education should be encouraged whenever possible. This concern is given heightened resonance by the fear that telling some students that they should stop their education with vocational high school training harkens back to a social class (and race)–based era of tracking and stratification.

These concerns are valid but need to be weighed against several other considerations. First, there exist some high-quality vocational and technical high schools providing levels of training that rival community college certificate programs and perhaps some community
college degree programs. An example of such a school is Greater Lowell Technical High School (GLT) in Tyngsboro, Massachusetts. GLT is a large vocational-technical high school with a strong record of placing students into jobs. Firms from as far away as Rhode Island regularly approach GLT placement staff often bypassing other closer vocational schools. Part of GLT’s success relates to top-quality facilities and advanced curricula. For example, according to GLT staff, the auto tech curriculum that GLT uses in its full-sized auto garage is the same as the curriculum used in Southern New Hampshire University. Part of the school’s success is also attributable to the general advantages of the Massachusetts vocational high school system, which involves significantly more time spent in applied learning on the job than other states’ systems.

The biggest part of GLT’s success, however, is due to its personalized approach to learning. Rather than just focusing on the skills of a given career, GLT goes out of its way to counsel students, track their progress, and offer them opportunities for leadership and management. The school runs a special preparatory camp for underprepared students before entering ninth grade. Students are required to commit to spending a certain amount of time with mentors and guidance counselors, and this time is tracked. Most important, when the various programs in the school engage in any sort of production work, GLT seeks to have students manage the project. For example, in recent school renovations, computer-aided drafting (CAD) students were responsible for soliciting specifications and drawing up plans. Likewise, students manage the on-campus restaurant. GLT has a variety of programs serving area manufacturers, including machining, metal fabrication, CAD, and electronics. The combination of high-quality applied learning and person-centered leadership development has enabled GLT to serve the skill needs of area employers and to put at-risk youth on viable career tracks.6

Unfortunately, most communities do not boast high-quality vocational-technical high schools. The larger point we wish to make is that the type of training required to produce highly skilled production workers does not have to take place in rarefied and expensive four-year college settings. Other options, ranging from community college degrees and certificates to high school programs to high-quality job-training programs, all merit consideration. One effective example of how to accomplish this is the early college high school model in which high school students take community college-level courses during part

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of the week and earn college credit in doing so. Evaluations of this model suggest that it substantially increases graduation rates among at-risk students and also increases postsecondary attendance as well as skills acquisition (Le and Frankfort 2011; American Institutes for Research and SRI International 2009). Other school districts have experimented with somewhat different models that link high schools and community colleges, and that include an element of skills training (Baker 2012).

Although high schools deserve more attention than they have received as part of the manufacturing workforce training system, as institutions high schools often exemplify the challenges facing disaggregated skill production systems. In our interviews, it was notable that many employers said they had no contact with local school administrators, and others said that their attempts at making contacts had gone unanswered. Thus one positive goal is to find ways to create a feedback loop between metropolitan school systems and local employers. In Rochester, an intermediary serving the local optics industry has helped to create such a feedback loop by working with local science teachers to develop early college optics programs and optics laboratories.7

Another initiative that attempts to overcome the isolation of high schools with respect to industry-relevant curriculum development is Project Lead the Way (PLTW), an organization that provides science, technology, engineering, and mathematics (STEM) curricula to high schools and middle schools. PLTW is in nearly five thousand schools nationwide and has a rigorous project-oriented approach that has shown promising results. Evaluations suggest that students in PLTW programs have shown better test performance, better attendance, more interest in college, and more willingness to take STEM subjects in college than comparable students (Tai 2012).

There is clearly a balance to be maintained here. School systems are responsible for general education, and it would be a mistake to tie the incentives of schools too closely to an overly specific agenda or the idiosyncratic needs of particular companies. However, by the same token, general education that leads to neither college nor a job is problematic.

