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The U.S. Skills Gap: Could It Threaten a Manufacturing Renaissance?

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AUGUST 28, 2013

These days, there are many reasons to be bullish about the future of U.S. manufacturing. As cost competitiveness in the U.S. continues to improve compared with, for example, China, Japan, and Western Europe, a growing number of companies big and small are considering repatriating the production of everything from machinery to electronics to U.S. shores. Some companies have already begun the shift. Others are planning to use the U.S. as a manufacturing platform from which to export to the rest of the world. The Boston Consulting Group has estimated that these trends could help create 2.5 million to 5 million U.S. jobs by the end of the decade. (See "Behind the American Export Surge (https://www.bcgperspectives.com/content/articles/lean_manufacturing_sourcing_procurement_behind_american_export_surge/) BCG Focus, August 2013.)

But even if economic factors are swinging in favor of the U.S., skepticism abounds over whether the manufacturing sector will really be able to absorb so much work. One concern is that the U.S. may no longer have enough skilled workers. Years of outsourcing and offshoring have so damaged U.S. manufacturing, the argument goes, that its once-abundant pool of welders, engineers, and machine operators have shifted to other occupations. And the U.S. education system is failing to train enough new skilled workers to replace those who retire.

Is the U.S. really facing a manufacturing-skills crisis? We believe such fears are overblown—at least for the near term. Our research finds little evidence of a meaningful and persistent skills gap in most parts of the U.S., including in its most important manufacturing zones. The real problem is that companies have become too passive in recruiting and developing skilled workers at a time when the U.S. education system has moved away from a focus on manufacturing skills in order to put greater emphasis on other capabilities. Over the long term, therefore, serious skills shortages could develop unless action is taken.

The following key findings are based on our analysis of job vacancy and wage data, as well as on a BCG survey of 100 companies with U.S. manufacturing operations. This is what we expect in the short term:

- We estimate that the U.S. is currently short around 80,000 to 100,000 highly skilled manufacturing workers. But those numbers represent less than 1 percent of the nation's total manufacturing workforce and less than 8 percent of its highly skilled workforce of approximately 1.4 million.

- The skilled-worker shortages that exist in the U.S. are localized. Only 5 of the nation's 50 largest manufacturing centers—Baton Rouge, Louisiana; Charlotte, North Carolina; Miami, Florida; San Antonio, Texas; and Wichita, Kansas—appear to have significant or severe skills gaps. Ninety percent of the biggest manufacturing areas do not show evidence of significant manufacturing-skills shortages.

This is the long-term situation:

- Companies are not doing enough to cultivate a new generation of skilled manufacturing workers in the U.S. Manufacturers have scaled back their in-house training over the years, and they underutilize important sources of new talent such as high schools and community colleges.

- The retirement of aging workers, as well as heightened demand for workers, could cause serious skilled-labor shortages in the U.S. By 2020, the nation could face a shortfall of around 875,000 machinists, welders, industrial-machinery operators, and other highly skilled manufacturing professionals, according to the U.S. Bureau of Labor Statistics and BCG estimates.

- Companies, schools, governments, and nonprofits must do much more to identify, recruit, train, and employ skilled manufacturing workers. A wide array of collaborative programs already exists across the U.S. But these programs are not nearly sufficient.

If the U.S. is to avert a manufacturing-skills crunch in the years ahead, the public and private sectors must begin taking aggressive steps now. The education system must prepare students for the increasingly sophisticated and demanding skills needed in manufacturing. High-quality training programs should be ramped up and should serve as models for new initiatives around the country. If such action is taken, the U.S. can remain on track for a manufacturing renaissance, generating good long-term jobs for its manufacturing sector.

