Productivity, the Workforce, and Technology Education

Scott D. Johnson

While the United States was once the premier leader in industrial strength and influence, countries previously unable to compete with the United States in both technological and economic arenas have made drastic changes in the way they develop and produce goods. Through modernization of their factories and by using innovative organizational systems, these so called non-industrial countries have begun to compete with the industrial giants on their own turf. New competition from countries such as Japan, Korea, and Brazil is having a dramatic impact on the economic, political, and educational systems within the United States. Examples of the results from this new competition include rising trade deficits, an increasing budget deficit, slow productivity growth, stagnant real wages, and a declining share of world markets (Young, 1988). All of these trends constitute a threat to the American standard of living. Unless changes are made to increase the competitive ability of the United States on economic and technological grounds, the quality of life in this country is certain to fall.

In response to the competitiveness problem, this country must strive to develop a highly skilled, adaptable workforce that develops and uses technology. This effort would result in a renewed competitive advantage through improved technologies and innovative, creative, and highly educated workers; something which may be the United States' biggest strength. This approach is not without its drawbacks. New technologies are likely to replace many workers which could result in higher unemployment. Advances in technology could also lead to a deskilling of the workforce which may result in a wider gap between the workers who develop new technologies and those who use them.

To return the United States to its former competitive status, improvements must occur in the productivity of the workforce. Technology education has a unique role to play in improving the productivity of the future workforce (Technology Education Advisory Council, 1988). In addition to providing students with the opportunity to interact with technological systems and proc-

---

Scott D. Johnson is Assistant Professor and Chair, Technology Education Division, Department of Vocational and Technical Education, University of Illinois at Urbana-Champaign, Champaign, Illinois. The preparation of this paper was supported in part by a grant from the Illinois State Board of Education; Department of Adult, Vocational, and Technical Education; Program Improvement Section.

esses, technology education reinforces the content learned in other curricular areas and enhances higher order thinking skills. Before expanding on the role of technology education in improving the productivity of the future workforce, an examination of the productivity issue and the impact of technology on the workforce is needed.

Improving Workforce Productivity

The United States must improve its level of productivity in order to become more competitive. It has been said that productivity is the main determinant of trends in living standards (Hatsopoulos, Krugman, & Summers, 1988). Therefore, if Americans are to continue enjoying their high standard of living, they will have to find ways to continually increase their own productivity. Recent evidence shows that competitors have been able to increase their productivity at a much faster rate than the U. S. For example, the U. S. was ranked below eleven of its competitors in productivity growth from 1973 through 1979 and from 1981 through 1985 (Berger, 1987; Klein, 1988). While the statistics point out weaknesses, all is not lost. After the dismal years of the 1970s and early 1980s, U. S. companies have shown productivity improvements in recent years. In 1985, the U. S. had the second highest growth in productivity among the twelve leading industrial countries with a 5.1% increase and in 1986 had the highest productivity growth at 3.7% (Klein, 1988).

While the recent improvements are encouraging, efforts must be made to ensure that these improvements in productivity continue. There are three primary ways to improve productivity: (a) through the development of new technologies, (b) through increased capital expenditures, and (c) through education and training.

Improve Productivity Through the Development of New Technologies

Eighty percent of the U. S. productivity growth can be attributed to technological innovation (Young, 1988). A strong research and development effort is needed to ensure that new innovations are forthcoming. Without research and development expenditures, it is doubtful that significant innovations can be developed. While the U. S. has been successful in developing new technologies in the past, it not likely to continue to be successful if current trends continue. Business and government expenditures for civilian research and development are a smaller proportion of the economy in the U. S. than in other developed countries (Berger, 1987). A continued commitment and support for research and development must be made if the U. S. is to maintain its leadership in the development of technological innovations.