**Priming the pump: The manufacturing workforce**

Many employers believe that they simply cannot convince people to work for them, and national associations echo these worries. When
firms express concern about their difficulties in attracting the workforce and skills that they require, they often point to the reluctance of young people and their parents to consider manufacturing as a career. With remarkable consistency, employers say that manufacturing has acquired a “bad rap.” They state that today’s youth mistakenly believe that manufacturing jobs are hot, dirty, and dangerous. Alternatively, if the work environment is in fact physically challenging, one hears that the work ethic of today’s youth has declined. It is also commonly asserted that parents and high school guidance counselors irrationally steer students away from viable careers as skilled production workers.

One issue concerning the flow of employees is the frequently heard concern that too few students are enrolled in STEM courses and that math capacities are declining. Perhaps surprisingly, research shows that there has been no decline in STEM education, and in fact there has been an increase (Carnevale, Smith, and Melton 2011). When it comes to math skills, the National Assessment of Educational Progress found in its most recent (2008) long-term trend assessment that the math achievement scores of nine- and thirteen-year-olds have improved since 2004 and the scores of seventeen-year-olds have held steady (Rampey, Dion, and Donahue 2009).

Our survey also gives reason to doubt that an inadequate flow of workers is the central issue. In our data only a quarter of the establishments experienced long-term vacancies that they could not fill, and only 16 percent experienced high levels of these vacancies. In addition, in response to a question about what the primary reason for long-term vacancies was, only 5 percent of respondents selected “too few candidates apply.”

In light of this evidence, these employer complaints lack a certain face validity. In today’s environment of high unemployment and scarce jobs, why would people turn away from firms that do offer opportunities? Notwithstanding what we regard as strong reasons to be skeptical of these complaints, we have come to believe, based on our fieldwork and the evidence from our survey, that there is some truth to them in certain situations. We base this conclusion not simply on firms expressing their concerns, of which we also heard many, but also on observed actions or lack of actions by employers and young people. As examples, consider some of the high-quality manufacturing vocational training programs that we examined: the mechatronics program at McComb Community College and the advanced technology education programs in South Carolina and Connecticut. In these programs, students receive
strong training in modern manufacturing skills, and in both cases the graduates of the program consistently obtain good jobs. Yet in both cases there are empty seats. Additional evidence of a problem of too few applicants is the time that managers in the firms we interviewed spent visiting schools, holding career fairs, hosting tours, and engaging in other actions aimed at attracting students. Time is money, and unless these firms actually faced challenges, it is not plausible that they would invest so much in these activities.

All of this forces us to return to the core issue: why is the supply of labor to these jobs sometimes restricted? Why are some students, their parents, and their school counselors not as enthusiastic about manufacturing employment as one might expect? A reasonable hypothesis is that the reluctance is a reflection of the poor employment prospects and risk in the industry. Consider that between 2000 and 2010 manufacturing employment fell by one-third (Bureau of Labor Statistics). Given this fact, it is entirely understandable that students and their parents would be leery of a mechatronics training program, even if it had the potential to lead to a relatively high-paying job. Furthermore, although many manufacturing jobs have the potential to end up at a decent rate of pay, many start at low rates in the $12 to $15 per-hour range. When students look at the fact that some level of job tenure is required to become fully productive (and hence move into the $20+ per-hour range), and the fact that the job they are training for may not exist in five years, the payoff to attending a two-year community college manufacturing program—or even obtaining a nine-month certificate—becomes somewhat unclear. The risks facing new entrants in the field are very real and cannot be mitigated by any single employer. There are, however, public policies that can alter the calculations that may bias young people away from manufacturing careers. A potential package might include part-time unemployment insurance (so-called short work) and improved training for dislocated workers.

The core challenge is to find ways to cushion the consequences of volatility and job loss. The idea behind part-time unemployment insurance is that a firm can choose to reduce hours and engage in work-sharing instead of laying people off. For those employees whose earnings are reduced because they are now part-time, the unemployment insurance system will pick up the difference. This option has long been available to states in America, and currently twenty-three have adopted it, but it has not been taken up aggressively nor publicized to employers. This is unfortunate because in a careful study of those states
that have adopted the program, Katherine Abraham and Susan Houseman show that the short-work option succeeded in reducing manufacturing unemployment (Abraham and Houseman 2012). Recent legislation extending the payroll tax cut included several steps aimed at encouraging and subsidizing states to adopt or expand the program (Abraham and Furman 2012). One of the attractive features of short-work policies is that they have the potential to subtly influence firm training and hiring decisions. By lengthening average job tenure, these policies can lengthen the time period over which firms can recoup training investments, thus potentially incentivizing greater levels of training. In addition, longer job tenure lowers the risk of paying higher wages up-front because there is more assurance that a given employee will be around long enough to gain the specific skills necessary to attain full productivity.