Defining the Skills Gap

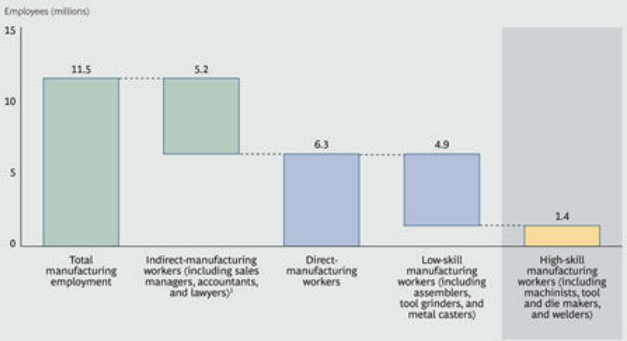
There is little question that the U.S. needs more skilled workers to fully capture the increased manufacturing opportunities made possible by shifting economic forces and the increasing competitiveness of the U.S. compared with other major manufacturing countries. In national surveys, many manufacturing executives complain that they cannot hire the talent they need in order to make their businesses grow. Indeed, it is difficult to find a CEO who will say that he or she can readily fill vacancies for engineers, machinists, and other skilled workers who meet the desired specifications. Demand for additional skilled talent, moreover, is likely to surge as the technological needs of modern production lines grow more sophisticated and U.S. output increases. An added concern is that many of today's skilled workers are approaching retirement.

The nature and magnitude of this challenge, however, should be kept in perspective. Before getting into the data, we need to clarify the definition of skilled labor, the size of the U.S. skilled workforce, and how company perceptions of a skills gap differ.

Skilled Labor. Generally, a high-skill occupation is one that requires a high-school degree, as well as some combination of postsecondary education, work experience, and on-the-job training. A welder, for example, is "highly skilled." Welders require some college or other kind of postsecondary education, several months of work experience, and a moderate level of on-the-job training, such as an apprenticeship. In general, it takes a welder at least two years to become certified. A typical assembly worker, however, does not require a high-school degree or any work experience—just a few months of on-the-job training. We therefore regard assembly work as a low-skill occupation. The threat of a shortage of low-skilled workers is limited because there are plenty of U.S. workers with enough education to be trained quickly for such jobs.

The Size of the Skilled Workforce. We estimate that, as of 2010, the U.S. had a highly skilled workforce of 1.4 million people who were employed directly in manufacturing. (See Exhibit 1.) This was out of 6.3 million people directly employed in manufacturing and a total of 11.5 million direct and indirect employees. (Those who are indirectly employed in manufacturing work in professions that serve the manufacturing industry, including sales, accounting, legal services, and travel.) Skilled workers, in other words, account for only around 10 percent of the total U.S. manufacturing workforce.

EXHIBIT 1 | As of 2010, There Were 1.4 Million Highly Skilled Manufacturing Workers in the U.S.



Sources: U.S. Bureau of Labor Statistics; BCG analysis.
[1]The U.S. Bureau of Labor Statistics' Occupational Employment Statistics program reports employment by occupation and by industry at a national level. Indirect-manufacturing jobs are professions that serve the manufacturing industry but are not directly associated with the production of manufactured goods.

High-skill manufacturing jobs are important for the U.S. economy and workforce. They pay around $50,000 a year on average. That is 35 percent more than the average wage for direct-manufacturing jobs of all skill levels and around 50 percent more than low-skill direct-manufacturing jobs, such as electronic-equipment assemblers, foundry mold makers, and operators of metal- and plastic-coating machines. The average U.S. services job, by contrast, paid only around $24,590 per year as of 2010.

The U.S. high-skill manufacturing workforce is concentrated within a handful of professions: 90 percent include only ten types of workers. The top five—machinists, welders, industrial-machinery mechanics, industrial engineers, and operators of computer-controlled machine tools—account for two-thirds of skilled manufacturing work.

