Advanced Manufacturing Techniques

Among U.S. Middle Market Manufacturers

A REPORT FROM THE NATIONAL CENTER FOR THE MIDDLE MARKET
AND THE NATIONAL ASSOCIATION OF MANUFACTURERS

NATIONAL CENTER FOR
THE MIDDLE MARKET

In Collaboration With

THE OHIO STATE UNIVERSITY FISHER COLLEGE OF BUSINESS

GE Capital

NATIONAL ASSOCIATION OF Manufacturers

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Middle Market Manufacturing
and Advanced Manufacturing Techniques

THE U.S. MIDDLE MARKET

The U.S. middle market is defined by companies with annual revenues between $10 million and $1 billion. In addition to their geographic and industry diversification, these companies are both publicly and privately held and include family-owned businesses and sole proprietorships. While the middle market represents approximately 3% of all U.S. companies, it accounts for a third of U.S. private sector GDP and jobs. The U.S. middle market is the segment that drives U.S. growth and competitiveness.

Advanced Manufacturing Techniques among U.S. Middle Market Manufacturers reports on insights from C-suite executives who lead middle market manufacturing firms across the nation. The report reveals findings related to the prevalence, impact, and challenges associated with advanced manufacturing technique usage in the middle market.

ADVANCED MANUFACTURING TECHNIQUES

Advanced manufacturing techniques (AMT) improve manufacturing processes and products through the use of innovative technologies. The technologies most frequently used by middle market manufacturing firms—which represent 17% of U.S. middle market revenues and approximately 33,000 companies—primarily include automation, computer technologies, process technologies and information technologies. Additional advanced manufacturing techniques include control systems, custom manufacturing, high precision technologies, sustainability technologies, high performance computing and advanced robotics. Advanced manufacturing techniques have the potential to significantly improve production output and profitability for manufacturers, ultimately serving as a catalyst for economic growth.

HOW IS THE RESEARCH CONDUCTED?

The survey was conducted among 200 C-suite executives and financial decision makers of America's middle market manufacturing firms on key indicators of advanced manufacturing technique usage and future growth; the impact of advanced manufacturing techniques on revenue, profits, and employment; implementation challenges; and barriers to advanced manufacturing technique adoption. The survey was designed to accurately reflect the 33,000 U.S. middle market manufacturers with revenues between $10MM and $1B, the upper and lower limits on middle market annual revenue. Research for this report was designed and managed by the National Center for the Middle Market in partnership with the National Association of Manufacturers.

THE NATIONAL CENTER FOR THE MIDDLE MARKET

Founded in 2011 in partnership with GE Capital, and located at The Ohio State University Fisher College of Business, The National Center for the Middle Market is the leading source of knowledge, leadership and innovative research on the U.S. middle market economy. The Center provides critical data, analysis, insights and perspectives to help accelerate growth, increase competitiveness and create jobs for companies, policymakers and other key stakeholders in this sector. The Center's website, which offers a range of tools and resources for middle market companies, can be visited at **www.middlemarketcenter.org.**

THE NATIONAL ASSOCIATION OF MANUFACTURERS

The National Association of Manufacturers (NAM) is the largest manufacturing association in the United States, representing small and large manufacturers in every industrial sector and in all 50 states. Manufacturing employs nearly 12 million men and women, contributes more than $1.8 trillion to the U.S. economy annually, has the largest economic impact of any major sector and accounts for the lion's share of private-sector research and development. The NAM is the powerful voice of the manufacturing community and the leading advocate for a policy agenda that helps manufacturers compete in the global economy and create jobs across the United States. For more information about the NAM, visit **www.nam.org**.

Executive Summary

There has been much discussion on the relative importance of rebuilding the U.S. manufacturing base. While some manufacturers have moved operations abroad or reduced capabilities, the middle market manufacturing base has remained a solid contributor to the local, regional and national economies. This is significant, since manufacturers represent more than 17% of U.S. middle market revenues and approximately 33,000 companies. One specific topic of discussion has been advanced manufacturing and the prospects for driving a manufacturing resurgence.

Research conducted by the National Center for the Middle Market and the National Association of Manufacturers explored the impact of advanced manufacturing techniques on improving competitiveness and catalyzing economic growth within the middle market manufacturing segment.

The research found that nearly half of middle market manufacturers currently leverage advanced manufacturing techniques—and to great advantage. The techniques have a significant impact on profitability within these companies without negatively effecting jobs.

Since just over half of middle market manufacturers do not currently consider themselves users of advanced manufacturing, an opportunity clearly exists for advanced manufacturing to grow within the middle market segment. Encouragingly, most manufacturers indicate that they plan to adopt advanced manufacturing techniques in the near term. However, implementation challenges and barriers to adoption must first be overcome.

While the cost of the techniques is one key hurdle to adoption, a skills gap—or a lack of production workers with the necessary skills to utilize advanced manufacturing techniques—is another major obstacle. Through a focus on training and collaboration with educational institutions, more middle manufacturers may be able to overcome the skills gap and take full advantage of the benefits of advanced manufacturing.

Key Findings:

INCREASED PENETRATION OF ADVANCED MANUFACTURING TECHNIQUES WITHIN THE MIDDLE MARKET

According to the survey, 92% of current middle market users of advanced manufacturing and 78% of non-users state that they expect to implement advanced manufacturing techniques over the next three to five years. Key motivators for adoption include improving production output, improving profitability and strengthening margins. Interestingly, reduction in workforce is not among the top motivations. The most commonly leveraged advanced manufacturing techniques include automation, computer technologies, process technologies and information technologies.

Today, 47% of middle market manufacturing firms indicate current advanced manufacturing usage. These firms tend to be at the upper end of the middle market revenue spectrum ($100MM - $1B). Advanced manufacturing users are also more likely to maintain some international presence and have established expansion plans.

ADVANCED MANUFACTURING CORRELATES TO INCREASED PROFITABILITY WITHOUT ELIMINATING JOBS

Advanced manufacturing techniques are highly effective in middle market firms. Users of advanced manufacturing nearly unanimously state that the techniques have had a positive impact on their profitability. On average, these firms reported a 20% increase in their profitability over the past five years.

Advanced manufacturing users reported a net increase in jobs over the past year of 3.4% and anticipate to further grow jobs by 4.7% over the next 12 months. Job growth for users of advanced manufacturing has been comparable to the job growth of non-users.

SKILLS GAP A KEY CHALLENGE

Regardless of the advanced manufacturing techniques used, approximately half of those surveyed report a skills gap, particularly in the area of science, math and technology. More than half of advanced manufacturing technique users—57%—find a need to regularly re-train their workforce to utilize new technologies, while 42% report that special technological skills are now required of new hires. Over 50% of advanced manufacturing users have positions they are still seeking to fill.

