

Most In-Demand Skills in Manufacturing

Lack of general mechanical aptitude – sometimes the basic ability to use hand tools – leaves manufacturers in a quandary.

In the 2019 Minnesota Hiring Difficulties Survey, manufacturing employers attributed one out of three hard-to-fill vacancies (34 percent) to skills gaps, a lack of skills in applicants. Hard-to-fill occupations, due to skills gaps, were Quality Technicians, Machinists, and CNC Machinists/Machine Tool Programmers (Table 1). These occupations have become more skilled and specialized as a result of automated technologies, but workforce skills haven't kept up. In contrast, Machinery Maintenance Workers, Industrial Machinery Mechanics, and CNC Machine Operators had a low incidence of skills gaps because they are becoming less skilled – and less in demand – as more complex tasks are being performed by machines. Table 1 also shows that most of these occupations require on-the-job training, either medium-term (more than one month and up to 12 months) or long-term (more than 12 months).

Which Skills are Hardest to Find?

By far the biggest gap identified in job applicants is general mechanical aptitude, sometimes as basic as the ability to use hand tools such as a drill or a screwdriver. Some employers would be willing to hire people straight out of high school if they had mechanical aptitude. Respondents characterized this gap as generational: Younger generations have not grown up tinkering and fixing things as a hobby like previous generations. Another hard-to-find skill set is math, especially trigonometry, algebra, and geometry. The disappearance of vocational and technical training from high school also contributed to youths' lack of exposure to the use of tools, measuring equipment, machine shop math, and hands-on problem solving.

Mechanical skills, in particular, are integral to new manufacturing technologies. They are required to understand what is happening under the

automation, such as setting up the automation, repairing and maintaining the machines, and understanding the properties of materials.

These responses illustrate the mix of skills that employers report as hardest to find:

“It would be helpful if more applicants had a hobby with cars or fixing things.”

“Some of the applicants don't even know what a drill is. In this position, it is a skill set.”

“The younger generation is not as mechanically inclined, so they require extra training when they are hired.”

“The work requires someone very mechanically inclined. It's a lot of math and problem solving. Finding somebody that has that tenacity to work through it is tough. Our products are not standardized. New issues emerge that require problem solving.”

“A lot of applicants are just operators, they push the button and the machine goes. With set-up there may be some programming involved, editing, or understanding the entire process of using the machine to check the part and reading/ understanding the data related to setting up the part.”

The survey also asked employers if skilled production staff have any gaps in skills or knowledge that would benefit from additional training. The skills most in need of improvement are developed through work experience, while a minority are

deemed well suited for classroom delivery. Among the latter, English as a Second Language was mentioned by employers who hire from the immigrant community.

Here are some examples:

“Our newest employees would benefit from going through our own on-the-job training and learning our specialized attachments.”

“We would need more robotics training through train the trainer, not needing to go back to school for. We would have

somebody from our site go and learn the skill and then come back and train the staff.”

“I cross-train them in-house. A person is used to operating a lathe but doesn’t operate a mill, so I will put them through running a mill so they learn that, too.”

“Some of our employees have not gone to school to be a welder or machinist. We’ve thought about getting them some blueprint reading/ training, some math classes that the machinists would need.”

Table 1. Role of Skills Gaps in Hiring Difficulties by Occupation

Occupation	Percent in which skills gaps are the biggest problem when hiring (1)	Most common training required (2)	Most typical on-the-job training needed for competency (2)
Quality Technicians/Inspectors (SOC 519061)	88%	High school diploma or equivalent	Moderate-term on-the-job training
Tool and Die Makers (SOC 514111)	78%	Vocational certificate	Long-term on-the-job training
Machinists and CNC Machinists/Machine Tool Programmers (SOC 514012 and 514041)	60%	Vocational certificate	Long-term on-the-job training
Welders (SOC 514122)	36%	High school diploma or equivalent	Moderate-term on-the-job training
Miscellaneous Engineering Technicians (SOC 173013, 173023, and 173024)	31%	Associate degree	None
Machinery Maintenance Workers and Industrial Machinery Mechanics (SOC 499041 and 499043)	22%	High school diploma or equivalent	Moderate-term on-the-job training
CNC Machine Operators (SOC 514011)	15%	High school diploma or equivalent	Moderate-term on-the-job training

(1) 2019 Minnesota Hiring Difficulties Survey.