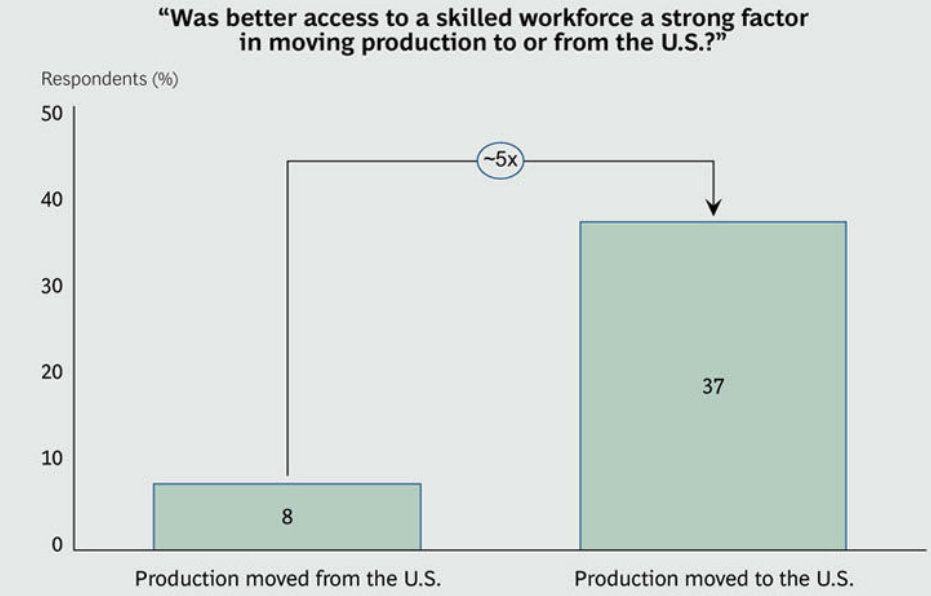
Skills Gap Perceptions. While some companies insist that the U.S. does not have enough skilled labor, others say the opposite—and they even regard the U.S. skilled-labor force as a competitive advantage.

There can be several explanations for this discrepancy. In some cases, manufacturers say they can't find the workers they need because there truly is a lack of such skills on the market. But quite often, the skilled workers are available—just

not at the price employers are willing to pay. Or companies do not bother to recruit at community colleges and vocational schools. In other instances, experienced skilled workers with good academic training are available—sometimes in-house—but companies are unwilling to invest the time and money to train these workers to use new technologies or specific machines.

Our survey of 100 U.S.-based manufacturing executives at companies with annual sales of at least $1 billion illustrates these divergent perceptions. Thirty-seven percent of executives surveyed said that adequate access to skilled labor was a strong factor in their decisions to move production to the U.S. from another country. That percentage is nearly five times the number who cited the need for skilled labor as a major reason for moving manufacturing from the U.S. (See Exhibit 2.) Only 8 percent said skilled labor was a major reason for their decision to locate a plant in a different country for export to the U.S. Siemens Corporation CEO Eric Spiegel said, "There's still more skilled labor [in the U.S.] than anywhere else in the world," according to a report in *The Washington Post*. (Siemens Corporation is the U.S. holding company of Germany's Siemens AG.)

EXHIBIT 2 | Skilled Labor Is More of a Draw to the U.S. Than Perceived Shortages Are a Deterrent



Source: BCG manufacturing survey, February 2012.

A company's circumstances can influence its view. Many companies have a hard time finding qualified workers because of the way these organizations set their pay and qualifications criteria. A recent job posting by a U.S. company seeking a laboratory technician illustrates why this is relevant. The applicant had to meet the following requirements: a bachelor's degree in chemistry plus more than one year of work experience, chemical-mixing knowledge, light-manufacturing experience, the ability to operate a forklift, and a willingness to work with hazardous materials. Furthermore, knowledge of SAP business-management software would be "helpful." The offered pay for a worker with such a diverse skill set? A mere $15 to $17 per hour. If the company cannot fill this job quickly, is that because of a skills gap, or is it because the company's expectations are unrealistically high?

A company's ability to train workers also influences its perception of supply and demand. For example, say that two companies are having difficulty recruiting a pipe welder. Company A is a large industrial conglomerate, has training infrastructure, and works with a community college to develop curricula. Company A says it does not perceive a skills shortage because it can "build" a pipe welder by training a high-school graduate or by hiring through its partnership with the community college. Company B, by contrast, is a small automotive supplier that lacks the resources for training programs. It says that there is a skills shortage because its available options may be more limited. If it does not have a relationship with the community college or an established apprenticeship program, the most likely way for Company B to hire a pipe welder is to compete for one by offering high pay.

And concerns in the U.S. about skills gaps are hardly unique. Virtually every major manufacturing nation believes it has a serious talent shortage. Germany's economics ministry has estimated that a chronic skills shortage costs the economy up to $27 billion a year, or around 1 percent of gross domestic product. The country's economic minister was quoted in the *Financial Times* as saying that the education system's inability to produce the skills needed by export industries could inflict "long-term damage." And according to media reports, some companies in China are already having a hard time finding enough skilled workers to fully operate factories, a problem that is expected to become far more serious in the future. In Japan, which has a rapidly aging population and a low birth rate, 80 percent of employers experience difficulty finding qualified talent, according to a recent Manpower report. The perception of a skills gap in the U.S., therefore, is no stronger than in most other major manufacturing nations.