Improve Productivity Through Increased Capital Expenditures

While the development of technology is a key to productivity growth, the technology is worthless unless it is actually used. A primary reason the U. S. has lost its competitive advantage in the steel and automobile industries is because those industries have been slow to realize that modern facilities, new equipment, and innovative organizational strategies are needed to keep up with the rest of the world. In recent years, U. S. competitors have been tooling up with modern facilities that incorporate the latest technologies and strategies such as robotics, computer-integrated manufacturing, just-in-time manufacturing, and the Japanese philosophy of Kaizen. At the same time, U. S. steel and automotive industries were trying to produce goods in antiquated facilities with pre-World War II technologies and traditional authoritative management strategies. The result of the unwillingness of these U. S. industries to expend the necessary capital to build new facilities and to acquire new technologies has been a decreased share of world markets, increased layoffs, and reduced profit margins. As an example of the discrepancy between U. S. capital expenditures and those of Japan, the Japanese spend 50% - 100% more per employee on capital than the U. S. To compound the problem, U. S. capital costs 50% - 75% more than Japanese capital (Hatsopoulos, Krugman, & Summers, 1988). On a positive note, the recent surge in productivity in the U. S. can be partially attributed to the willingness of companies to begin investing in new capital.

Improve Productivity Through Education and Training

As stated by the *President's Commission on Industrial Competitiveness* (1985), this country has failed to develop its human resources as well as other nations. This problem becomes evident when comparing our educational system with those of other countries. Only 70% of the students in American schools successfully complete high school while 98% of Japanese students complete high school (Jonas, 1987). The recent plethora of national reports that focus on educational reform further support the need for strengthening America's educational systems (Carnegie Forum, 1986; National Commission on Secondary Vocational Education, 1984; Parnell, 1985).

Even if the U. S. is able to continue developing new technologies and makes the capital expenditures necessary to utilize those developments, great improvements in productivity will be unlikely unless workers have the level of education and skill needed to handle the advanced technologies (Berger, 1987). In response to this need, educational programs at the secondary and post-secondary levels need to identify the knowledge and skills that will be needed by the future workforce to successfully work with and maintain the advanced technologies and develop appropriate delivery systems for the teaching of the new content.

The Impact of Technology on the Workforce

There are several views regarding technological advancement and its effect on the workforce (Naylor, 1985; Rumberger, 1984). One view is that technological advances will be the primary source of new jobs in the future. People read and hear about new jobs being created in the areas of robotics, computers, lasers, and optics. A common belief is that jobs in these areas are completely new and will result in job opportunities for a great many workers. The second view is that advanced technologies will vastly upgrade the skill requirements of future jobs. Advances in technology are believed to make jobs much more complex and therefore, will require higher level skills in the future. A third view is that the development of new technologies will result in the displacement of massive numbers of workers. The development of robotics and automated processes is viewed as a means to eliminate the human worker from the labor force.

It is true that technology is having a definite effect on the nature and characteristics of the workforce. New occupations are being created while traditional occupations are being changed or eliminated. The workers that fill these changing occupations must update their knowledge and skills to remain employable.

A wider variety of skills are now needed by the workforce. The diversity of occupations has increased to the point where workers must do things that were once performed by many different individuals. Future workers still need to have specific technical skills. However, employers are beginning to want their new employees to have better basic skills. Basic skills enhance workers' abilities to learn new information and techniques and will make the future workforce more adaptable as advances in technology further changes the workplace.

It is evident that technology is having a significant impact on the workforce. However, the true nature of that impact is unclear. Are the above views accurate or are they only myths? The following discussion describes some of the impacts of technology on the workforce and presents the uncertainties that exist regarding the changes that will occur in the future.

The Impact of Technology on Future Occupations

The impact of technology on future occupations is unclear. Will the advances in technology result in more high technology related jobs or will there be an increase in the number of low technology related jobs? The answer to this question is critical to the economic and social well being of this country. To identify the actual impact of technology on future occupations, it is necessary to examine the various views that currently exist.