(2) On-the-job training includes employer-sponsored training programs. Source: Bureau of Labor Statistics Education and Training measures www.bls.gov/emp/tables/education-and-training-by-occupation.htm

Study Design: This study leverages spring 2018 Minnesota Job Vacancy Survey results. A subset of reported vacancies was selected for further study based on occupation and industry. For all selected vacancies, the research team made follow-up phone calls to employers to ask about their experiences filling these vacancies. In total, 146 establishments out of the 217 sampled responded to the follow-up telephone survey, representing a 67 percent response rate.¹ Survey findings are summarized in this Trends article mn.gov/deed/newscenter/publications/trends/september-2019/mfg-hiring-difficulties.jsp.

¹Results and detailed methodology from previous rounds of the survey are available on DEED's website at mn.gov/deed/data/lmi-reports/hiring-difficulties-mn/. Comprehensive information about the JVS methodology is available at mn.gov/deed/data/data-tools/job-vacancy/jvs-methodology.jsp.

“The staff would benefit from English as a Second Language training. That is the biggest obstacle we have.”

“Machinists could use skilled training on learning things like programming and keeping up-to-date with newer machines. We bring in a new machine every year to be more up with what we have in our machine shop. We offer training on how to program the new machines.”

Table 2 summarizes the skills most frequently lacking in candidates or in current workers in skilled production.

As low-skilled manufacturing jobs (such as assemblers and operators) are replaced with higher-skilled jobs, mechanical and math skills will continue to be the foundation upon which emerging skill sets are built, such as machine learning and robotics. We won't be able to upskill the workforce or train new workers in emerging job roles if we fail to develop math and mechanical skills from an early age.

Whose Job is it to Fill Skills Gaps?

How can the skills (Table 2) be developed? According to survey results, expanding

manufacturing-related vocational and associate degree programs, especially in Greater Minnesota² would help mitigate workforce shortages in occupations listed in Table 1 as requiring post-secondary training. However, employers also made it very clear that increasing post-secondary training is not enough. As the following responses indicate, lack of experience could still be a barrier to hiring even if candidates have good educational credentials:

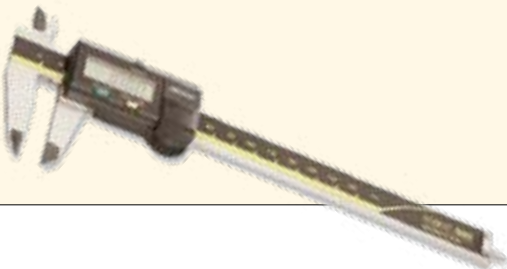
“Experience is lacking, not post-secondary training. Each brand of machine does a little bit different style of offset. People who are applying seemed like they had only seen a CNC Machine but never had a whole lot of experience with one.”

“The quality control inspector job requires specialized experience more than any type of degree. The specialized experience is developed here as an operator.”

“We have trouble finding candidates with previous experience working on a Swiss machine. Those machines are not very common, so finding someone who has worked on that machine before is tough.”

²DEED's Occupations In Demand tool shows that only two schools offer a program in Tool and Die Making in the entire state (https://apps.deed.state.mn.us/lmi/oid/CIP_SchoolDetail.aspx?id=514111&geog=2701000000) and no program for CNC Machining exists in Northwest Minnesota (see https://apps.deed.state.mn.us/lmi/oid/CIP_SchoolDetail.aspx?id=514012&geog=2701000000).