Quantifying the Skills Gap

To separate fact from perception, we used a variety of methods to gauge whether the U.S. really has a manufacturing-skills gap and, if so, whether it is serious. Our analysis of wage growth is derived from simple supply-and-demand economics. If demand for a certain skill exceeds supply, employers are likely to have to raise wages significantly to attract workers with the hard-to-find skill. According to a historical review of manufacturing wages relative to GDP, a significant skills gap can be said to exist when wage growth has outpaced inflation by at least 3 percentage points annually for five years. This pace of wage growth has been observed to be a reliable indicator of skills shortages in other sectors, such as energy, because it suggests that employers are being forced to bid up pay to attract scarce workers.

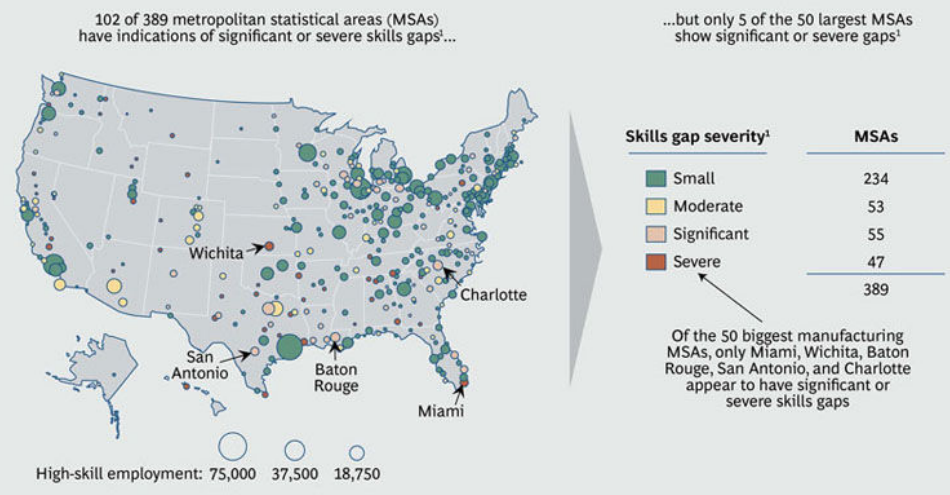
Using the criteria above, our analysis of U.S. wage data suggests that there currently is a shortfall of between 80,000 and 100,000 highly skilled manufacturing workers. That represents less than 1 percent of the nation's 11.5 million manufacturing workers and less than 8 percent of its 1.4 million highly skilled workers. Nationwide, the compound average growth rate in the wages of highly skilled direct-manufacturing workers averaged 2.5 percent from 2005 to 2010—roughly the rate of inflation. In fact, overall manufacturing wages have not outpaced inflation by more than 2 percent over a five-year period in the past 30 years.

Wage data for specific major manufacturing professions also suggest that there is no nationwide shortage of skilled workers. Wage growth for machinists outpaced inflation by only 0.1 percentage point from 2005 to 2010, for example, and the average for the top five occupations was only 0.5 percent. The fact that employers did not pay a significant premium to fill these positions implies there was little or no shortage.

These data suggest that skills shortages at the national level likely have more to do with business hiring cycles than with a structural problem in the U.S. labor market. Our analysis also suggests that existing manufacturing-skills gaps are local, rather than national. We analyzed wage data in 389 metropolitan statistical areas (MSAs)—regions that have at least one urban area with 50,000 people or more—in the U.S. Only 5 of the nation's 50 largest manufacturing MSAs appear to have significant or severe gaps for workers such as welders, machinists, and industrial-machinery operators. They are Baton Rouge, Charlotte, Miami, San Antonio, and Wichita.