Short work can ease the burden associated with temporary layoffs and can delay permanent layoffs. But fundamentally it is a response to cyclical volatility and not a solution to the risks associated with long-run, or secular, shifts in labor demand. Workers with a substantial amount of tenure (three years or more) suffer earnings losses on the order of 20 percent after losing their jobs if they are lucky enough to obtain new work, and many do not even manage this (von Wachter 2010). In contrast to widespread skepticism, however, there is some evidence that for many dislocated workers—particularly those who take technical courses—retraining can raise earnings (Brookings Institution). Enabling dislocated workers, many of whom are not eligible for Pell grants, to access substantial amounts of training in community colleges and other appropriate settings, would be a positive step forward. It is important that the quantity of training truly be substantial and that any reforms move us beyond the short-term training and job-search assistance that characterizes most current efforts (Brookings Institution).

Taken together, the combination of short work and retraining opportunities should ease some of the concern young people, parents, and school counselors feel about the prospects of entering an uncertain and volatile industry. The key point is that to the extent we want individuals to make investments in the skill sets demanded by volatile industries in a context of rapid technical change and globalization, we should design institutions that reduce some of the individual risk entailed in these investment decisions. Having said this, short work and retraining are only partial, and in some instances short-run,
solutions to the inherent insecurity of manufacturing. Other approaches, such as wage insurance, are probably not feasible and so improving the health of the overall manufacturing sector is likely the best long-run solution.

The potential for certification standards to improve labor supply

Concern about skill shortages in manufacturing has heightened interest in a national program of skill credentials. The core idea is to develop a system of nationally recognized, stackable, modular skill certifications that students obtain and that employers use in their hiring and promotion practices. Certification systems typically involve identifying particular skills or packages of skills that are demanded by employers. The systems specify a training curriculum and a testing procedure that will indicate mastery of the skills in question. Examples of target skills could be particular types of metalworking skills or more general safety or quality skills. President Obama endorsed the concept in a speech at Northern Virginia Community College, and the broad-based nature of the effort is apparent in the impressive range of foundations, employer associations, and nonprofits that have involved themselves in developing and supporting standards (White House Office of the Press Secretary 2011). Given this depth of support, it is important to think carefully about the contributions of the credentials effort to solving the broader challenges presented here.

Efforts to establish a skills credentials system are not new. In 1992, the Department of Labor established twenty-two pilot credentials programs, and in 1994, the Goals 2000: Educate America Act created the National Skills Standards Board with the mandate to develop and market standards across a wide spectrum of industries. The skill standards movement resonates for several reasons. First, it parallels the effort to improve K–12 education via standards, and because there is wide agreement among education experts that standards represent a fruitful strategy, it is an easy step to apply that notion to other arenas. Second, other nations, notably Germany, have had a great deal of success in developing a high-quality manufacturing labor force via a complex system of which standards are a central component.

Our assessment of the certification movement is that there are reasons to hope that the project can improve the quality of the manufacturing workforce, but, at the same time, it is important not to oversell the effort as the centerpiece of an overall workforce strategy.
Certifications can be helpful but have to be seen as just one component of a much more comprehensive strategy.

The main challenge to the effectiveness of certification is low employer use of the system. Because the system is voluntary, the incentive to use the system at the individual firm level must be strong. However, there are several reasons why many manufacturers will likely opt out. First, it is not the case that the U.S. has no existing system of skill credentials on which employers can rely. The alternative to a new credentialing system is clearly not the absence of anything, but instead is the system of community college AA degrees and certifications that is already in place throughout the country. As we saw in our earlier discussion of community colleges, there is a substantial rate of return to both certificates and AA degrees. This fact implies these existing credentials are valued by employers and are thus useful in judging the quality of potential workers. In addition, this system may provide opportunities for customization and tailoring of skill training that a uniform national system cannot.