EDUCATIONAL PARTNERSHIPS AND TRAINING KEY TO ADDRESSING THE SKILLS GAP

Overwhelmingly, 95% of advanced manufacturing users have shifted their recruitment and training strategies to address the skills gap. Specifically, 51% of advanced manufacturing users have created new internal training programs, while 42% have collaborated with technical schools and community colleges.

Advanced manufacturing presents an opportunity to increase productivity and competitiveness. Addressing the skills gap will allow companies to reap the full benefits of these powerful techniques.

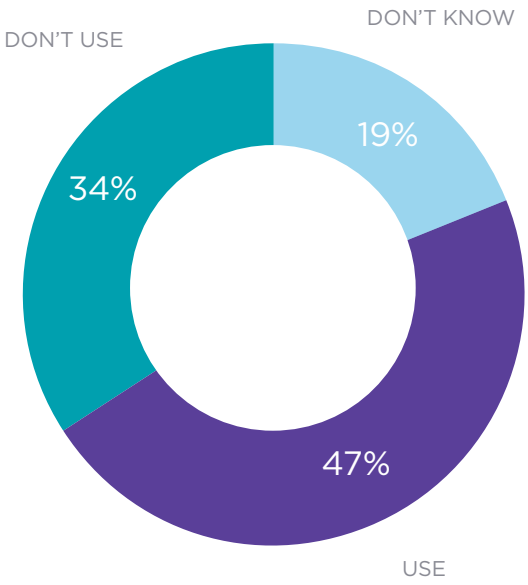
Incidence, Motivators and Growth
of Advanced Manufacturing Techniques

To middle market manufacturers, advanced manufacturing is synonymous with terms such as 'automation,' 'robotics' and 'computer technologies.' Research shows that manufacturers are relatively committed to these technologies. Currently, 47% of middle market manufacturers indicate use of at least one advanced manufacturing technique. The techniques most commonly leveraged include automation; computer technologies such as CAD, CAE or CAM; process technologies and information technologies.

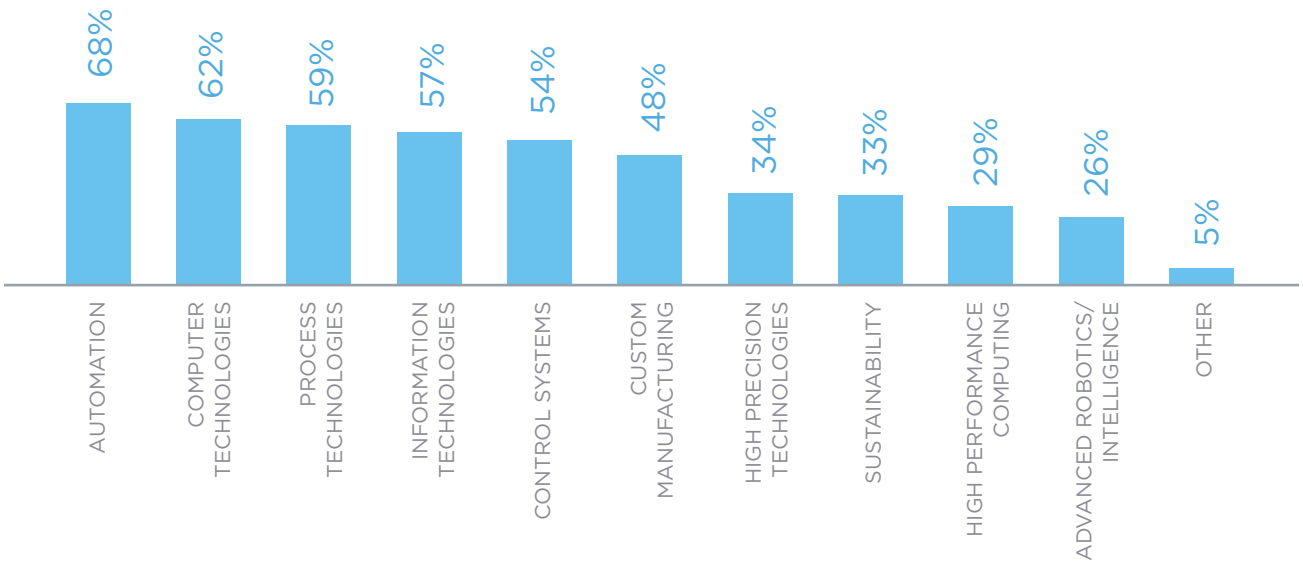
Incidence

Currently, 47% of middle market manufacturers indicate use of at least one advanced manufacturing technique. The techniques most commonly leveraged include automation (68%); computer technologies such as CAD, CAE or CAM (62%); process technologies (59%) and information technologies (57%).

INCIDENCE OF AMT USE



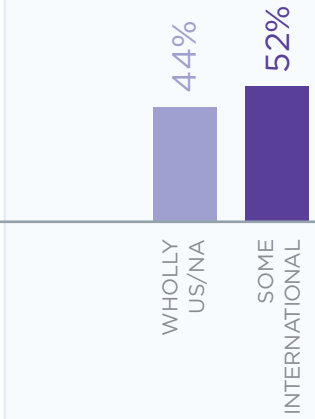
ADVANCED MANUFACTURING TECHNOLOGIES USED



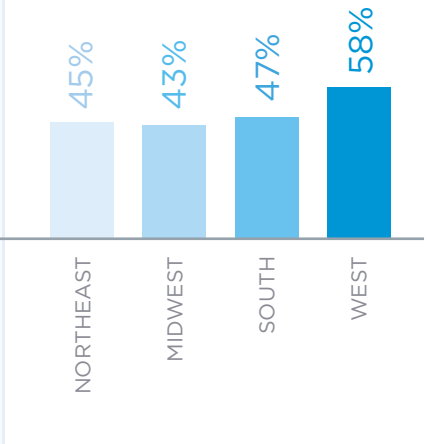
USER PROFILE

BY REVENUE SIZE

BY OPERATIONS



BY REGION



Middle market advanced manufacturing users tend to be emerging large companies at the upper end of the middle market revenue spectrum with revenues ranging from $100MM — <$1B. Usage of advanced manufacturing techniques is greatest among companies with at least some international operations, companies located in the Western U.S. and companies in the metal manufacturing and computers/electronics manufacturing subsectors.

Additionally, users of the techniques are significantly more likely to have established expansion plans than non-users (75% vs 59%).