Table 2: Skills/Knowledge/Experience Shortage Areas

Lacking in applicants	Lacking in workforce
<p>Degrees or Certifications:</p> <p>Machining and CNC Machining Vocational degree, Machine Tool Technology Vocational degree; any degree in Mechatronics and Robotics; boiler operator license; welding certificate</p> <p>Knowledge:</p> <p>Manufacturing math, especially trigonometry and algebra; blueprint reading; hydraulics, pneumatics, and electronics (logic controls); special machine language codes (especially G and M code)</p>	<p>Most Commonly Cited Training Needed:</p> <p>6G welding certification; CWI (Certified Welding Inspector) certification; Computer-Aided Design classes; machine shop courses to keep up-to-date with newer machines; general math, algebra training; English as a Second Language; computer programming</p>
<p>Skills best developed on the job:</p> <ul style="list-style-type: none"> • Mechanical training, including use of hand tools and power tools (i.e., drills, press, etc.) • Read and understand proper use of measuring equipment (microscopes, micrometer, gauges, calipers) • Geometric Dimensioning and Tolerancing (GD&T) experience • Welding, both general and precision welding • Operate Computer-Aided Design (CAD) software and convert designs into computer-aided manufacturing (CAM) programs • Experience with industrial manufacturing equipment such as motors and controls, including ability to assess, diagnose, and repair machinery such as CNC machines, industrial robotics components, electrical equipment, pneumatic and hydraulic equipment • Experience building fixtures (devices that hold metal while it is bored, stamped, or drilled) • Robotics and mechatronics skills (mechanical and electronics) • Experience building and repairing tools from blueprints • Experience running or programming a CMM (Coordinate Measuring Machine) to inspect parts • Experience with multi-axis milling and lathe 	<p>Skills best developed on the job:</p> <ul style="list-style-type: none"> • General mechanical knowledge and abilities • Blueprint reading • Tool and safety training • Use of inspection equipment/tools such as calipers, drop indicators, micrometers and pin gauges; experience measuring and interpreting quality metrics • Soldering and welding • Robotics • Experience with Programmable Logic Controls • Able to adapt to different coding language platforms • Able to adapt to a variety of machines, such as lathe and mill machines • LEAN or continuous improvement 



Identifying skills needs and determining the best training delivery methods are daunting tasks in today's manufacturing firms. Skill requirements are becoming more STEM-like and multi-disciplinary, not only because IT skills have been added to the daily work, but also because of changing technologies. Many job postings reviewed in this study require a mix of skill sets traditionally acquired through separate educational tracks, making it harder for employers to find post-secondary programs that meet all of their needs. A machinist today might be expected to perform manual machining as well as computer-aided machining, work on a variety of machines, do preventive maintenance,

inspect and monitor quality, and participate in product design decisions alongside engineers. CNC programmers are expected to learn more about the machining side of the work. Manufacturing technicians and quality inspectors are often required to know how to operate and program CNC machines to inspect quality. The ideal training would teach programming, knowledge of mechanical and electrical principles, knowledge of quality measurement and reading data for process improvement purposes, problem-solving, and occasionally project management.

Rapidly changing technologies make it very hard for employers to accurately identify and draw the talent they need. Since every

market is impacted differently, employers are on their own when it comes to determining which skills can be taught internally and which are best taught in post-secondary school. For example, when hiring a machinist, some employers only want a high school diploma while others require a degree. And, of those who require only a high school diploma, some complain about not finding candidates with formal post-secondary credentials.

The absence of an industry-recognized standard to certify competency levels in machining-related occupations compounds the problem. One of the few existing industry-recognized credentials, the National Institute for Metalworking Skills (NIMS) Credentialing program, is considered inadequate by some employers because it only measures foundational knowledge, and the exams contain errors and obsolete practices. Therefore, efforts should not be limited to designing high-quality certification standards that employers can agree upon but should include frequent updates to ensure their relevance.