View 1: Advanced technology jobs are growing at a rapid rate. One view regarding job growth says that technology-related jobs are growing at a significant rate. Based on Bureau of Labor statistics, the fastest growing occupations are in advanced technology areas. As shown in Table 1, eight of the ten fastest growing occupations may be classified as "high technology" occupations (Kutscher, 1987). These fast growing occupations include technicians, engineers, operators, and repairers. As a result of this information, it would appear that advanced technologies will be the primary source of new jobs in the future. In fact, numerous secondary and post-secondary schools are using this information to develop courses in robotics, CAD, CAM, lasers, and computers.

Table 1
Ten Fastest Growing Occupations in Percentage Terms

Occupation	Percent Change	Change in Total Employment	Percent of Total Job Growth
Computer Service Techs.	97	53,000	0.21
Legal Assistants	94	43,000	0.17
Comp. Systems Analysts	85	217,000	0.85
Computer Programmers	77	205,000	0.80
Computer Operators	76	160,000	0.63
Office Machine Repairers	72	40,000	0.16
Physical Therapy Asst.	68	26,000	0.09
Electrical Engineers	65	209,000	0.82
Civil Eng. Technicians	64	23,000	0.09
Peripheral Elect. Operators	64	31,000	0.12

Note: Adapted from "Impact of Technology on Employment in the United States" by R. Kutscher, in *The Future Impact of Technology on Work and Education* (p. 48), G. Burke and R. W. Rumberger (Eds.), 1987, Philadelphia, PA: The Falmer Press, Taylor & Francis.

However, describing job growth in percentage terms does not paint a true picture of the impact of technology on the growth of occupations in the future. A closer examination of Table 1 shows that while the fastest growing occupations are growing at a high rate, they will result in relatively few jobs. For example, the fastest growing occupation in percentage terms is computer service technicians. While this occupation is growing at a fantastic 97% rate, it accounts for less than 1/4th of 1 percent of the total projected job growth. In fact, the ten fastest growing occupations in percentage terms account for less than 4% of the total job growth. Based on this low percentage of the total job growth, technology educators, particularly at the upper secondary and post-secondary levels, must be careful when planning to develop new programs which are oriented towards these "fast growing" advanced technology occupations. It is possible that many of these new jobs will be filled without the need for numerous advanced technology programs. In fact, current data suggests that there are more graduates of advanced technology programs than positions available (Grubb, 1984; Naylor, 1985). Continued growth in enrollments may compound that problem.

View 2: Low tech jobs are growing at a rapid rate. A second view regarding the impact of technology on job growth suggests that advances in technology will result in an increase in low technology-related jobs. This view is in direct contrast to the first view. Based on Bureau of Labor statistics, the fastest growing occupations are not in advanced technology areas. As shown in Table 2, the majority of the ten fastest growing occupations (in absolute terms) are not in advanced technology areas (Kutscher, 1987). For example, the fastest growing occupation in absolute terms is building custodians. While that occupation certainly changes as technology advances, it is not considered a "high tech" occupation. Advanced technology occupations are those that require an in depth knowledge of the theories and principles of science, engineering, and mathematics that underlie technology. This definition includes engineers, scientists, mathematical specialists, engineering and science technicians, and computer specialists (Rumberger & Levin, 1985). Note that while the occupations listed in Table 2 are not growing at a high percentage rate, they do account for a great number of jobs. In fact, these ten fast growing occupations will account for almost 25% of the total job growth in the future.

It is true that advanced technology occupations are growing at a rapid rate although the impact of that growth is less significant because of the small number of actual jobs that are created. One reason for the inability of advanced technology occupations to create a large number of jobs is because of the potential of technology to reduce the need for workers. Automated systems are being developed that are able to reorganize traditional production processes. The change from individual machines to complete manufacturing systems has enabled employers to reduce the number of workers while increasing productivity. For example, the inte-

Table 2
Ten Fastest Growing Occupations in Absolute Terms

Occupation	Percent Change	Change in Total Employment	Percent of Total Job Growth
Building Custodians	27.5	779,000	3.0
Cashiers	47.5	744,000	2.9
Secretaries	29.5	719,000	2.8