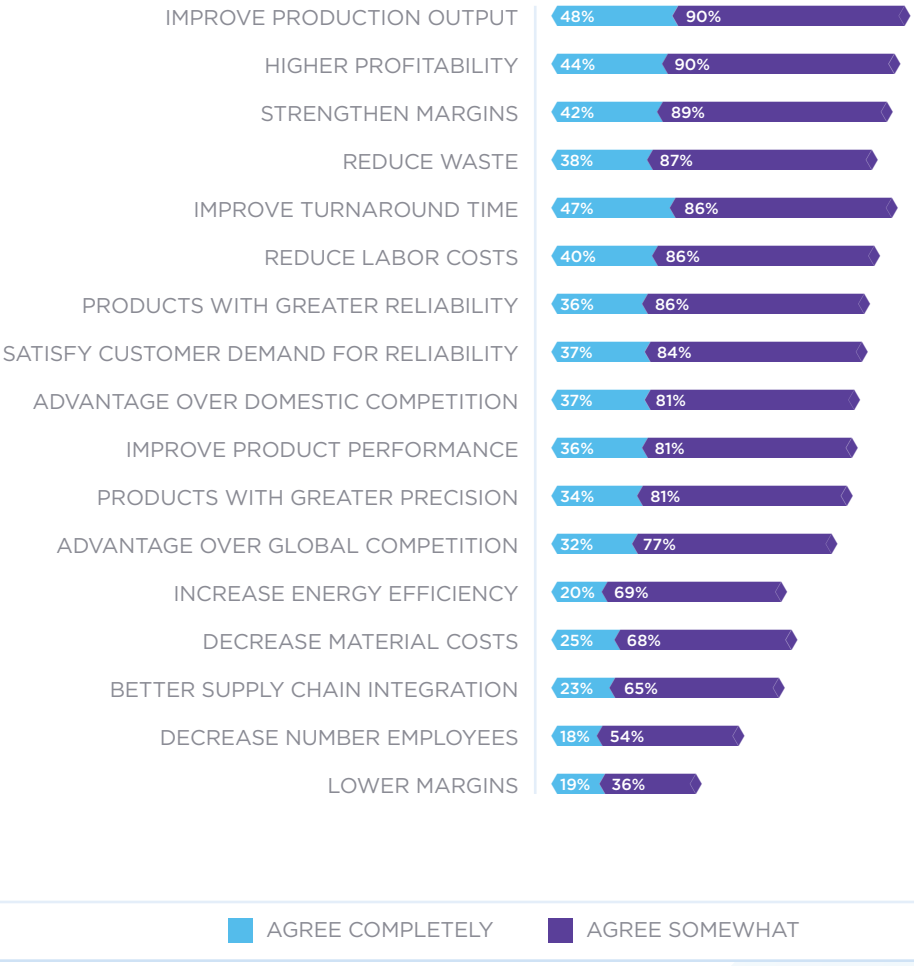
Advanced manufacturing users are more likely than non-users to agree that their size gives them unique advantages, that they can adapt the newest technologies more quickly than others and that innovation is a key to their success.

Motivators

In general, middle market manufacturers who leverage advanced manufacturing techniques are primarily motivated to do so by the opportunity to improve production output, improve profitability and strengthen margins. Interestingly, reduction in workforce is not among the top motivations for implementation.

The motivators for adoption tend to vary based on firm revenue. Lower middle firms ($10MM - <$50MM) list strengthening margins as the number one incentive, while emerging large firms ($100MM - <$1B) focus more on reducing waste, reducing labor costs and gaining a competitive advantage.

REASONS TO USE AMT

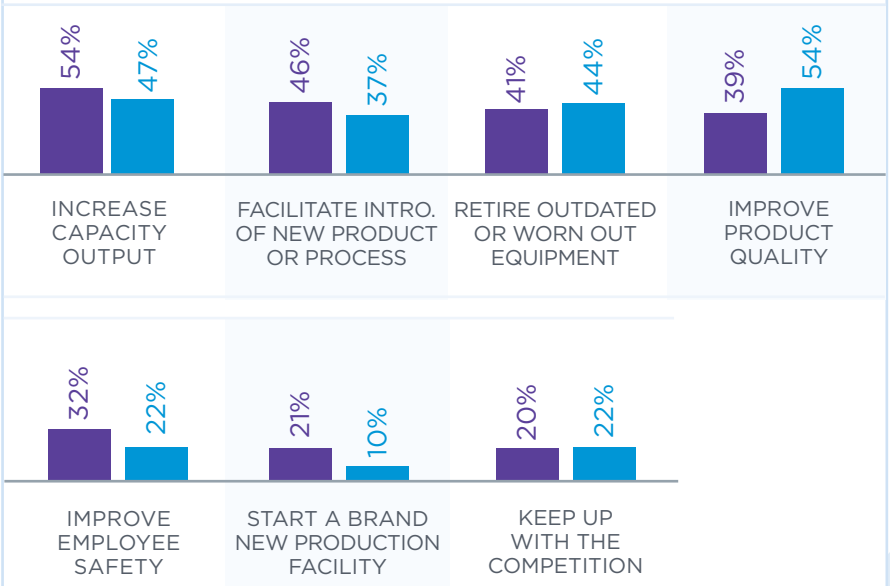


Growth

Regardless of current advanced manufacturing usage, the majority of middle market manufacturers expect to implement advanced manufacturing techniques in the near term. Within the next three to five years, current users say they will most likely implement automation (41%), control systems (36%) and process technologies (35%). Current non-users will concentrate on custom manufacturing (31%), process technologies (29%) and automation (28%).