In the vast majority of MSAs—234, to be exact—the evidence points to small skills gaps. This group includes most of the biggest manufacturing centers in the U.S., such as the Detroit, Chicago, Houston, Los Angeles, and Minneapolis areas. The 234 MSAs with small skills gaps account for more than two-thirds of U.S. manufacturing output. Roughly one-quarter of MSAs have significant or serious gaps, but these areas account for less than 20 percent of U.S. manufacturing. (See Exhibit 3.)

EXHIBIT 3 | Urban Areas with Significant Skills Gaps Account for a Small Portion of the Total Manufacturing Output



Sources: U.S. Bureau of Labor Statistics; U.S. Bureau of Economic Analysis; BCG analysis.
[1]In MSAs with small gaps, the wages of less than 10 percent of highly skilled workers are rising at a CAGR greater than 3 percent for five years; in MSAs with moderate gaps, the wages of 10 to 20 percent of highly skilled workers are rising at a CAGR greater than 3 percent for five years; in MSAs with significant gaps, the wages of 20 to 40 percent of highly skilled workers are rising at a CAGR greater than 3 percent for five years; in MSAs with severe gaps, the wages of more than 40 percent of highly skilled workers are rising at a CAGR greater than 3 percent for five years.

Other indicators support our findings. According to responses to a BCG survey of companies with U.S. manufacturing operations, anywhere from 6 to 8 percent of high-skill manufacturing positions are unfilled, and less than 1 percent of all manufacturing positions are unfilled. Such vacancy rates are within the historical range for the past decade. Likewise, the 45 hours worked each week by the average U.S. manufacturing laborer is well within the historical range of the past two decades, indicating that companies aren't using overtime to make up for skilled-labor shortages.

Where Gaps Exist Now

One factor that distinguishes U.S. regions with serious skills gaps is the relatively small size of their manufacturing bases. Of the seven states exhibiting significant or severe skills gaps—meaning that wage growth for high-skill manufacturing professions has outpaced inflation—six are in the bottom quartile of total U.S. manufacturing output. The exception is Alabama, which shows evidence of a significant skills gap. The three states in which wage inflation suggests severe shortages—Alaska, New Mexico, and Wyoming—have populations of 2 million or less. The major manufacturing states in the Northeast, Midwest, South, and West all have small skills gaps, according to our methodology.

The same is true for U.S. MSAs with significant or severe skills gaps. Virtually all have fewer than 7,000 highly skilled manufacturing workers, and in some cases, fewer than 1,000. By contrast, the biggest U.S. manufacturing MSAs—those with 75,000 or more—all have small skills gaps.

This should not be surprising. Regions with big manufacturing clusters tend to attract the highest concentrations of skilled professionals. Employers can therefore draw upon a much bigger talent pool. In areas with more limited manufacturing production, however, the odds of finding an experienced professional with the right skills at the right time and price are dramatically lower.

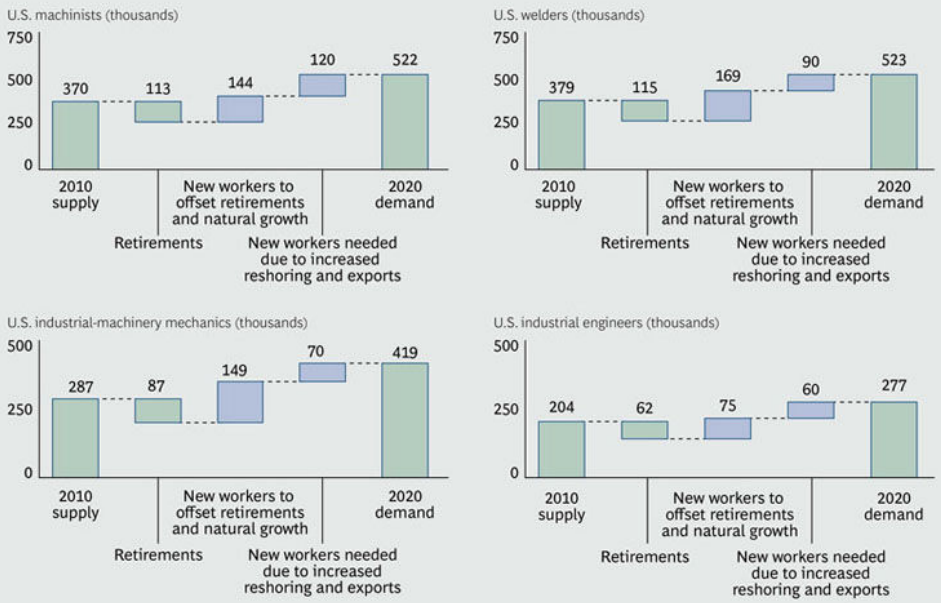
Even in areas that indicate the worst shortages, skills gaps are typically limited to a handful of occupations. For example, an analysis of the labor situation and wage rates in Wichita suggests that that city has significant shortages of machinists, industrial-engineering technicians, mechanical drafters, and computer-controlled machine-tool operators. But on the basis of our supply-and-demand analysis, Wichita appears to have a good supply of other manufacturing professionals, such as welders, industrial engineers, computer numerical-control (CNC) machine-tool programmers, materials engineers, and industrial-production managers. Chattanooga, Tennessee, by contrast, would seem to be lacking industrial-machinery mechanics, industrial engineers, and chemical-plant operators. And in Brownsville, Texas, welders, machinists, and industrial-production managers are among the most-needed professionals. Such differences reinforce the argument that skills shortages tend to do with local, rather than national, imbalances between supply and demand.