General Office Clerks	29.6	696,000	2.7
Sales Clerks	23.5	685,000	2.7
Registered Nurse	48.9	642,000	2.5
Waiter & Waitresses	33.8	562,000	2.2
Teachers	37.4	511,000	2.0
Truck drivers	26.5	425,000	1.7
Nursing Aides & Orderlies	34.5	423,000	1.7

Note: Adapted from "Impact of Technology on Employment in the United States" by R. Kutscher, in *The Future Impact of Technology on Work and Education* (p. 47), G. Burke and R. W. Rumberger (Eds.), 1987, Philadelphia, PA: The Falmer Press, Taylor & Francis, Inc.

gration of a robotic welder into the auto industry replaces two to three human welders and achieves productivity gains that range from 5:1 to as high as 20:1.

Based on the above discussion, it should be clear that technology does impact the total growth of occupations. Advanced technology occupations are growing at a high rate yet they are a small fraction of the total job growth. While low technology occupations are not growing at as fast a rate, they contribute to a greater percentage of total job growth. Because it is possible to interpret job growth in different ways, technology educators must use caution when determining whether or not to emphasize advanced technologies in their curriculum. Clearly, attempting to justify technology education programs that emphasize advanced technologies solely because of high percentage job growth statistics may be a mistake.

The Impact of Technology on Skill Requirements

Technology will also have an impact on the skill requirements needed for *all* jobs at *all* levels (Rumberger, 1984). As occupational skill requirements change as a result of technology, the education and training needed by future and existing workers must also change. However, are the skill requirements increasing or decreasing as a result of the advances in technology? The answer to this question may have a great impact on the content and delivery of technology education programs.

The literature identifies three different views regarding the impact of technology on skill requirements. Each of these views will be examined as they relate to technology education curriculum and instruction.

View 1: Advanced technology creates a wider gap between high skill and low skill jobs. The first view suggests that advances in technology will create a wider gap between the high skill level jobs and the low skill level jobs (Nettle, 1986; Rumberger, 1 984) which may result in a bi-modal distribution of the workforce (Grubb, 1984). Figure 1 graphically shows the potential distribution of occupations based on skill levels if this view is true.

Figure 1. Distribution of worker skill levels.

This view is built on the premise that technology creates a need for highly trained and educated workers to design, develop, and maintain the new technologies. These individuals will require some type of college degree which will increase the need for workers with M.A.'s and Ph.D.'s in technical areas. On the other end of the skill continuum are a great number of low skilled, low paid workers who have little need for training. This bi-modal distribution is thought to be made up of 80% semi skilled or unskilled workers and only 20% highly skilled workers (Nettle, 1986).

View 2: Advanced technology creates jobs at both middle and high skill levels. The second view suggests that advances in technology creates jobs at both the high and middle skill levels (Grubb, 1984). Data collected for high technology and conventional manufacturing sectors in Texas clearly show that the occupational distribution of advanced technology manufacturing is *not* bi-modal. Figure 2 graphically shows the occupational distribution between high technology and conventional manufacturing industries based on 1980 Census data. As suggested in the first view, the need for high skill levels increases as advanced technology is incorporated. However, in contrast to the first view, Figure 2 also shows that the need for middle level skills increases as technology is incorporated.

Figure 2. Manufacturing occupational distribution.
Note: Graph developed from data in "The Bandwagon Once More: Vocational Preparation for High-Tech Occupations" by W. N. Grubb, 1984, *Harvard Educational Review*, *54*, p. 435. Copyright 1984 by President and Fellows of Harvard College.

While the above data is from one state in one primary industry, the data does corroborate with national data from the Bureau of Labor Statistics (Grubb, 1984). Advanced technology sectors do hire more technicians and computer specialists. In addition, the projected growth in middle to high skill level technician jobs are higher in most high tech industries than in conventional industries. This is especially true in the health and information technology fields where more technicians are being used to perform very specific tasks, thus freeing the professional to monitor technicians and to perform other tasks.

As low skill level assemblers are replaced by middle skill level technicians, the amount of training needed to obtain the higher skill level positions will increase. Figure 3 shows the difference in the amount of education needed by the workforce in conventional and high technology manufacturing industries. An increased demand for education at the post-secondary level can be projected as technology is integrated into the private sector.