KEY CAPITAL PRIORITIES

NEXT YEAR

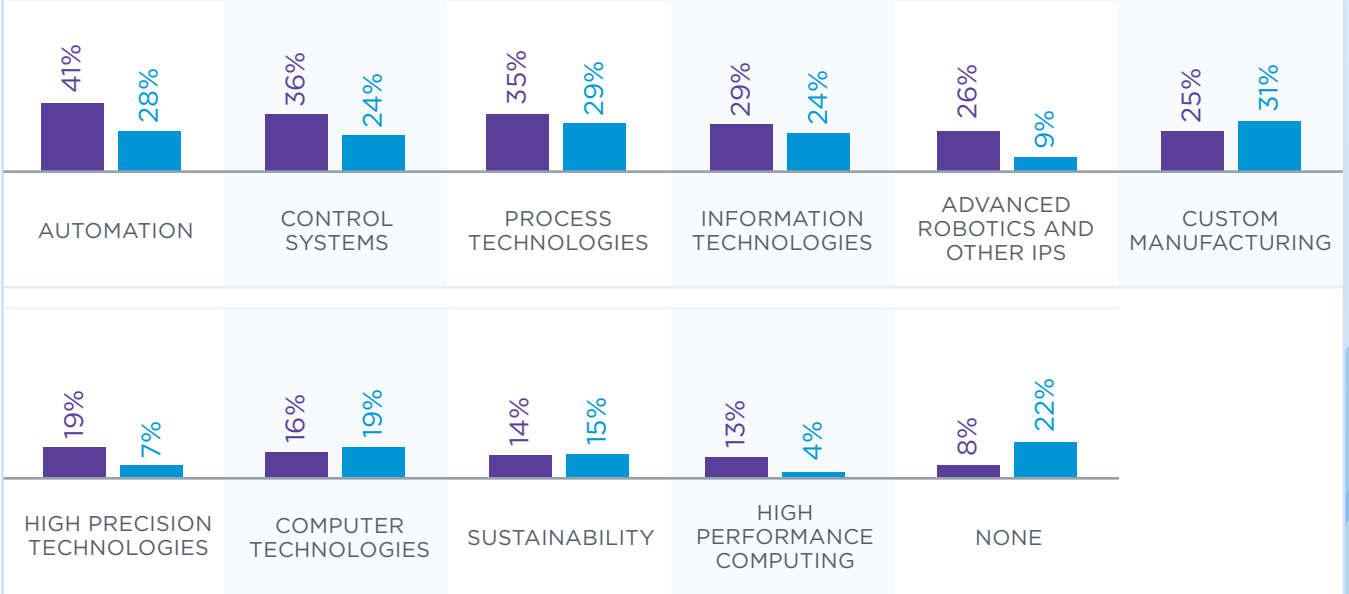


USERS OF AMT

NON-USERS OF AMT

PLANNED ADVANCED MANUFACTURING TECHNOLOGIES TO IMPLEMENT

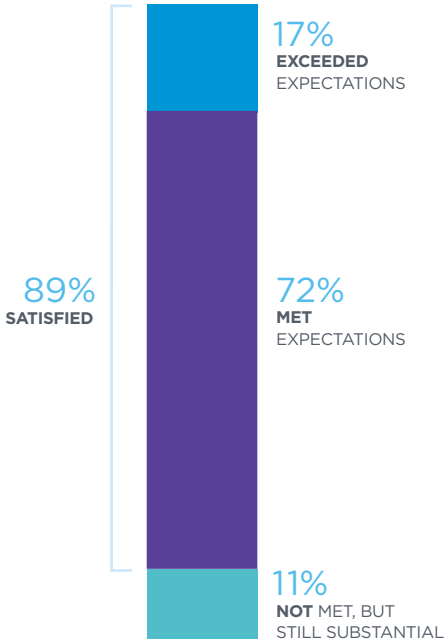
NEXT 3-5 YEARS



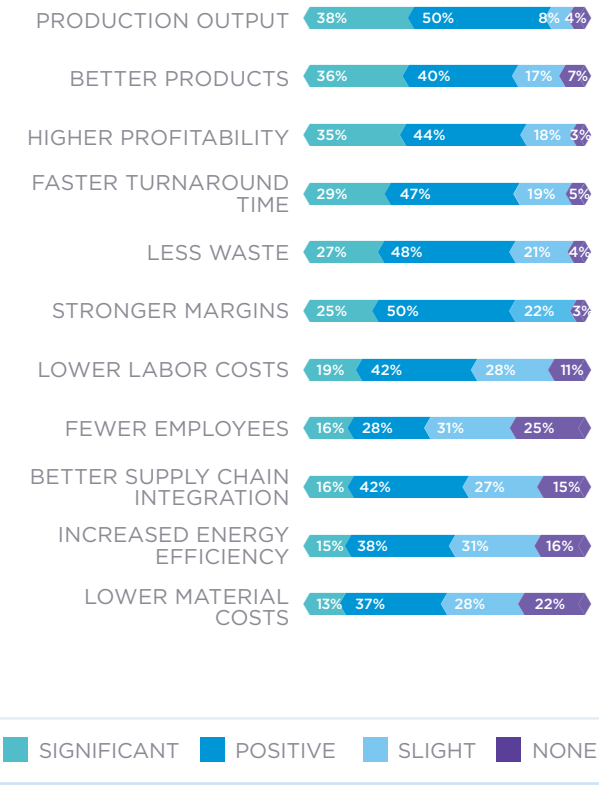
Performance

Nine out of ten middle market users of advanced manufacturing techniques indicate that the technologies have met or exceeded their expectations, clearly demonstrating the effectiveness of advanced manufacturing in middle market firms. The techniques significantly or positively improved production output for 88% of users, improved profitability for 79% of users, improved turnaround times for 76% of users and improved product quality for 76% of users. Additionally, the techniques significantly or positively reduced waste and strengthened margins for 75% of users. What's more, middle market manufacturers reaped the advantages of advanced manufacturing without sacrificing jobs.

AMT SATISFACTION



DEGREE OF IMPACT



Revenues

Over the course of the next year, middle market users of advanced manufacturing techniques expect their revenues to increase on average by 8.4%. Non-users anticipate an average increase of only 6.6%.

GROSS REVENUE SHIFT

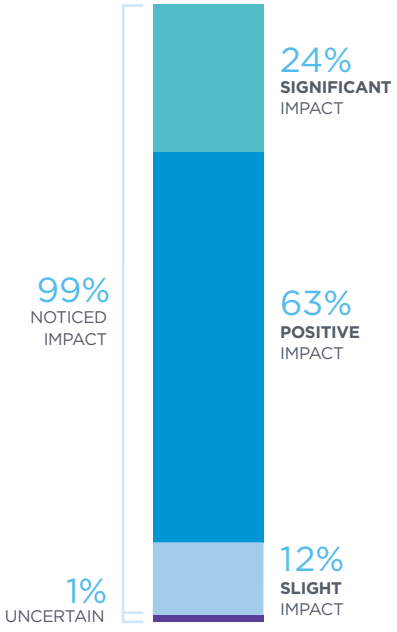
ANTICIPATED ONE YEAR FROM NOW

TOTAL	USERS	NON-USERS
7.7%	8.4%	6.6%
WILL INCREASE 69%	WILL INCREASE 73%	WILL INCREASE 66%
NO CHANGE OVER LAST YEAR 25%	NO CHANGE OVER LAST YEAR 22%	NO CHANGE OVER LAST YEAR 25%
WILL DECREASE 7%	WILL DECREASE 6%	WILL DECREASE 9%

Profit

Advanced manufacturing techniques have improved profitability in varying degrees for nearly all middle market users. Some 63% of users cite a positive impact, and an additional 24% of users categorize the impact as significant. On average, middle market manufacturers who use advanced manufacturing report a 20% increase in their profitability over the past five years.

AMT IMPACT



Employment

Despite the misconception that advanced manufacturing techniques lead to fewer jobs, research shows that job growth for middle market users of the techniques is nearly the same as job growth for non-users. Over the past 12 months, middle market users report actual employment growth of 3.4%, which is similar to the 4.1% growth reported by non-users. Users and non-users alike anticipate robust future year employment growth of 4.7%.