Skills shortages are generally created by a new surge in demand for certain specialists. Workers such as rotary drill operators, petroleum engineers, extraction helpers, roustabouts, and derrick operators in the booming oil and gas industry provide a good illustration. From 2005 to 2010, employment in these key trades more than doubled from 15,350 to 31,410 workers. Wages for these workers rose, on average, 3.9 percentage points faster than inflation. The most acute shortages were for extraction helpers and rotary drill operators, whose pay rose 9.4 and 6.6 percentage points faster than inflation, respectively, over those five years. A gap exists in these instances because companies are required to pay increasingly higher wages to find and attract the desired employees.

Projected Future Gaps

Although there is limited evidence of a skills crisis today, we believe that long-term concerns at the national level could be more serious—if companies do not do more to develop future talent. (See Exhibit 4.) Our estimate of a potential shortfall of around 875,000 machinists, welders, industrial-machinery mechanics, and industrial engineers by 2020 is based on U.S. Bureau of Labor Statistics data, as well as our projections of demand growth.

EXHIBIT 4 | Manufacturers Must Act Now to Avoid Future Gaps



Sources: U.S. Bureau of Labor Statistics; BCG analysis.

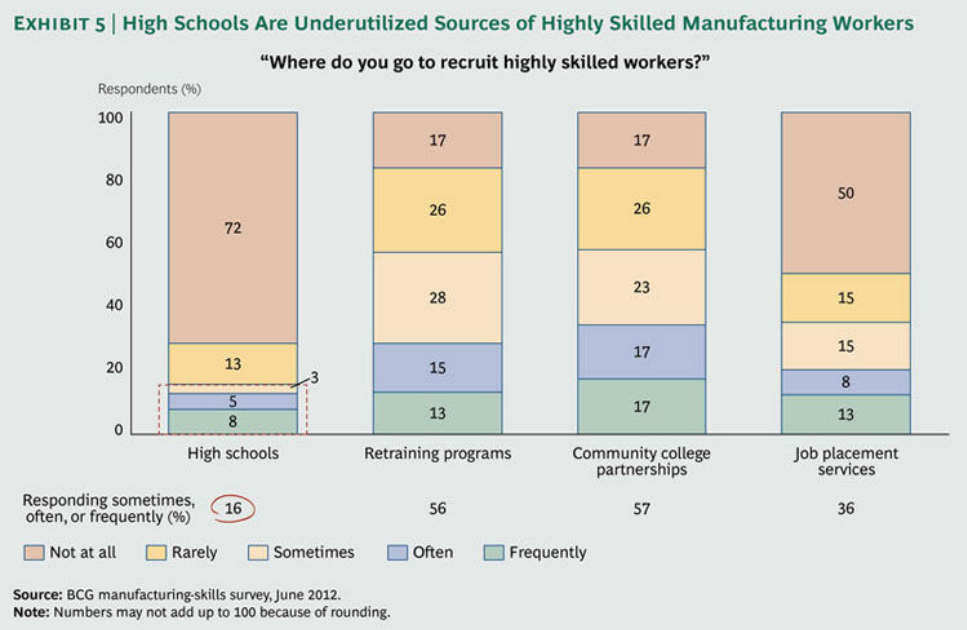
New skilled workers will be needed not only to keep pace with expected growth in U.S. manufacturing production but also to replace professionals who are expected to retire from the U.S. labor force. The U.S. had 370,000 machinists as of 2010, for example, and demand is projected to reach 522,000 in 2020, primarily because of market growth and manufacturing work that has been repatriated from countries such as China and from high-cost economies. However, it can be assumed that around 113,000 machinists will retire before 2020. If these forecasts are correct, an additional 264,000 machinists must join the U.S. workforce to meet demand in 2020. The talent gaps for welders, engineers, and machinery mechanics could be just as severe.