A second reason some employers may opt out relates to one of the system’s potential benefits: mobility. Some employers may be concerned that promoting a credentialing system will make workers more footloose and deprive firms of returns on human capital investments in those workers.

It is hard to know in principle just what the employer take-up rate is likely to be, but the experience of the effort in the 1990s does provide some clues. Evaluations by Mathematica found very spotty use, and a Government Accounting Office review of the initiatives noted that advocates could provide no evidence of benefits to employers. These assessments are not entirely fair because the efforts were pilot programs and lacked the broad-based support that we see now, but the results are at least cautionary.

The results of our survey suggest that concerns about employer take-up are realistic. Only 7.3 percent of establishments responded affirmatively to the question, “Do you use any formal industry skill credentials system, such as those provided by industry associations or national testing services, for hiring core employees?”

Set against these concerns, advocates of new skill certification systems might argue that it is worth pursuing a system with stronger incentives or coercive aspects for three reasons. First, they might say that a national system of credentials would permit much greater geographic mobility of labor and hence a more efficient labor market.
than currently exists. As an example, in the absence of a national skill certification system, would an employer in Texas know what to make of a community college certificate obtained in Michigan by a job applicant? Second, advocates might point to the very uneven quality of community colleges. They could view a certification system as a tool for upgrading the quality of manufacturing education. Third, proponents might note that even a region with a well-functioning community college system might still exhibit a poor skill-production system for certain industries due to coordination and communication failures. Certifications could theoretically assist in overcoming these challenges.

When it comes to worries about mobility, the evidence does not suggest that this is a serious source of concern. To begin with, a strong credentials system does not necessarily bring with it high mobility. German manufacturing workers tend to have much longer tenure than American workers despite the fact that there is a strong German credentialing system. Perhaps more to the point, there is no strong evidence that U.S. credentials lead to mobility. A useful comparison is between manufacturing workers and construction workers, an occupation with a strong, well-developed, and nationally recognized credentialing system. This comparison also roughly controls for education and occupational strata. Despite the fact that construction credentials might theoretically enable more mobility, between 2011 and 2012 the percentage of construction and manufacturing employees who moved between counties was essentially identical (U.S. Census Bureau 2012).13

Credentials can be very helpful in encouraging educational institutions to concentrate on and improve their training efforts in manufacturing skills. The credentialing movement gives advocates of greater community college involvement a tool that schools can focus on and a standard against which to judge their progress. By pushing for national certifications and putting the prestige and funding of many impressive organizations behind the effort, the certification movement does indeed have the potential to highlight the needs of manufacturing and strengthen the offerings of our educational institutions.

Note that in this context certifications have the potential to do more than just enable an under-resourced community college to implement a higher quality curriculum. Even in cases when the community college has substantial resources and curriculum development expertise, it may not receive consistent signals from the employer community. As
we saw with the example of the Rochester optics industry, disorganization or changes in industry structure may lead to coordination failures in the skill production system. Certificates can theoretically provide a useful coordinating signal in this situation.

As long as we are realistic about what can and cannot be expected from this initiative, improving certifications is a step that can support the broader strategies aimed at improving the labor supply to America’s manufacturing firms.

**The employer side of the bargain**

Just as prices are the result of the intersection of supply and demand, employment outcomes are the result not only of the supply-side measures discussed previously but also of the demand-side measures that firms take when they recruit, hire, and train workers. Employers must also take action to address the challenges of obtaining a skilled workforce. This is particularly the case in the new disaggregated skill production system. Employers must be more active and outward facing than ever before. The steps employers need to take include upgrading their human resource policies and working cooperatively with their fellow employers and with schools in their regions to address workforce issues.