NET EMPLOYMENT SHIFT

ANTICIPATED ONE YEAR FROM NOW

TOTAL	USERS	NON-USERS
4.0%	4.7%	3.5%
WILL INCREASE 46%	WILL INCREASE 49%	WILL INCREASE 50%
NO CHANGE OVER LAST YEAR 44%	NO CHANGE OVER LAST YEAR 41%	NO CHANGE OVER LAST YEAR 40%
WILL DECREASE 10%	WILL DECREASE 10%	WILL DECREASE 10%

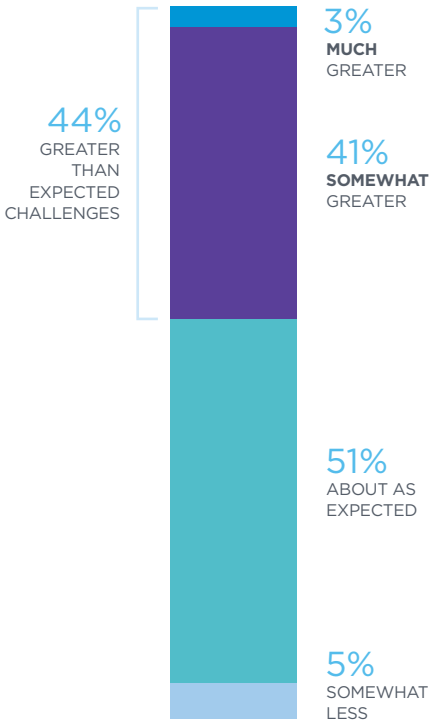
Challenges and Barriers

While advanced manufacturing techniques deliver significant advantages, middle market manufacturers do not realize those benefits without at least some degree of challenge. Not surprisingly, the challenges for current users of the technologies are quite similar to the barriers to adoption for non-users.

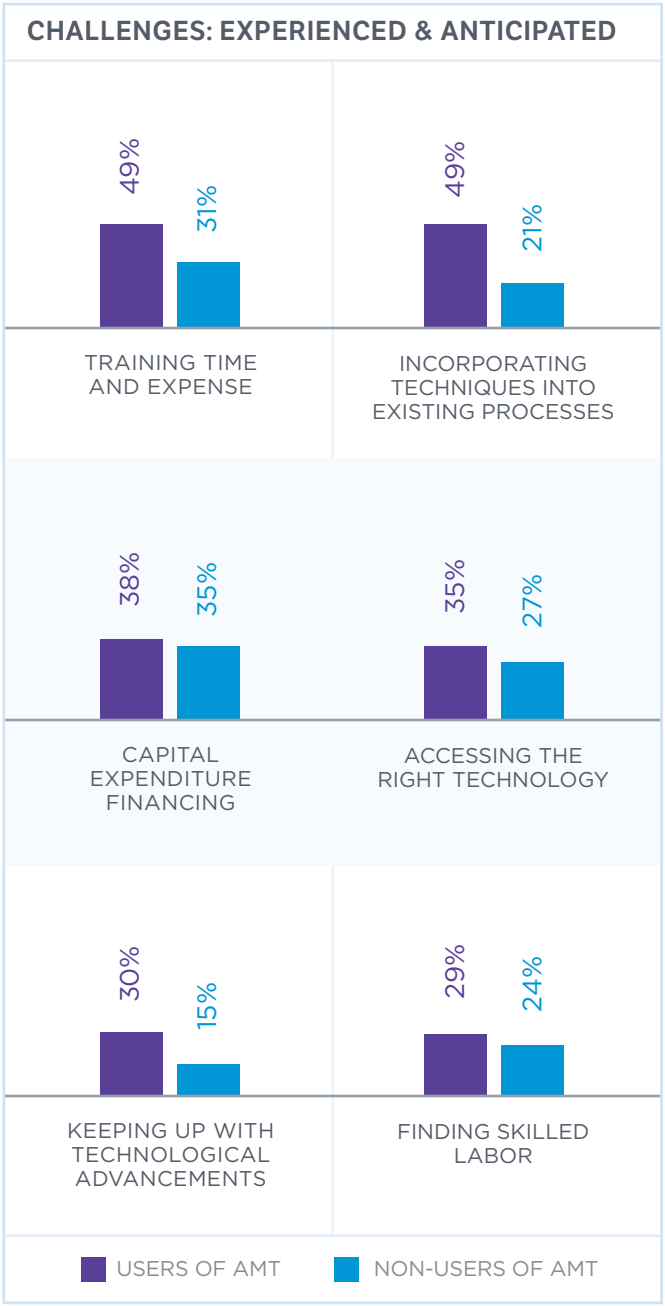
Implementation Challenges

Virtually all (97%) middle market manufacturers currently using advanced manufacturing have experienced some challenges with implementation. Just over half of these manufacturers said the challenges were as expected; however, over 40% described the challenges as somewhat greater than expected. Users cited cost (in terms of time and money invested in training), merging new techniques with existing processes and financing as key implementation challenges. Over a quarter of the manufacturers, or 29%, list finding skilled labor as a challenge.