While employers understand the importance of their relationship with local colleges and high schools, working out the terms of partnerships takes time and effort. The following

response illustrates how hard and time-consuming it can be for employers to identify competencies and educational requirements for a CNC machinist:

“We tried to implement a part-time apprenticeship program that lasted three years and was a hybrid between on-the-job training and getting the full degree. However, at the end of the program we determined that it was not the best way to develop the skills we need. We realized that a full CNC machinist has to have the two-year degree. Our interns that go through the formal Machine Tool two-year degree program receive better quality instruction. Therefore, we are now offering tuition reimbursement to people willing to actually get the two-year Machine Tool degree or Mechatronics degree.”

Unless employers can clearly identify their skills needs and types of training to acquire them, they will struggle to

communicate their needs not only to job seekers but to vocational training institutions.

Filling Skills Gaps: Best Practices

The survey asked employers what they’ve done in response to hiring difficulties. The most effective strategies address the disincentives employers face in delivering on-the-job training. Here are some steps Minnesota manufacturers are taking to bridge skills shortages before they turn into full-blown hiring difficulties:

- Promote high school summer internships to encourage young people to pursue careers and training in manufacturing. This helps employers by creating a pool of experienced candidates;
- Partner with local technical schools by offering internships and work-based learning opportunities for students early in the program. Developing a relationship with post-secondary institutions could

lead to collaboration on updating the curriculum with industry-approved competency standards, which is essential to improving alignment between school offerings and employer needs;

- Improve internal training by assessing skills needs, training the trainers, and investing in equipment – such as welding and machining laboratories – to simulate the work environment and prepare new hires;
- Improve employee retention through enhanced training for new hires, offering career ladder opportunities, and linking skills mastery to pay raises;
- Make use of state-funded programs, especially the Minnesota Apprenticeship Initiative³ (MAI), which offers grants to assist with the costs of developing apprenticeship programs, and the Pipeline Training program⁴, which supports work-based training combined with classroom training through a partner college.

³This program, funded by the Minnesota Department of Employment and Economic Development and the Minnesota Department of Labor and Industry, offers grants to assist employers with costs associated with developing apprenticeship programs. The goal is to get 100 companies to hire 1,000 apprentices by the end of 2020. www.dli.mn.gov/mai

⁴This program, funded by the Minnesota Department of Labor and Industry, supports employers in delivering work-based training together with classroom training through a partner college. Employers can hire students enrolled in trades-related post-secondary programs and provide them with OJT that relates to what they are studying. Employers also reimburse the cost of their tuition, with part of this funding coming from the state via a grant. The company agrees to offer participants a full-time position upon completion of their degree. In return, the students agree to work for the company for two years. The program also provides technical assistance to help employers identify internal skill needs and design delivery methods. www.dli.mn.gov/pipeline

Conclusions

Manufacturing offers well-paying jobs that require only a high school diploma or short-term post-secondary training. With the rising cost of college, more should be done to connect high school students to excellent opportunities in manufacturing, including access to an affordable college education, technical skills acquisition and the potential for career advancement.

But despite these advantages, the talent pipeline is shrinking faster than the system's ability to

build it. A coordinated response is needed at three levels: middle and high school, two-year post-secondary and trade schools, and businesses. Here are actions that could be effective at each level:

1. High schools can equip students with foundational skills, such as mechanical and math skills, computer coding, and problem solving. Since these competencies are essential in many industries and careers, school counselors and parents should be persuaded of their value.

More investments are needed to make Career and Technical Education more academically rigorous and to expand opportunities to combine classroom and workplace experience.

2. Post-secondary schools can design more inter-disciplinary curricula aligned with emerging skill requirements. Schools could coordinate with employers to offer students opportunities to work while they are in school. The guarantee of a full-time job at the end of the program is a powerful incentive for prospective students.

3. Employers are in the best position to identify and teach specific skills. Making employer-sponsored training more effective can improve retention, enabling firms to promote from within.

Without greater investment and collaboration, employers will have more difficulty and face more costs meeting their skill needs, especially in industry sectors and regions where retirements hit the hardest. A concerted effort must be undertaken to grow the talent needed to keep Minnesota manufacturing at the cutting edge of technology. **■**