View 3: Advanced technology decreases the overall skill requirements of the workforce. The third view suggests that advances in technology will actually decrease the overall skill requirements needed by the workforce (Bartel & Lichtenberg, 1987; Faddis, Ashley, & Abram, 1982; Rumberger, 1984, 1987). While the characteristics of future jobs will likely change, the overall skill requirements are expected to decrease. A general assumption

Figure 3. Post-secondary educational levels needed by future workers.
Note: Graph developed from data in "The Bandwagon Once More: Vocational Preparation for High-Tech Occupations" by W. N. Grubb, 1984, *Harvard Educational Review*, *54*, p. 435. Copyright 1984 by President and Fellows of Harvard College.

regarding the impact of technology on skill requirements is that as technology advances, the skills needed to work with technology also increase. This view appears to be developed as a result of interaction with the technological world. For example, many people believe that a computerized word processor is a highly technical tool that is much more complex than the manual or electric typewriters with which they are comfortable. Another example involves the many backyard mechanics who at one time were able to repair their own automobiles. Because of the advances in technology, these mechanically inclined individuals are having considerable difficulty comprehending the new technological systems found in late model vehicles.

As technology advances it certainly appears as though the skill requirements needed to work with those technologies also increase. This statement is only partly true. Research indicates that the impact of technology on worker skill requirements is very different from the general assumption (see Figure 4). While the skill requirements do increase initially, as a technology is further developed and refined, the skill requirements needed to use that technology actually decrease. An example of this phenomenon is the computer. When the computer was originally invented, it was a very complex machine that was difficult to use. Following the development of technologies that lead to the production of transistors and then integrated circuits, the computer became a smaller, more powerful machine that was immensely more complex than the original computer. However, while the computer became much more advanced, it also became more “user friendly.” Refinements in computer technology have led to the development of a machine that is relatively easy to use. The trend to simplify the use of equipment results in a deskilling of the workforce because the technology reduces the need for much of the mental and physical work needed to conduct daily work tasks. Other examples of this deskilling phenomenon can be found in computer programming, automated production, printing, clerical work, and machining.

Figure 4. Impact of technology on worker skills.
Note: Adapted from "The Relationship of Increasing Automation to Skill Requirements" by J. R. Bright, in *Technology and the American Economy*, National Commission on Technology, Automation, and Economic Progress, 1966, Washington, DC: US Government Printing Office.

These three views present differing projections of the impact of technology on the skill requirements of the workforce. First, technology has resulted in a decrease in the skill requirements of some jobs. Second, technology has resulted in an increase in the skill requirements of other jobs. Overall, however, it appears as though there has been little change in the *average* skill requirements of jobs. In a recent study of 200 individual case studies, Flynn (1985) found that while some workers' skill requirements have been upgraded, other workers' skill requirements have been downgraded. It appears as though the overall effect of technology on the skill requirements is small. On an individual basis, however, the effect of technology on skill requirements appears to be quite drastic.

Technology Education's Role in Improving Workforce Productivity

As previously discussed, it is critical that productivity increase in order to regain a competitive advantage in the global marketplace. The problem of increasing productivity is compounded by the ever changing workplace in which a knowledgeable and skilled workforce is needed to adapt to new technological processes. The recent trends in technology and the workplace suggest that the secondary school curriculum needs modification in order to equip students with the knowledge and skills needed to be successful. For example, the most effective and efficient method of preparing the future workforce may no longer include vocational education's traditional emphasis on specific technical job skills. Because of the rapid and complex changes in technological knowledge and skill, the specific technical job skills taught in many secondary vocational programs are obsolete when vocational graduates enter the workforce.

While specific technical job skills will always be needed, they are no longer a sufficient condition for employment.

What role can technology education play in improving the competitive advantage of the United States? A well designed and delivered technology education curriculum will be able to enhance future workforce productivity because it (a) is well suited to reinforce what students have learned in other curricular areas, (b) is ideal for enhancing cognitive process abilities, and (c) promotes active involvement with technology.