CHALLENGES COMPARED TO EXPECTATIONS



CHALLENGES: EXPERIENCED & ANTICIPATED

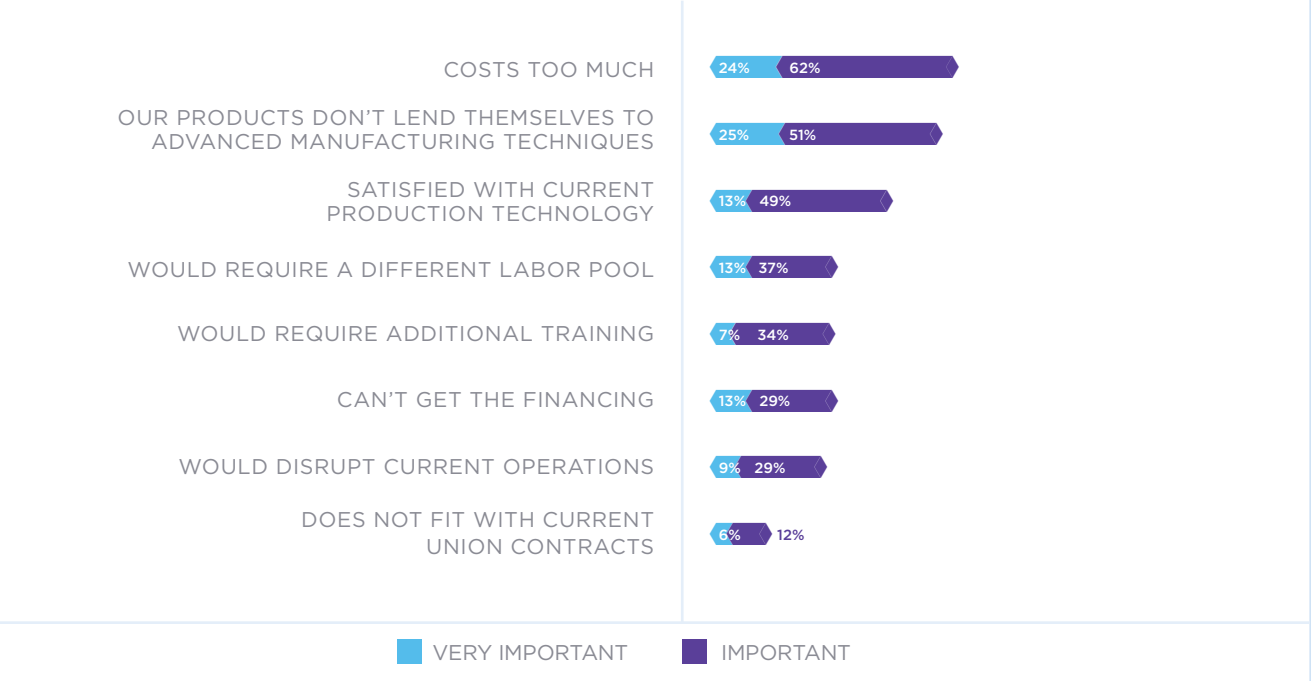


Barriers to Adoption

Of those middle market manufacturers who do not currently use advanced manufacturing techniques, 62% cite cost as the greatest inhibitor to implementation, with almost a quarter saying cost is a very important factor in the decision not to implement advanced manufacturing at this time. Slightly over half of non-users claim that their products do not mesh well with advanced manufacturing techniques, while 49% indicate they are satisfied with their current production technology and 37% say advanced manufacturing would require a different labor pool.

Barriers to adopting advanced manufacturing vary based on the size of the middle market company. Lower middle firms ($10MM - <$50MM) are more likely to list cost as an important or very important hurdle than their larger counterparts, while emerging large manufacturers ($100MM - <$1B) are more likely to list incompatibility with current union contractors as a barrier.

REASONS NOT TO USE AMT



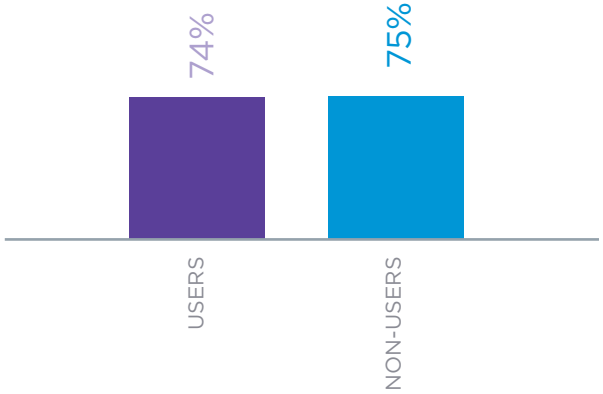
The Skills Gap

Middle market manufacturers struggle with a skills gap regardless of whether or not they use advanced manufacturing techniques. Three in four manufacturers are trying to hire, and 52% of advanced manufacturing users and 47% of non-users have unfilled positions. The skills gap issue is most prevalent in the South and less of a challenge in the West.

On average, manufacturers indicate that production line workers are most likely to lack the necessary skills. Science, math and technology represent the greatest deficiencies among applicants for skilled production positions, followed by characteristics such as attendance, timeliness and work ethic. Users of advanced manufacturing techniques are more likely to note STEM skills deficiencies than non-users (74% compared to 62%).