Firms are under considerable competitive pressure. But it is also important to recognize that although on average manufacturing labor represents only about 15 percent of costs, it appears to bear a disproportionate share of cutbacks (McKinsey and Company 2012, 117). The severity of cutbacks since the new millennium raises the possibility that in pursuit of other strategic goals, firms are actually creating some of the problems that are cited in the skill-gap debate. Two issues are particularly concerning. The first is that many firms have limited the training they provide their employees, which is particularly ironic given the concern about skill shortages. When we asked firms in our survey about their training policy, only 22 percent reported that they had increased their investment in formal training during the previous five years. Second, starting wages are quite low, and, as we demonstrated in chapter 2, manufacturing wages have stagnated. As noted previously, it is not hard to understand why young people are reluctant to enter manufacturing when they consider the risks involved and weigh these against starting wages that are often comparable to wages in service sector industries that show no signs of sectoral decline.
Many of the firms we interviewed have made significant commitments to working with their local educational institutions in terms of giving them advice and, in at some cases, providing modern equipment that the schools can use to prepare students. However, some of the labor market intermediaries we interviewed—particularly those located in more distressed labor markets—reported how hard they found it to get the attention of employers and involve them in solving the labor market challenges that they face. To the extent that employers wish to increase the flow of skilled workers over current levels, commitment to working with partners in the new skill production system needs to become more widespread.

Conclusion: Meeting the workforce needs of U.S. manufacturers

Although skill shortages in the manufacturing sector are not the broad-based problem that is sometimes claimed, our survey evidence indicates that there is a subset of firms that experience real difficulties in accessing skilled workers. To the extent there are challenges, we believe many of these are related to the transformation of the American skill production system. The new system, which is quite developed in some areas and in rough transition in others, replaces the old system of internal corporate training and internal labor markets that characterized larger manufacturing plants in past decades. This new system is characterized by the use of external actors such as community colleges to train workers. Because of its disaggregated nature it is susceptible to a variety of coordination and public goods market failures, and, even when it operates well, it needs a much higher level of maintenance and attention to ensure good labor market outcomes.

The keys to the successful operation of the new system are effective intermediaries and high-quality, flexible educational institutions. We have described a number of examples of these. Ultimately, our survey results indicate that connecting the relevant players—firms, community colleges, and other training resources—may be a more critical task than improving the quality of, say, the training programs offered by a local community college. Thus although there are a number of initiatives aimed at elevating the quality of individual institutions, we would argue that a significant portion of the dollars devoted to addressing manufacturing workforce issues should be directed toward facilitating the creation and operation of intermediaries, or networks of community colleges, and toward overcoming coordination failures more generally. It is important to note that offering financial incentives to
individual institutions, or holding competitions with prizes for the development of manufacturing training programs, will be unlikely to address any fundamental underlying problems in skill production for manufacturing. Unless these initiatives contain intermediary or other mechanisms to address coordination and communication failures, they will likely fail in the communities that need them most and succeed only in the areas where they were really unnecessary.

Because the education and career choices of individual students and workers form a key part of the national skill gap debate, we also examine various supply-side barriers that are often claimed to reduce the flow of skilled workers into manufacturing. We argue that to the extent there is any reservation about manufacturing careers on the part of students, parents, and guidance counselors, such reservations are likely rational responses to volatility and sectoral decline in manufacturing. Because workforce investment in the type of engineering and high-tech production skills that characterize modern manufacturing is socially desirable, we propose that public policy, via tools such as short work and a more developed training system for dislocated workers, should shift some of the risk that comes from investing in industry-specific skills away from individuals.

We also assess the potential for national skill certification systems to address manufacturing labor supply challenges. We conclude that these systems are unlikely to improve labor mobility but that they have modest potential to improve the manufacturing-related operations of community colleges and to address communication failures between educational institutions and employers.

Finally, we note that employers have a more active, outward-facing role to play in the new skill production system. Firms must work closely with educational institutions, intermediaries, government actors, and other players to secure the skills that they require to thrive now and in the future.

Ultimately, if firms and policymakers focus attention on all of the components of the new skill production system, and continually seek to strengthen the linkages and communication among the various actors, then there is no reason why the U.S. system cannot produce the skilled workers that manufacturers of all sizes and stripes demand.