Reinforce Academic Content From Other Curricular Areas

A major goal of technology education is to provide students with the knowledge, skills, and attitudes needed to become productive citizens in a highly technological and ever changing society. As a result of the recent advances in technology and the changes that are occurring in the workplace, there should be an increased emphasis on transferable, basic skills. Future workers need to have solid reading, writing, and computational skills. Because technology education offers students the opportunity to learn and apply subject matter from a variety of disciplines in realistic settings, it is well suited to reinforce the general knowledge and skills that are becoming increasingly important. Technology education teachers, by the very nature of their subject matter, incorporate reading, writing, mathematics, science, and social studies content into their courses. By emphasizing generic skills, academic content, and basic technical skills, technology education students will have the opportunity to gain the skills that are needed to keep up with the rapid changes in society and the workplace.

Since 1985, several state and national reports have appeared which suggest what skills and competencies will be needed by the future workforce. These reports have gained a great deal of national attention and seem to be adding fuel to the education reform movement of the 1980s. Because these reports were developed with industry, government, and education involvement, they have the potential to significantly impact the secondary school curriculum.

The state and national workforce projection reports discuss the changes that are occurring in the workplace and identify the skills and competencies needed by the worker of the future. These desired skills and competencies can be summarized into fifteen categories (Johnson, Foster, & Satchwell, 1989).

Figure 5: Summary of workforce competency reports.
Note: From *Sophisticated Technology, the Workforce, and Vocational Education* (p. 33) by S. D. Johnson, W. T. Foster, and R. Satchwell, 1989, Springfield, Illinois: Illinois State Board of Education, Department of Adult, Vocational and Technical Education.

As shown in Figure 5, there is considerable consistency in the recommendations of the workforce projection reports. As one would expect, the basic skills of reading, written and oral communication, and computation are identified by all of the competency reports. As technology advances, the written material used to support new equipment and processes becomes more technical, and therefore, much more difficult to read. As a result, future workers need higher reading and comprehension levels than the present workforce. For example, approximately 70% of the written material used in a cross section of jobs requires *at least* a high school reading level (Mikulecky, 1984) while most technical occupations require at least a 12th grade reading level (McLaughlin, Bennett, & Verity, 1988). The ability to communicate effectively is also essential for productive employment. Workers are being asked to work in teams, deal directly with customers, and participate in decision-making. All of these changes increase the importance of the ability to speak and write effectively.

The worker of the future must also be proficient in basic computational skills which includes working with fractions, decimals, proportions, and measurements. As occupations become more technical, skill with algebra, geometry, statistics, trigonometry, and calculus becomes essential. The importance given to these "academic" skills by the workforce projection reports supports the current trend to increase the integration of the academic and the vocational/technical areas; a trend which has been heavily supported in the technology education movement.

Evidence for the integration of academic content into technology education curricula can be found in each issue of *The Technology Teacher*, the journal of the International Technology Education Association. Each issue of *The Technology Teacher* explicitly presents effective ways to interface the mathematical, scientific, and technological aspects of various technologies. The Council on Technology Teacher Education has also supported the integration of academic content into technology education programs through their annual yearbook (Zuga, 1988). Possibly the best example of the potential for integrating academic content into technology education was provided at *Technology Education Symposium XI*. At this annual symposium, seventeen presenters described their attempts to develop interdisciplinary technology education programs (Erekson & Johnson, 1989). Based on the success of the programs that were described at the symposium, it is clear that technology education is a valid approach for reinforcing basic academic skills.

Enhance Higher Order Thinking Skills

In addition to the academic skills needed by the worker of the future, the workforce projection reports stress the importance of cognitive process skills. Cognitive process skills include the higher order thinking skills of problem solving, decision making, and creativity; skills which lead to flexible behavior and the ability to learn. It is in this area, improving student thinking skills, in which technology education may have the most to contribute. In fact, it has been suggested that improving student problem solving skills should be a major goal of technology education programs (Clark, 1989; Technology Education Advisory Council, 1988; Waetjen, 1989).