Addressing Talent Gaps

Filling current gaps in the U.S. skilled manufacturing workforce—and preventing those shortages from developing into a real national crisis in the years ahead—requires aggressive action now. Companies, schools, governments, and nonprofit agencies must collaborate to expand the training and recruitment of the next generation of manufacturing talent and to build public awareness of the attractiveness of skilled manufacturing professions.

Our research found that much more must be done to keep the U.S. competitive in the future. Responses to our 2012 manufacturing-skills survey showed that most U.S. companies vastly underutilize important external sources of highly skilled talent. Eighty-eight percent of respondents said they sometimes, often, or frequently rely on internal training when they have trouble filling a high-skill job, while only 48 percent said they turn to community colleges.

Companies do not use U.S. high schools and community colleges enough for grooming new talent. (See Exhibit 5.) Only 13 percent of companies we surveyed reported that they often or frequently recruit in U.S. high schools. Seventy-two percent said that they don't recruit in high schools at all. Only 34 percent of respondents said that they often or frequently take advantage of community college partnerships to recruit skilled workers, and just 28 percent often or frequently make use of retraining programs. Some 65 percent of companies said that they use job placement services rarely or not at all.



By ramping up their activities in high schools, community colleges, and public-private training programs—rather than only recruiting among workers currently in the job market—corporations could considerably expand their pool of skilled workers. But for such efforts to be effective, it will be important to revitalize the interest of U.S. students in manufacturing careers. The U.S. education system must once again recognize the value of training students for these types of careers.

Fortunately, a diverse group of stakeholders in the public, private, and nonprofit sectors in a number of U.S. states already are working to address such talent needs in order to capture the economic benefits of a globally competitive manufacturing base. Some programs are aimed at building manufacturing topics into high-school curricula. Other partnerships are developing training programs for the general public. State and municipal programs are working with employers to fill high-skill positions, while partnerships involving vocational schools provide classroom training.

There are also programs in which coalitions of companies share costs to teach targeted manufacturing skills to postsecondary students or to train manufacturing professionals on the job. For example, Hypertherm, a New Hampshire-based maker of advanced cutting systems, took the step of launching its own training institute when it faced the task of having to hire 180 skilled machinists over the course of three years. The program was so successful that Hypertherm has opened the institute to other U.S. employers that need trained machinists.

Here are a few other promising examples that we examined:

Austin Polytechnical Academy. Founded in 2007 by the Chicago Manufacturing Renaissance Council to revitalize the city's manufacturing industry, the Austin Polytechnical Academy represents an effort to redefine and modernize vocational education. The academy is part of the Chicago Public Schools and works with local manufacturers to teach students all aspects of industry, from skilled production and engineering to management and ownership. It has its own manufacturing-training center, but it also offers a college preparatory education. The academy's 60 industry partners, which include WaterSaver Faucet, Johnson Controls, Winzeler Gear, and Atlas Tool & Die Works, have provided more funding as well as field trips, speakers, mentoring, internships, and full-time employment for graduates. So far, 145 students have earned 206 credentials demonstrating competence in areas such as metal forming, measurement, and CNC operation and programming for mills and lathes.

Quick Start. This program is part of the Technical College System of Georgia and provides free customized workforce training as an incentive for companies to move to or expand in Georgia. To qualify, a company has to create 15 of the same type of jobs in a 12-month period. Quick Start's operating budget of more than $15 million is funded by the state. In 2011, Quick Start worked with manufacturing companies such as NCR, Kia Motors, and Mitsubishi Power Systems. The jobs created with Quick Start support have been credited with making an economic impact of $417 million.