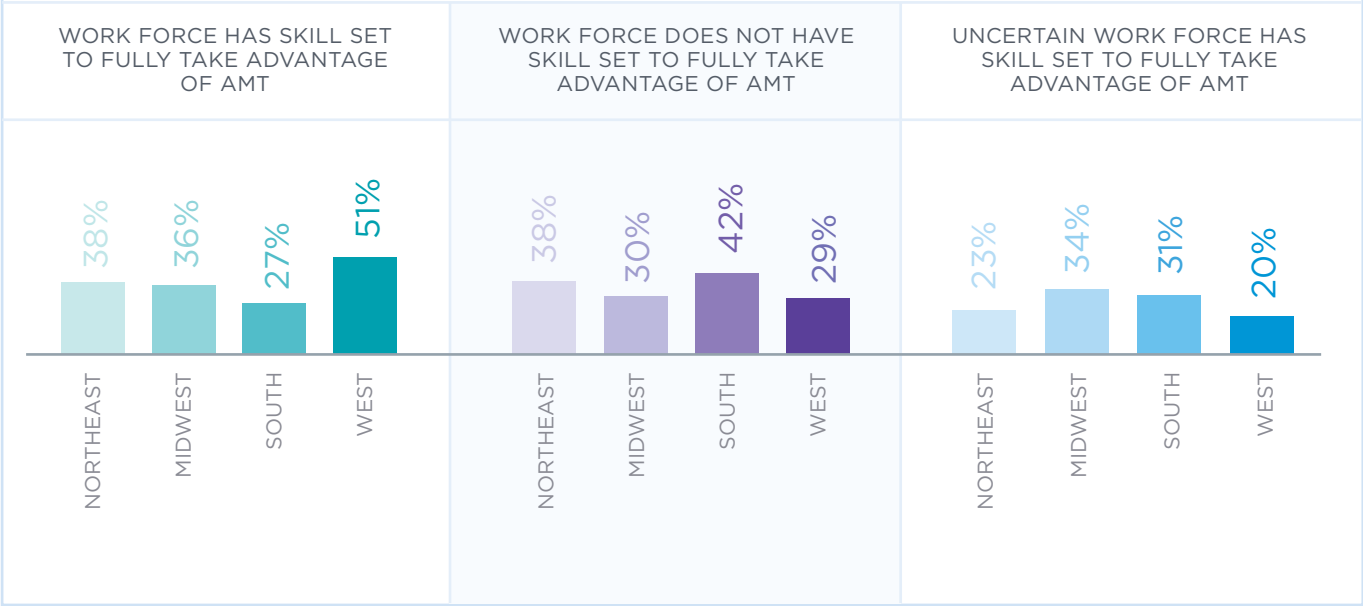
HOW SKILLS GAPS ARE ADDRESSED

TRYING TO HIRE



UNFILLED POSITIONS

CHALLENGES COMPARED TO EXPECTATIONS

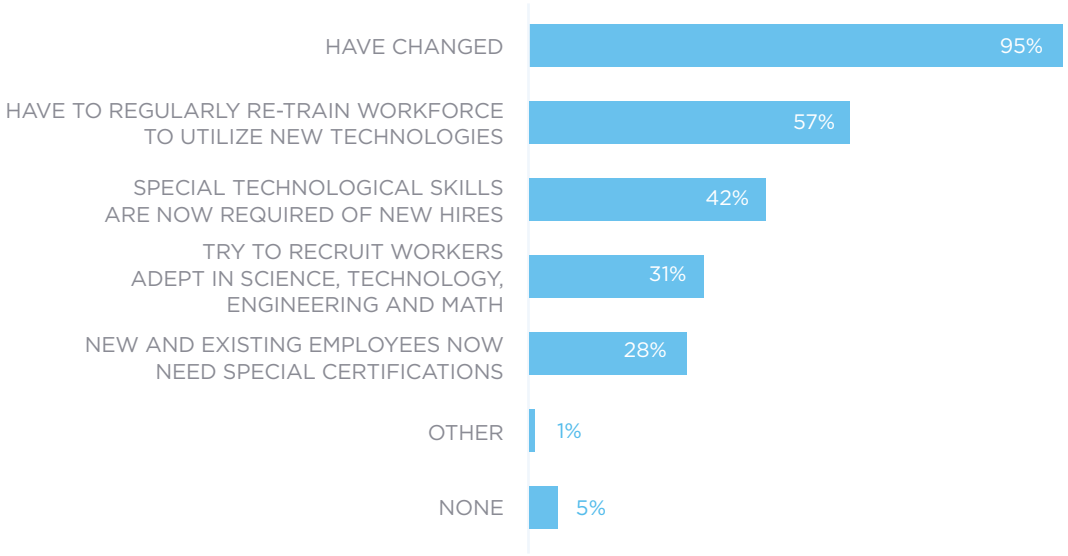


Addressing the Skills Gap

Middle market users of advanced manufacturing as well as non-users are attempting to address the skills gap. For users, the vast majority, or 95%, have shifted recruitment strategies. Specifically, 57% regularly retrain workers to leverage new technologies, 42% require new hires to demonstrate special technological skills and 31% actively recruit workers with STEM skills.

CHANGES DRIVEN BY AMT

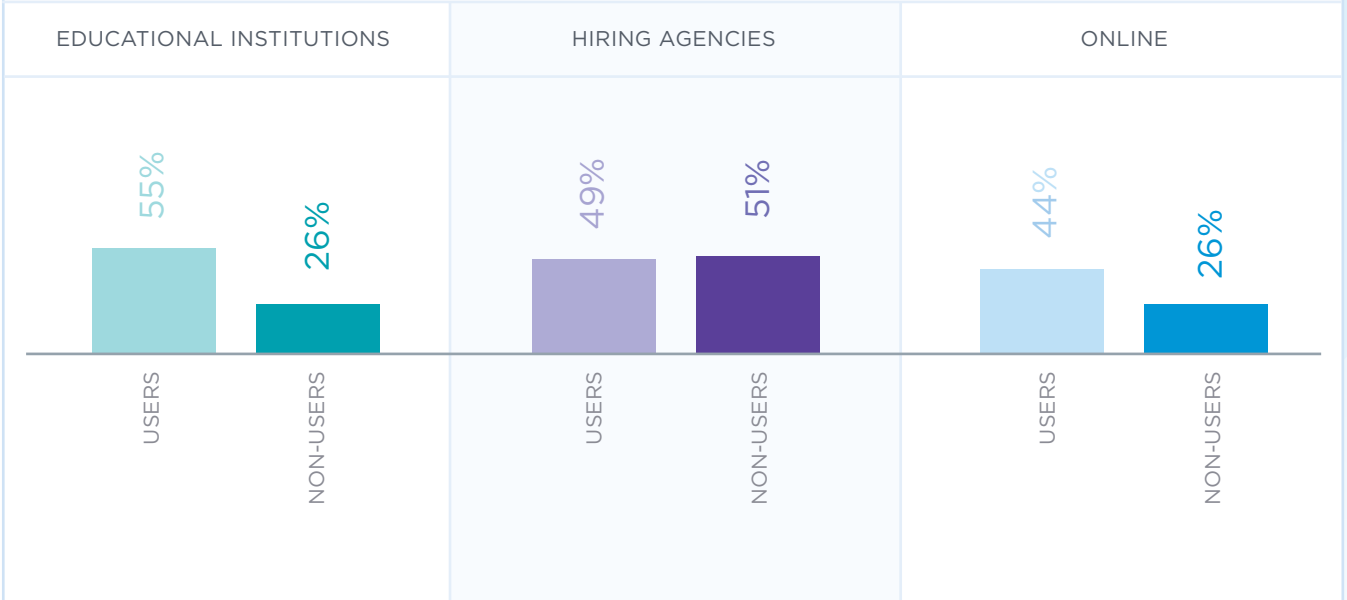
TRAINING/RECRUITMENT



While 47% of non-users of advanced manufacturing rely on temporary staffing services to address the skills gap, manufacturers who use advanced manufacturing are more likely to create or expand internal training programs (51%) or collaborate with technical schools and community colleges (42%) to resolve the skills gap challenge. Users of advanced manufacturing are also more likely than non-users to turn to educational institutions (55% vs 26%) and the Internet (44% vs 26%) as sources for skilled employees.

HOW AMT SKILLS GAPS ARE ADDRESSED

TOP SOURCES OF SKILLED EMPLOYEES



The NCMM's Perspective

Kenneth K. Boyer, PhD, Dean's Distinguished Professor, The Ohio State University Fisher College of Business

There is a theory named the Red Queen Running, from the book *Alice in Wonderland*, that posits that companies must run continuously to keep up with the fast moving landscape. The results of the current Advanced Manufacturing Technologies study well illustrate that many middle market firms are firmly in the race, yet there are many challenges and barriers in their path.

TRAIN AND DEVELOP EMPLOYEES

First, it is encouraging that 47% of middle market companies note that they use these technologies, but even more important, that they report an average profit increase of 20% based on these technologies. Being proactive with manufacturing technology has been shown to be a critical strategy for being successful in numerous research studies. However, the average increase in profits of 20% obscures the reality that there is inevitably great variability in results. Research in numerous studies has indicated that companies should spend more on training - perhaps twice as much - than on buying the actual technology[1]. Results show that users allocate 8.8 weeks on training and 7.4% of sales on training/development – substantially more than non-users. This is of critical importance since there is a positive relationship between training and performance.

BE FLEXIBLE

Second, managers must remember to be flexible, both in terms of what technologies companies invest in, and in how they are applied. It is critical that managers carefully consider what technologies are the best fit, and allocate their investments accordingly. Much research has shown that careful investment strategies are critical – and interestingly, the mix of technologies is relatively constant over the years. Robots may be cool in TV and the movies, but they were the lowest usage technology in 1994 and in 2013 – partly because they are very expensive and limited in application to a few industries. Similarly, the highest ranked technologies today are automation and computer technologies – not very different from Computer Aided Design (CAD) and Computer Numerical Control Machine Tools in 1994[2]. Just as important as flexibility in which technologies to use is the need to remember to use them to customize and make manufacturing more flexible. Research has consistently shown that using technology to be agile and make different products is a better strategy than simply using technology to increase output and replace people[3]. The current study shows that middle market firms most value advanced manufacturing techniques to improve production output (90%) and increase profitability (90%) – yet the research suggests a cautionary note, increasing production output alone is not a sure route to increased profits, it is important to increase output of what the customer wants – i.e., to capitalize on flexibility. The average increase in profits of 20% suggests that many middle market firms have found a working strategy.