Waetjen (1989) observes that many of the recent curriculum guides for technology education identify problem solving as a major teaching method for improving student's understanding of technology and their ability to solve technological problems. While problem solving is viewed in these curriculum documents as a method of teaching, when used properly it also leads to the enhancement of student problem solving abilities. For example, instructors typically solve problems before they are given to students in order to eliminate potential difficulties. As a result, students complete these problems (more appropriately called exercises) with very little cognitive effort. However, creative technology teachers provide their students with ill-structured problems that require the students to actually solve the problems. Students are required to identify the problem, collect information, search for potential solutions, select a solution strategy, and evaluate the result. By actively solving realistic technological problems in technology education courses, students are being forced to think, reason, and make decisions. Through these problem solving activities, students can develop the cognitive skills that are too often neglected in the schools even though they are becoming prerequisites for success in the world of work.

Promote Active Involvement with Technology

While emphasizing academic and cognitive process skills are important goals for a technology education program, they should not be the sole focus. Educational reformers of the 1980s have suggested that employers want graduates to have only strong basic skills and that each business will provide the necessary technical training for their workers (U. S. Department of Education, 1986). However, recent evidence does not support that contention.

Employers still need employees who possess a high level of technical competence. Technical skills are essential because they facilitate the acquisition of additional skills. On a very practical level, when a new technology is adopted by a company, employers tend to involve those workers who have the greatest level of technical skill. For example, when CNC machining is introduced into a factory, it is common for management to select their best machinists to learn the new process. Consequently, technical skills are more important than many education reformers would suggest.

The lack of emphasis given to technical skills in the workforce projection reports suggests that these skills are a "given" for employment. As stated by the Michigan Employability Skills Task Force (1988): "While not specifically addressed in the Employability Skills Profile, the importance of vocational-technical skills should not be overlooked or minimized. The value of specific vocational training will, in addition to the Profile skills, often enhance one's employment opportunities, qualify one for special job classifications, and lead to ultimate success." (p. 4) As stated by Gray (1989), it seems that what employers mean by basic skills is somewhat different from what academicians mean. In the mind of most academicians, basic skills include reading, writing, and computation. However, there is little doubt that, in the minds of most employers, technical skills are the most basic job competency (Johnson, Foster, & Satchwell, 1989). Because technical skills are a necessity for productive employment, technology education instructors and curriculum developers must continue the industrial arts tradition of hands-on, experiential learning with tools, materials, and systems. Technology education programs may be the only place where secondary level students can experience and interact with technological devices and systems.

While the relationship between technology education curricula and traditional vocational outcomes such as workforce training and productivity have not been actively addressed by the field, technology education does have a unique and significant role to play in the effort to improve workforce productivity. Clearly this role is not to provide the specific vocational and technical skills needed for productive employment. Those skills are best provided through post-secondary programs in community colleges and technical institutes. Technology education can, however, empower its students with a literacy that enhances future learning and interaction with technology, that is, the broad skills and competencies that are most desired by employers. Through hands-on experiences with technology, students can integrate and apply their learning, enhance their higher order thinking skills, and increase their ability to interact with technological devices and systems.

References

Bartel, A. P., & Lichtenberg, F. R. (1987). The comparative advantage of educated workers in implementing new technology. *The Review of Economics and Statistics*, *69*(1), 1-11.

Berger, J. (1987, April 20). Productivity: Why it's the no. 1 underachiever. *Business Week*, pp. 54-55.

Carnegie Forum on Education and the Economy. (1986). A nation prepared: Teachers for the 21st century. Princeton, NJ: Carnegie Foundation.

Clark, S. C. (1989). The industrial arts paradigm: Adjustment, replacement, or extinction? *Journal of Technology Education*, *1*(1), 7-21.

Employability Skills Task Force. (1988). Report to the Governor's Commission on Jobs and Economic Development (A Michigan employability profile). Detroit, MI: Governor's Commission on Jobs and Economic Development.

