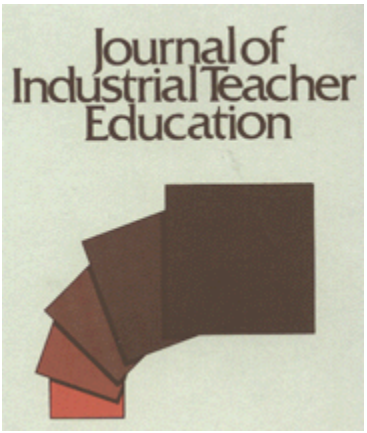


Current Editor:
Janet Z Burns jburns@gsu.edu

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# Replacing Technically Skilled Workers: Challenges and Suggestions

**Cheryl E. P. Evanciew**
**Steven V. Wither**
**Clemson University**

Throughout the early 1900s, the United States could either find technically skilled workers based upon their backgrounds or was able to train workers quickly. Farmers, military personnel, and other sources of skilled workers were available to fill the needs of the workforce. These sources of readily available skilled workers are no longer as common, and the educational system is not preparing the number of graduates seen during the 1970s and 1980s. With the current increase in manufacturing productivity, is a skilled workforce still required?

The manufacturing industry has used and continues to use a variety of strategies to increase productivity and decrease production costs. One requirement for success noted in these initiatives is to ensure reliable equipment. The formulas and plans for the proposed initiatives assume the equipment will run as designed each and every time it is needed. The formulas in these initiatives range from how to eliminate waste in the process to how to run the equipment at customer demand rates, such as lean manufacturing.

But what if the manufacturer begins a production run and the equipment does not operate correctly? What if, during a production run to supply a just-in-time process, the equipment fails? The work behind the formulas and scenarios that are used in these productivity

initiatives then fails to produce, due to lack of reliable equipment. It is apparent that manufacturing needs people with the skills to maintain equipment in such a way as to ensure operability and reliability. These required maintenance skills are not easily found in today's workforce.

Effective plant maintenance is required for any productivity initiative to succeed. Unfortunately, maintenance is often a misunderstood discipline; and the maintenance worker is just as often misunderstood. Maintenance is commonly described in terms of preserving or sustaining equipment in proper condition, while repair is viewed as an action necessary to restore equipment to sound condition after damage. Herein lies the problem with many manufacturing facilities. The emphasis for maintenance should not be on repair, but on equipment maintenance. Today's skilled maintenance worker is a hidden treasure because the maintenance skills required for reliable plant equipment are usually not found in the average citizen. Plants are searching for skilled workers to fill the knowledge and skill voids in their maintenance staff.

## Is There a Skill Deficiency?

Are industries really in need of skilled maintenance employees? A survey conducted by Jasinowski (2001) for the National Association of Manufacturers revealed these findings. "In 2001 more than 80 percent of manufacturers (in the survey) reported a shortage of qualified job candidates despite the recession in manufacturing and the economic downturn overall" (p. 1). Jasinowski further indicated that "demographic experts predict we will need up to 12 million skilled workers before 2020, despite an increase in 18-24 year olds through 2015" (p. 21).

The Manufacturing Skill Standards Council (MSSC) (2002) has also indicated a projected need for skilled maintenance workers. The mission of the MSSC is to develop a national skill standards system for manufacturing in response to industry's growing need to find skilled workers. The MSSC system, skill standards, assessments, and certifications, is designed to give manufacturers a yardstick to measure, improve, and profit from a workforce trained in cutting-edge manufacturing skills. The MSSC provided the following projections.

> The Big Three U.S. automakers will need some 250,000 mostly skilled new workers by the year 2005. In the same time frame, more than one million technicians will be needed to meet the requirements of the information technology industry. The semiconductor industry is conducting a national campaign to train and attract 40,000 manufacturing technicians over the next 5 years (1999 through 2003). (p. 1)

One reason that society may not be more concerned about the maintenance or skilled workforce is the way the numbers are collected and communicated. The previous projections may not reveal a shortage until the projections are combined. If it is assumed that the people with the required skills to fill these positions are easily found, then the shortages do not appear to be problematic. However, as other data will show, fewer people are entering these needed fields; and fewer yet have the skills to train others. The collection of specific data indicating trends for skilled workers and those prepared to train them can be hidden. How skilled workers are defined and which skills are needed determines how the numbers for a job title are reported.