BE PATIENT

Finally, managers should remember the adage that patience is a virtue. Manufacturing technologies often have a long lead time between implementation and increased performance – often several years[4]. The current study highlights a couple of interesting findings. First, both users of advanced manufacturing techniques and non-users plan to implement significantly more technology in the next three to five years – this is good because being proactive with technology is a proven success strategy. However, the study also shows that 57% of users have to regularly re-train the workforce and 42% have to hire workers with special skills. It is reassuring that many users are employing internal training programs (51%) and collaborating with educational institutions on skills certification programs (42%).

CONCLUSION

Many, but not all, middle market companies are making effective use of advanced manufacturing technologies. The factory of the future is here – yet it is changing all the time, so companies that are proactive greatly increase their chances of success.

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1. Boyer, K.K., Leong, G.K., Ward, P.T., Krajewski, L.J., 1997, "Unlocking the Potential of Advanced Manufacturing Technologies", *Journal of Operations Management*, Vol. 15. McDermott, C.M., Stock, G.N., 1999, "Organizational Culture and Advanced Manufacturing Technology Implementation", *Journal of Operations Management*, Vol. 17, N. 5, pp. 521-533.

2. Boyer, K.K., "Investing in Advanced Manufacturing Technology", *The Fabricator*, Vol. 24, No. 8, October, 1994, pp. 60-65.

3. Boyer, K.K., Ward, P.T., Leong, G.K., 1996, "Approaches to the Factory of the Future: An Empirical Taxonomy", *Journal of Operations Management*, Vol. 14, No. 4, 1996, pp. 297-313.

4. Boyer, K.K., 1999, "Evolutionary Patterns of Flexible Automation and Performance: A Longitudinal Study", *Management Science*, Vol. 45, No. 6, 1999, pp. 824-842.

The NAM's Perspective

Chad Moutray, Chief Economist
National Association of Manufacturers

The manufacturing sector in the United States is poised for growth across the next decade. Business leaders are looking increasingly at the United States as a viable location for investment, spurred by lower energy prices; increased productivity and quality; higher transportation expenses; and rising costs elsewhere. The manufacturing resurgence has garnered tremendous attention, spotlighting an industry that some had written off just a few years ago. Manufacturers have added roughly 500,000 net new workers since the end of the recession, with prospects for future growth high.

Of course, much of that future success depends on our ability to compete globally, implementing the latest innovations and technologies, pursuing growth in new markets and hiring the most talented people. That is why the results of the National Association of Manufacturers (NAM) and the National Center for the Middle Market's *Advanced Manufacturing Techniques* study are so important. Many Americans, especially the younger generation, have a preconceived notion of what a blue-collar worker is, and for that reason, we have very real challenges in changing perceptions about modern manufacturing. Manufacturing today is an extremely high-tech, high-skill endeavor that is always evolving, and the data tends to back this view up.

This research shows that nearly half of all middle-market manufacturing companies use advanced production techniques. This includes a wide variety of high-tech tools, including automation, computerization, control systems, robotics and processes to improve sustainability. There are many reasons why manufacturers are adopting these technologies, ranging from productivity gains to higher profit margins to waste reduction. By using more advanced techniques, manufacturers can reduce labor costs, produce better products and improve their global competitiveness.

As noted, the implementation of advanced manufacturing techniques relies heavily on high-skilled talent. Yet, many of them cannot find the workers with the skills needed to fill open positions. Roughly half of all survey respondents said they have unfilled positions due to a skills gap. An internal NAM survey of middle-market manufacturers conducted in October 2012 found that more than 62 percent had unfilled positions that they were unable to fill. This statistic is surprising given the still-elevated unemployment rates that we continue to experience. This issue is not going to go away anytime soon. With baby boomer retirements, the pipeline of available new talent to replace the aging manufacturing workforce is shrinking.

This survey finds most applicants lack science, technology, engineering and math (STEM) skills needed for today's shop floors, with manufacturers also citing the importance of management and communications skills. Manufacturers using advanced production techniques were more likely to create internal programs and/or collaborate with educational institutions to address their hiring needs proactively than those that did not profess to use such techniques.

To combat the skills gap, the Manufacturing Institute—the nonpartisan affiliate of the NAM—announced the goal of credentialing 500,000 workers with skills certifications aligned to manufacturers' hiring needs by the end of 2016. President Obama highlighted the Institute's NAM-Endorsed Skills Certification System in June 2011 as a model for industry-based credentials and announced key steps toward building the educated and skilled workforce manufacturers in the United States need to compete successfully in the 21st-century economy.

The NAM-Endorsed Skills Certification System is a group of stackable credentials applicable to all sectors of the manufacturing economy. These nationally portable, industry-recognized credentials validate the skills and competencies needed to be productive and successful in entry-level positions in any manufacturing environment, and they can be learned and earned in secondary and postsecondary education. The result is a professional and technical manufacturing workforce with valuable industry credentials, making companies more innovative, more competitive and more marketable. The certification system, which is already available in 31 states and continues to expand, can help manufacturers achieve the trained workforce they demand.

Beyond certification, it is also important to change perceptions about what modern, advanced manufacturing is and what it is not. "Dream It. Do It." is the Institute's national manufacturing career awareness and recruitment program that includes local and national activities in 25 areas around the country to engage, educate and employ the next generation of skilled manufacturing talent.

In summary, these survey results highlight the changing manufacturing landscape, one that increasingly embraces advanced manufacturing techniques. Manufacturers are benefiting from investments made in innovation and technology in years past. Those investments help to propel productivity, keep manufacturing costs down, increase process efficiencies and allow U.S. companies to become more competitive globally.

To stay ahead, however, we must stay focused on new innovations that keep us at the forefront of technology. This means continuing to invest in both human and physical capital and expanding research and development efforts.

Advanced Manufacturing Resources

National resources to assist with the improvement of existing advanced manufacturing techniques or the implementation of advanced manufacturing techniques.

American Society for Training & Development
www.astd.org

The Manufacturing Institute
www.themanufacturinginstitute.org/skills-certification

National Center for Construction Education and Research
www.nccer.org

Career One Stop
www.careeronestop.org/educationtraining

Employment & Training Administration
www.doleta.gov

State Community Colleges
www.community-college.org

Department of Labor
www.dol.gov

Skills USA
www.skillsusa.org/events

National Skills Coalition
www.nationalskillscoalition.org

Keytrain/Workeys
www.keytrain.com

Complete College America
www.completecollege.org

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The National Center for the Middle Market is the leading source of knowledge, leadership, and innovative research focused on the U.S. Middle Market economy. The Center provides critical data, analysis, insights, and perspectives to help accelerate growth, increase competitiveness, and create jobs for companies, policymakers, and other key stakeholders in this sector. Stay connected to the Center by contacting middlemarketcenter@fisher.osu.edu.

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