Erekson, T. L., & Johnson, S. D. (1989). Proceedings of Technology Education XI, Technology Education: An Interdisciplinary Endeavor. Champaign, IL: Department of Vocational and Technical Education, University of Illinois at Urbana-Champaign.

Faddis, C., Ashley, W. L., & Abram, R. E. (1982). *Preparing for high technology: Strategies for change*. Columbus, OH: Ohio State University. National Center for Research in Vocational Education. (ERIC Document Reproduction Service No. ED 216 168)

Flynn, P. M. (1985). *The impact of technological change on jobs and workers*. Unpublished manuscript.

Gray, K. (1989). Setting the record straight. *Vocational Educational Journal*, *64*(4), 26-28.

Grubb, W. N. (1984). The bandwagon once more: Vocational preparation for high-tech occupations. *Harvard Educational Review*, *54*(4), 429-451.

Hatsopoulos, G. H., Krugman, P. R., & Summers, L. H. (1988). U.S. competitiveness: Beyond the trade deficit. *Science*, *241*, 299-316.

Johnson, S. D., Foster, W. T., & Satchwell, R. (1989). *Sophisticated technologies, the workforce, and vocational education*. Springfield, IL: Depart-

ment of Adult, Vocational and Technical Education, Illinois State Board of Education.
Jonas, N. (1987, April 20). No pain, no gain: How America can grow again. *Business Week*, pp. 68-69.
Klein, L. R. (1988). Components of competitiveness. *Science*, *241*, 308-313.
Kutscher, R. (1987). The impact of technology on employment in the United States: Past and future. In G. Burke, & R. W. Rumberger (Ed.), *The future impact of technology on work and education*, (pp. 33-54). London: The Falmer Press.
McLaughlin, A., Bennett, W. J., & Verity, C. W. (1988). *Building a quality workforce*. Washington, DC: U.S. Department of Labor, U.S. Department of Education, U.S. Department of Commerce.
Mikulecky, L. (1984, January). Literacy in the real world. *Reading Informer* (Special issue), 2-8.
National Commission on Secondary Vocational Education. (1984). *The unfinished agenda: The role of vocational education in the high school*. Columbus, OH: The Ohio State University, The National Center for Research in Vocational Education.
Naylor, M. (1985). *Jobs of the future*. Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education. (ERIC Document Reproduction Service No. ED 259 216)
Nettle, A. (1986). *A high tech future*. London, England: London University, Inst. of Education. (ERIC Document Reproduction Service No. ED 280 963)
Parnell, D. (1985). *The neglected majority* (2nd ed.). Washington, DC: Community College Press.
President's Commission on Industrial Competitiveness. *Global competition: The new reality* (Vol. 2). Washington, DC: Government Printing Office.
Rumberger, R. (1984). *Demystifying high technology*. Columbus, OH: The Ohio State University, Columbus. National Center for Research in Vocational Education. (ERIC Document Reproduction Service No. ED 240 305)
Rumberger, R. (1987). The potential impact of technology on the skill requirements of future jobs. In G. Burke, & R. W. Rumberger (Ed.), *The future impact of technology on work and education* (pp. 74-95). London: The Falmer Press.
Rumberger, R. W., & Levin, H. M. (1985). Forecasting the impact of new technologies on the future job market. *Technological Forecasting and Social Change*, *27*, 399-417.
Technology Education Advisory Council. (1988). *Technology: A national imperative*. Reston, VA: International Technology Education Association.
U.S. Department of Education. (1986). *What works: Research about teaching and learning*. Washington, DC: Author.
Waetjen, W. B. (1989). *Technological problem solving: A proposal*. Reston, VA: International Technology Education Association.
Young, J. A. (1988). Technology and competitiveness: A key to the economic future of the United States. *Science, 241*, 313-316.
Zuga, K. F. (1988). Interdisciplinary approach. In W. H. Kemp, & A. E. Schwaller (Eds.), *Instructional strategies for technology education* (pp. 56-71). Mission Hills, CA: Glencoe Publishing Company.

。