According to Strategic Work Systems, Inc. (SWS, Inc.) (2002), a consulting firm focused on improving industrial competitiveness, clients basically use three time-tested classifications for plant workers that operate or maintain the equipment: (a) production or operators, (b) mechanical maintenance, and (c) electrical/instrumentation maintenance. Most manufacturing industries have additional specialized job categories, but these three basic classifications are consistently used across various industrial sectors. Even with these three job classifications, it

should be noted that the required skills for these classifications are quite varied. Collecting data on these classifications would be more reliable if employees all had the same description of required job duties, tasks, and responsibilities.

Some plants actually use multi-skilled maintenance workers as operators; these workers operate and maintain the equipment. Some plants have their operators perform various levels of equipment maintenance; again, the operators are classified as multi-skilled workers. More and more industries are requiring their maintenance personnel to be multi-skilled. Most statistics break jobs down into age-old categories, but multi-skilled requirements are often inappropriately classified. This means there may be a large number of skilled workers that must be replaced, but who are not accounted for in the statistical projections.

## Past Strategies for an Industrial Workforce

The sources of technical skills available in the past century are no longer abundantly available today, and many of those skills no longer apply to today's equipment and controls. Manufacturing industries can no longer draw from a large pool of applicants and expect to pull people with a depth of skills and experiences into maintenance-related activities. The manufacturing industry can no longer rely on the sources of skilled training that they once took for granted. In the earliest part of the 20th century, a variety of skilled workers were available; apprentices, immigrants, and military personnel all provided many of the skills for the industrial workforce. These sources, though still existing, have been reduced in numbers.

### *Apprenticeships*

Rarely do we find the volume of apprenticeship programs in today's industrial environment that we saw earlier in the past century. Although registered apprenticeship programs exist, some industries choose to use the term "apprenticeship" to describe their training program. These "apprenticeship" programs typically involve a structure in which an individual takes a core group of courses and then follows a more experienced worker for an interim period, usually two to four years. SWS, Inc. (2002), has observed that often, the apprenticeships do not involve any structure or systematic approach to ensure that a given standard of skills is met. More often, the apprentice learns both the good and bad habits from someone who learned in the same manner. These mentors often avoid passing on their secrets and skills for fear of being replaced. The only hope for these programs is that there are some skilled maintenance workers remaining in the workforce that are willing to share their knowledge, skill, and experience.

### *Immigrants*

Immigrants continue to fill job positions, but many of these individuals are seeking opportunities to learn a skill rather than share an existing technical skill. Oftentimes immigrants are placed in unskilled labor jobs. According to a survey done by the Census Bureau for 2000 (Council on Hemispheric Affairs, 2001), "A staggering 29 percent, or 8.8 million, of the foreign born population in the U.S. came from Mexico" (p. 3). Mexicans make up 9 of every 11 new arrivals into the United States. The percentage of Hispanic immigrants has increased from nearly 5% of the population in 1970 to a projected 25% of the population in 2050 (Council of Economic Advisors for the President's Initiative on Race, 1998, p. 12).

Local industries have found this to be a double-edged sword. Manufacturing can employ these immigrants for low wages; however, the language barrier and oftentimes the lack of skills require additional cost for skill training. Many of these immigrants have flooded the landscaping and construction industries; but, overall, immigrants do not possess highly technical skills, especially in manufacturing.

*Technical Education*

From the early 1900s, career and technical education (CTE) focused on knowledge and skill in the areas needed by the industrial trades (Gray, 1996). The supporting curricula for these areas were what differentiated CTE schools from the standard high school curriculum or the curriculum for those who would enroll in higher education.