Custom Machine. This program, offered by the Center for Manufacturing Technology in Woburn, Massachusetts, customizes training programs for employers and individual certificate programs. It trains machine tool operators, teaches general machine-shop and safety practices, and helps assess new hires. Up to one dozen students graduate from the program every eight weeks. Eighty percent of graduates are placed in manufacturing programs.

Manufacturing Works. Based in Chicago and serving employers throughout Cook County, this organization works with manufacturers to assess and hire employees. It pools together job seekers and company job postings. In 2010, Manufacturing Works was credited with placing 440 manufacturing employees with 115 companies, saving those companies some $5 million in hiring costs and more than 81,000 hours of HR time.

Such programs are encouraging, but they are not nearly extensive enough to meet the long-term needs of U.S. manufacturing. They also fall well short of what nations such as Germany are doing to make sure their manufacturing sectors can compete in the future. Stakeholders at the state and local level must drive these collaborative skills-training initiatives on the basis of the needs of the most competitive industrial clusters in their regions.

An Agenda for a Twenty-First Century Manufacturing Talent Base

Talk of a current manufacturing-skills crisis in the U.S. is overstated. But there are considerable shortages of specific skills at the local level in small manufacturing communities and in some job classifications. Severe shortages of highly skilled manufacturing professionals could develop into a national problem during this decade as U.S. manufacturing output expands and today's experienced machinists, engineers, CNC operators, and other skilled workers move into retirement.

Companies big and small need to become more proactive in addressing manufacturing skills gaps and in planning for future HR needs. They should work with schools, government agencies, and nonprofits across the U.S. to keep a pipeline of new talent flowing. They need to take aggressive action now to ensure that there can be a U.S. manufacturing resurgence.

Manufacturing companies should begin by using demographic risk-management and workforce-planning tools to understand future manufacturing-skills challenges and to enlarge the pool of potential candidates. They should return to the historical practice of investing in internal training programs in order to build the capabilities they will require to remain competitive, as well as matching younger talent with experienced employees in an apprenticeship model.

Because many high-skill manufacturing jobs require only a high-school education and some on-the-job training, companies should build up their visibility in high schools, create greater awareness of attractive manufacturing-career opportunities, and step up recruitment. Small manufacturers need to partner more actively with community colleges and vocational programs to assure that there is an ample pool of the right skills to meet future needs.

Corporations should also collaborate more with education partners and government on programs that focus on developing specific skills. If strong public-private partnerships do not exist in their regions, manufacturers should help build them, applying best practices of successful programs elsewhere in the U.S.

Public agencies, including local governments, should also rigorously analyze the availability of specific key manufacturing skills in their regions. They should determine whether the skills pool is sufficient to support both the ongoing needs of existing production facilities and those of investments planned for the future. They should support needed training programs and offer financial aid or loan forgiveness to individuals who enter college programs in order to acquire specific manufacturing skills. Government agencies should also support the development of clusters in key advanced manufacturing industries for which their regions have a competitive advantage.

Educational and other supporting organizations should link the worker supply chain at colleges and vocational schools more tightly with the needs of manufacturers. They should create hybrid educational systems to teach technical skills in addition to teaching critical thinking.

By understanding the magnitude of the challenge and investing now to cultivate the next generation of professionals, all stakeholders can ensure that a skills crunch won't derail the U.S. manufacturing resurgence. Indeed, the availability of manufacturing talent could well become a major competitive advantage for the U.S.

Authors and Acknowledgments

Acknowledgments

This report would not have been possible without the efforts of Louis Hobson, Brianne Blakey, Frank Roberts, Collin Galster, and Steven Won of the BCG project team. The authors also would like to thank David Fondiller, Alexandra Corriveau, Madeleine Desmond, Beth Gillette, and Mike Petkewich for their guidance and interactions with the media, Pete Engardio for his writing assistance, and Katherine Andrews, Gary Callahan, Sarah Davis, Abigail Garland, Kim Friedman, and Sara Strassenreiter for their editorial and production help.

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