Notes

1. Information based on interviews with staff at Rochester optics firms, community college officials, and trade association representatives during the week of October 22, 2012.
2. For the number of community colleges see http://www.aacc.nche.edu/AboutCC/Pages/default.aspx. Among community colleges, 17 percent have enrollment of at least ten thousand and 12 percent have enrollment of five hundred or below. Twenty-three percent of community colleges are in California. See National Center for Education Statistics, “Community Colleges: Special Supplement to the Condition of Education,” 033 (2008): 3.

3. The first widely noted research on rates of return to community college credentials reported positive results, and more recent research has updated these findings and controlled for a large range of personal and family variables. The rates of return range from 13 percent for men who obtain an AA degree to a remarkable 38.9 percent for women. In general the results are more robust for women across all specifications, but for both genders the overall positive message is clear for those who manage to obtain a credential.


5. The federal government collects data on graduation rates via its Integrated Postsecondary Education Data System, and according to the most recent figures only 27.0 percent of public community college students who entered in 2008 had obtained a degree or certificate within 150 percent of the expected time, that is, by 2011. These outcomes are more than a little discouraging. The problem with these data is that they only refer to full-time students whereas we saw that a strong majority of students attend part-time. Many observers would point out that they are also somewhat unfair. Given the substantial fraction of part-time students, focusing on a three-year completion rate may be too stringent. The Department of Education does not collect outcomes for a longer enrollment period; however, a recent effort, executed by Jobs for the Future as part of the Lumina Foundation Achieving the Dream initiative, did collect detailed outcome data from six states for a six-year period since enrollment. In these data, at best only four out of ten students reach their goals within six years of enrolling, and in most of the states the results are even worse (even assuming that the story for transfer students has a uniformly happy ending).


7. Information based on interviews with staff at Rochester optics firms, community college officials, and trade association representatives during the week of October 22, 2012.

8. Carnevale et al. find that although STEM shortages may exist, their cause is diversion of STEM-trained workers into high-paying non-STEM fields rather than stagnant supply of STEM-trained workers. In fact, they find that the number of workers with high-level STEM skills has increased by 60 percent since 1980.

9. As described in a White House blog (http://www.whitehouse.gov/blog/2012/06/18/reforming-unemployment-insurance-protect-jobs-and-incomes-american-workers), “In states that already have a permanent work sharing program in place, the new law provides temporary Federal reimbursement for the benefits paid to workers under the state program. In states that do not, it offers a temporary Federal work sharing program to bridge the gap until the state can create a permanent program. Finally, states that create a new program or wish to expand an existing one will have access to $100 million in Federal implementation grants to help them jump-start program participation.”
10. This research is based on evidence from retraining dislocated workers in community colleges in Washington State. As such it is obviously more limited than one would want but still suggestive. See Louis S. Jacobson, Robert J. LaLonde, and Daniel G. Sullivan, “Policies to Reduce High-Tenured Displaced Workers’ Earnings Losses Through Retraining,” The Hamilton Project (Washington, DC: Brookings Institution, November 2011).

11. For example, a recent proposal put forward by the Hamilton Project (a Brookings Institution initiative) is that employees who earned $50,000 at a lost job be eligible for a training account of up to $30,000 to be allocated on a regular basis as long as the individual is in training.

12. The White House, Office of the Press Secretary, “President Obama and Skills for America’s Future Partners Announce Initiatives Critical to Improving Manufacturing Workforce” (June 8, 2011). Among the organizations involved are the Aspen Institute, ACT, Gates Foundation, Lumina Foundation, the Joyce Foundation, the National Association of Manufacturers, the Society of Manufacturing Engineers, the American Welding Society, and the National Institute of Metalworking Skills.

13. From 2011 to 2012, 3.8 percent of construction workers moved out of their county of residence, and for manufacturing workers the figure was 3.4 percent (U.S. Census Bureau 2012).

References


Carnevale, Anthony, Stephen Rose, and Andrew Hanson. 2012. *Certificates: Gateway to Gainful Employment and College Degrees*. Washington, DC: Georgetown University, Center for Education and the Workforce (June).