According to Lynch (2000), the industrial CTE programs of the early 1900s were grounded primarily in the need to prepare more immigrants and blue-collar-type workers with practical skills for the nation's factories. Lynch stated that:

> ...the focus of federal legislation shifted over the years to ask states to offer programs and training to support national defense efforts (1920s), reduce unemployment problems (1930s), assist the war effort (1940s), include junior (now most are called community) colleges in the 1950s, and shift industries to peacetime economic development in the 1950s and 1960s. (p. 9)

"No uniform curriculum or standards or teacher licensure, no reporting system and no (as yet) agreed-upon accountability system" (Lynch, 2000, p. 12) was established for CTE subjects. The process for entering CTE schools was fairly consistent during the past century. Gray (1996) indicated the following:

> The model was pretty simple; students would select a course of study depending on the type of occupation or role they aspired to and were suited for. For individuals entering the work force, the curriculum was vocationalized to include...industrial education for those interested in skilled craft trades. (p. 2)

## Initiatives to Compensate for Maintenance Worker Deficiencies

*Designs for Ease of Operation and Maintenance*

One initiative observed by SWS, Inc. (2002), in various industries during the past 20 years and recommended during their training was designing equipment for ease of operation and maintenance. This design process is an element of total productive maintenance, which involves the people who operate and maintain the equipment. The results of the design changes allow operators and maintenance employees to perform more efficient maintenance and operation procedures with observable, measurable results in major equipment overhauls, repairs, operation, and maintenance. Oftentimes, the maintenance improvements make inspections easier and more efficient or provide for better lubrication of the equipment; but the major overhauls or skills for removing, replacing, aligning, and balancing, etc., are still required.

Typically, SWS, Inc. (2002), observed that designing equipment for easier operability and maintainability includes (but is not limited to) modifications that extend component life, color coding and visual systems, easy access to normally hard-to-reach-areas, quick disconnects to electrical and fluid power sources, quick release door latches, part specifications and lube points applied to the equipment, easy-to-remove housing, centrally located lube stations or instrument stations, ergonomic principles, and integral help screens and on-board troubleshooting diagnostics.

Improvements should continually be made to equipment; but regardless of the improvements, all equipment must be correctly maintained and operated. Too often, equipment and parts manufacturers are in the same predicament and are also searching for employees with the necessary skill to operate and maintain equipment.

*Managing Equipment Manufacturers and Vendors*

Manufacturers make the equipment, while vendors sell the equipment and sometimes modify it before delivery to the customer. Plant engineers and management must supervise the activities of their equipment manufacturers and vendors to ensure that the products and services they ordered are received and for the agreed-upon price. Managing vendors includes having the vendors pass on the necessary operation and maintenance knowledge and skills to plant personnel. To properly manage vendors, equipment specifications must be written to ensure clarity of design expectations to the vendor and to other plant personnel. Plant personnel must also clearly define maintenance and operations training specifications when ordering equipment. The training specification identifies the existing skill level of the employees, the training audience, objectives, knowledge and skill expectations, and trainer qualifications. This is especially true when modernizing part of the plant or production line. A training specification should go out to each of the vendors, detailing the training requirements or expectations and the required documentation.

*Other Initiatives*

There are numerous other initiatives that companies use to compensate for skill deficiencies in the maintenance workforce or to minimize errors in their plant processes. Some of these initiatives have proven to be good practices that show business returns. Some successful initiatives or equipment modifications observed by SWS, Inc. (2002), included purchasing new computerized maintenance management systems, controlling spares and inventory, streamlining the work order process and defining new job role responsibilities, implementing planned and predictive maintenance activities, improving access to areas that are hard to clean and inspect, writing or revising procedures or applying visual systems to the equipment, identifying sources of problems, keeping good documentation and history on the equipment, and using appropriate tools. Any initiative, however, cannot equal the returns of a skilled workforce. Modifying plant processes will not show returns on the investment unless employees directly affected by the changes are provided appropriate training.

These are just the beginning of a long list of initiatives used to increase productivity and reduce cost. These initiatives are measured by either better work efficiency or lower cost for production, and require some amount of training. Each of these, however, assumes that a trained workforce is already applying the fundamental skills and providing for the basic requirements of the equipment. Yet, industries around the globe are complaining of the difficulties and costs of keeping their equipment maintained. Too often, the causes for poor equipment performance or cost of equipment repairs are traced back to human error. A worker incorrectly installed a bearing, causing premature bearing failure. A worker used the wrong tool for the job, causing additional cost for the premature failure or to fix what was destroyed.

## Present Challenges to Education and Training

*Is Technology Education Taught In Our Schools?*

It appears that each state is different in its offering of technology education courses in grades K-12 in varying degrees. One goal of technology education courses is to teach technological literacy, which is defined as "the ability to use, manage, understand, and assess technology, or as a means of changing the natural world to satisfy our needs" (International Technology Education Association, 2000, p. 7). The process of achieving technological literacy begins at an early age. Nationwide, most students receive little or no formal exposure to the study of technology (International Technology Education Association).

It is unfortunate today to learn of a technology education class that, most likely, focuses on keyboarding skills, computer awareness, and exposure to various software applications, rather than the career clusters associated with industry. While this may meet a certain need, it

definitely falls short of addressing a broader category of technology. It also does not help that educators and parents are often confused about the differences between technology education and educational technology. The unique feature of technology education that is not found in the science and mathematics courses is the hands-on experiences using the tools of industry. This is where a student can begin to gain skills and insights into industrial tools, machines, materials and processes. It must be considered how much more our youth would be prepared for the industrial work environment if they were exposed to these technologies at an earlier age.

*Technology Education as a Part of General Education*

States and local school districts are so limited with the time and resources necessary to meet the existing standardized competencies that they view the study of technology, as part of the core curriculum, as a luxury. Yet technology education reinforces and complements the material students learn in other classes. Technology education courses provide practical applications to the students' other class subjects and allow the students to apply the facts, principles, and concepts in a way they can retain and synthesize for future use. Technology education courses allow students to learn how to make connections among different fields of study and begin to understand how all knowledge is interconnected. Educators must involve the students in the integration and application of their academic subjects by exposing them to the various subjects offered in technology education in order to prepare them for leading the next generation of jobs. Students must learn to use, manage, and understand technology. There is also the concern whether the present educational system is structured to prepare today's youth for these changes.

*Conflicting Initiatives*

According to Bragg, Layton, and Hammonds (n.d.),

> ...the nation's public schools are caught in a quagmire of different national reform initiatives such as Goals 2000, School-to-Work Opportunities (STWOA), and Tech Prep, with many more reform initiatives dictated to public schools at the local and state level. This uncoordinated educational reform effort creates confusion and fragmentation of activities within schools as evidenced by the "fad" perception that many of these efforts hold among teachers, parents, and school administrators. A concerted effort at all administrative level is needed to link reform initiatives together that can build on existing efforts, improve upon the reform processes and move forward with school reform initiatives (p. 3).

Many of the activities or groups of knowledge and skill that were once unique to technology education courses, such as manufacturing, construction, communication, power, energy, and transportation, are now absorbed into science or physics courses. Furthermore, support from industries is needed for proper development and structure of industry-focused programs.

Perhaps the lack of industrial support is reflected in the conflicting initiatives found in plants and industries. A specific application of this problem is in the local plants and industries in which the work culture does not support new ideas or skills. Oftentimes, training is thrown at a problem. If training is provided, yet the plant does not support the answers provided by the training, then the training investment is lost. Latino (1999) explained this situation:

> In class, students are taught an analytical approach to problem solving. To implement these techniques in the field requires time, support systems, and a commitment to perform better, not faster. When students return to a reactive environment in which "fix it" rather then "solve it" is the prevailing mindset, the training payoff is lost for both workers and the company (p. 3).

There are definite roadblocks to teaching technology education under the framework of general education, including funding, implementation consistencies, and resource support. A general technology education course, however, will prove useful to students in whatever field they endeavor. Technology education offers a wide range of experiences in a variety of knowledge or skill clusters. The broad range of knowledge and skills students learn under the four major clusters of a technology education program can be applied to a variety of situations, regardless of the students' career choice, using a problem-solving process.

CTE for high school students must also be supported to meet the needs of tomorrow's workforce. It is difficult to assess the status of CTE across the United States because of the various ways in which enrollment numbers are assessed. The numbers appear somewhat loose, such as trying to describe the number of needed maintenance workers. Norton Grubb, a principal researcher with NCRVE, noted (as cited in Lynch, 2000), "Some states count students into a program only if they take three or more technical classes while others count them each time they take a technical class" (p. 17). States determine enrollment differently, and some only count a student enrolled in CTE centers. This lack of uniform data and the inability to establish significant cause-and-effect relationships among student numbers, program and curriculum intensity, and possible impact hinders CTE educators in their accountability and assessment of program effectiveness.

*College-Bound Emphasis*

There is a perception that CTE is for those who are not academically gifted or for those appearing below average, but nothing could be farther from the truth. Youths must be purposely directed to ITE and CTE courses as educational options. Gray, Wang, and Malizia (1995) identified the following statistics:

> In 1972, 63% of high school seniors in a *National Center for Educational Statistics (NCES)* sample reported that they intended to go to a four-year college and/or graduate school; in 1992, 95% said they planned to continue their education: 84% of those wanted to attend four-year colleges. (p. 1)

Completion or graduation rates are low for the numbers entering college, indicating that many of these students are not prepared for college, even though there appears to be an increasing drift of students into the college prep programs. Gray, Wang, and Malizia (1995) show that completion or graduation rates of college-bound students range from 40% to 60%. Is the educational system missing something? Should it be providing alternatives to these students?

Across the nation, students are counseled that there is only one way to win; and that is to get a four-year baccalaureate degree. Numerous data support this argument. Gray (1996) found the following:

> Between 1982 and 1990, the national percentage of students enrolled in college preparatory programs increased by 10%. During the same period, enrollment in CTE programs declined in 32 states. In a national survey of 1992 high school seniors, 85% indicated they planned to obtain a baccalaureate degree and 30% had already decided to go on to graduate school. Less than one percent of all students who take the college boards plan to pursue anything other than a four-year college degree. Correspondingly, the percentage of high school graduates who go directly on to higher education has grown significantly since the late 1970s. Nationally, 63% of the 1991 graduates went on to higher education, compared to 49% in 1980 and 46% in 1973. (p. 3)

It is interesting that while "nearly three-quarters of high school graduates go on to some form of post-secondary education, 60% do not receive a bachelor's degree" (Jasinowski, 2001,

p. 22). Students tend to shun other options, thinking that college will provide the only hope of success, and thus leave school lacking career options and resources. CTE could provide many of the needed hands-on experiences to resolve the problem of having young employees join the industrial workforce without the necessary hands-on experiences.

*Establishing a National Standard*

An established national standard for industrial maintenance workers would help improve the processes for preparing people for the workforce. Standards, however, should not be used across industry to limit involvement or restrict industries from doing what will best meet their needs.

The MSSC (2002) described a skill standard as:

> ...a tool for assessing skill level or knowledge and skill deficiencies, a description of the work to be performed, how well the work must be performed and the level of knowledge and skill required to perform that work. Companies, labor unions, employees, educators and students use standards. A skill standard is a communication tool that details the skills and knowledge a person has, helps identify a skills match or gap, and can help focus learning and training activities. Defining these skills is necessary for determining the focus of training. (p. 1)

Most modern industrial processes require highly educated personnel with certain core attitudes, knowledge, and skill. Skill standards can help define what core attitudes, knowledge, and skills are needed in industry and thus help career and technical counselors and teachers develop programs that give students these core competencies before entering the workforce.

The mission of the National Association of Manufacturers (NAM), the MSSC, and the National Skill Standards Board (NSSB) is to encourage the creation of a nationwide system of workforce skill standards for manufacturing and related workers. Educators should consider the work of these associations and continue to refine the standards into a core set of attitudes, knowledge, and skills that would be used as a consistent standard across the United States. These standards should not, ultimately, be restrictive, but should provide a baseline of competencies from which to start. They could essentially be a defined minimum standard for all industrial maintenance workers. Industries would not be restricted in hiring someone without training in these areas, but it could raise the bar for entry-level requirements and possibly define a standard for our CTE schools.

## Summary

Employers would do well to find ways to retain a high level of experience and transfer their knowledge to younger workers before the experienced workers retire and leave knowledge and skill voids in the workplace. Some key activities which could help ensure that the future workforce is prepared to compete in a global market are as follows: (a) define the knowledge and skill requirements for maintaining the plant equipment; (b) develop methods to legally assess and select candidates for maintenance; (c) develop a structured, systematic method for in-plant hands-on training, qualification, and application of learned skills, with the required management and budgeting support; (d) determine the attrition rate and those that have specific, unique, equipment knowledge and skill; (e) determine local and state training resources/schools and in-plant resources (materials, trainers, etc.); (f) develop coaching and mentoring skills and processes as part of the work culture; and (g) acknowledge that training is an on-going process, not a one-time event with a beginning and an end.

*Addressing Future Workforce Needs*

Technology continues to move forward, providing new materials, processes, tools, and equipment. Yet, the basic or fundamental maintenance skills have barely changed in the past 50 years. Processes and equipment have improved, and better tools and equipment are now used in maintenance; but the core or fundamental skills remain relatively unchanged. Unfortunately, there are fewer numbers of skilled maintenance employees. Furthermore, there are not the necessary numbers of students or those interested in teaching technology education or CTE to replace the workers.

Industries must begin now preparing for tomorrow's workforce. Since today's youth are not brought up on farms or in similar backgrounds, where will they get the skills and technological fundamentals to meet the industrial challenges in the future? The sources that once provided the various backgrounds of skills needed in the industrial workforce are no longer prevalent. Manufacturing in the United States must remain strong if the economy is to remain strong. So many companies downsizing and shipping plants overseas have bruised the economy. There may have seen short-term gains, but the long-term profits or benefits are yet to be seen. Operating productive plants is a multifaceted process and involves more than just training the workforce. Without it, however, these plants cannot remain competitive. The following are some strategies for meeting the skill gap challenge.

*Establishing Standards*

The NSSB and the MSSC have been encouraging the creation of a nationwide system of voluntary skill standards for manufacturing, installation, and repair. Collaboration with these and other groups to develop a consistent baseline of expected entry skills may help to ease the hiring and skill preparation burden. Collaborating with local industries to share the cost of training and encourage local school boards to support technology education schools should also be considered.

## Final Words

There is no one thing that caused this situation, and no one thing will correct it. To echo the statement of Dugger, Jr., and Gilberti (as cited in the *Standards for Technological Literacy: Content for the Study of Technology*), "With the growing importance of technology to our society, it is vital that students receive an education that emphasizes technological literacy" (International Technology Education Association, 2000, pp. vii-viii). This statement is true, regardless whether or not students work in industry. Technology education will only enhance the knowledge and skill of the individual students; and except for the home, this may be their only exposure to tools, systems, and processes. Exposing students to industrial processes, tools, equipment, and the knowledge to succeed in industry need not wait until students are out of school and entering the workforce. They simply will not gain hands-on experiences and skills in the various industrial processes in their other courses.

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Evanciew is Assistant Professor in the Department of Technology and Human Resource Development at Clemson University in Clemson, South Carolina. Evanciew can be reached at evancie@clemson.edu.