Articles

Coping at the Crossroads: Societal and Educational Transformation in the United States

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As the nature of a workforce changes over time, one broadly-defined group of workers diminishes in numbers while another group increases in numbers. For example, during the period 1890-1910, the major proportion of the workforce in the United States shifted from agriculture to industrial production (U.S. Bureau of the Census, 1975). Figure 1 presents the concept. Relentless technological developments gave rise to new job classifications and to increased employment opportunities in industrial production. At the same time, technological developments diminished employment opportunities in another field, in this case, agriculture. Over the long term, then, one might expect that demand for groups of occupations will increase over time, but will be expected to decline when that employment sector is eclipsed by yet another employment sector, driven by a new technological wave.

The intersection of the two curves charting the demand for agricultural occupations and industrial occupations occurred during a time of rapid societal change, which was, in turn, a significant impetus for major educational change. Moreover, because these times of change have historical precedents, they may have a relatively high degree of predictability. Indeed, Toffler (1990) suggested that recent events are shaped by "distinct patterns . . . [and] identifiable forces" that once understood allow us to "cope strategically, rather than haphazardly . . ." (p. xvii).

To explore the hypothesis that educational ferment is a naturally occurring phenomena at the juncture of technological ages, selected economic transition points will be juxtaposed with developments in the evolving field of technology education. From this perspective, the recently-recognized shift in

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employment patterns from manufacturing-based employment to information-based employment has influenced the shift from an industrial materials content base to a technology systems base in contemporary technology education programs.

Figure 1. Labor force transition and educational reform.

Pace of Change

Zias (1976) argued that practitioners need a comprehensive historical understanding of an educational field in order to confront contemporary problems realistically. Without the underpinnings of a strong historical perspective, educators may confront the present with the naive belief that no previous situation has been characterized by such rapid and sweeping change. However, since the onset of the industrial revolution, rapid technological change has been characteristic rather than unique. Way (1964) noted that:

> Change has always been a part of the human condition. What is different now is the pace of change, and the prospect that it will come faster and faster, affecting every part of life including personal values, morality, and religion, which seem almost remote from technology . . . So swift is the acceleration, that trying to 'make sense' of change will become our basic industry. (p. 113)

It appears that Way's prediction has already been realized. Snyder's (1987) interpretation of the composition of the U.S. workforce places more than 50% of the labor force now as information workers. The task of making sense of change has become a basic requirement of everyday life.

Wave Theory as an Explanation of the Change Process

The explanation of social change and the prediction of likely future change through applications of wave theory is not new. Toffler (1970, 1980, 1990) has written extensively about the three great waves that have transformed human society: agricultural; industrial; and post-industrial, or information. In a contemporary analysis of economic activity, Van Duijn (1983) compared the economic wave cycle theories of Mensch, Jantsch and others. This seminal work condensed the thoughts of many theorists in many languages and emphasized the influence of technological innovation on economic and industrial growth and decline. Van Duijn cited Mensch, in particular, as depicting technological innovation as driving cyclical periods of increase and decline. Ayers (1990) identified five long economic cycles since the beginning of the industrial revolution, and concluded that "advances in technology, together with, and exhaustion of, certain natural resources, have combined to bring about a series of coordinated technological transformations that are correlated with waves of economic activity" (p. 3). Combining the agricultural, industrial, and information waves delineated by Toffler with the five economic cycles described by Ayers clearly identifies periods of unusual social stress. This analysis also provides a useful framework for reviewing the relationships of social stress and changes in education. The analysis also poses predicative implications.

Figure 2. Transformational waves and long economic cycles.

The First Long Cycle

According to Ayers (1990a), a cluster of inventions in Great Britain about 1775 made possible the development of the steam engine, wrought iron, and cotton textiles (Ayers, 1990 a; Kicklighter, 1968). These developments, coupled with a shift to coal as a major energy source and the construction of an inter-linked canal system, fueled the first long cycle. Power, manufacturing and transportation were the hub of the new technology which emerged.

Educational response. From this shift from agrarian to industrial economies, two societal stresses also developed, First, populations shifted to urban areas, and secondly, demands for trained industrial workers began to develop. From the initiation of industrial activity, changes in society created conflicting viewpoints on the proper education for changing circumstances. During the first cycle, the Calvinist ideals championed by Francke and the sense-realist approach favored by Rousseau exerted significant influence on education. The *Schools of Industry* which proliferated in Austria, Germany, and Britain sought to develop the habits of industry among the poor (Bennett, 1926). With the development of such practically-oriented programs, education was viewed as important for all individuals growing up in the society. Education was also viewed as a contributor to the solution of social problems.

Rousseau is credited with opening a new era in education by recognizing that “manual arts may be a means of mental training” (Bennett, 1926, p. 81). Rousseau believed that the education of children should be a natural, spontaneous affair catering to the natural curiosity of children. The concept of “learning by doing” has developed a rich educational tradition that flourished in the work of Pestalozzi, Fellenberg, and Froebel. These ideas all contributed to educational influences in the United States as this nation underwent similar shifts in economy and society.

The Second Long Cycle

The first and second long cycles together make up what is commonly referred to as the industrial revolution (Ayers, 1990a). The second cycle, which began in Britain about 1825, was stimulated by technological inventions and improvements that led to the railroad construction boom of 1838-1843 and the accompanying telegraph network. These two innovations created a faster, more efficient transportation system coupled with a new communication network. Together, these systems established an infrastructure which further expanded the opportunities for economic development. In the United States, the events were somewhat later, but very similar. Fulton applied steam to boats in 1838, the telegraph spanned the continent in 1861 and the historic "golden spike" connected the railway systems of the east and west in 1867.

Educational response. While workers in the first cycle of industrialization needed only minimal skills to perform their jobs, many second cycle workers were required to develop much higher levels of technical competence. By 1875, few U.S. students finished high school and fewer had employable skills despite a growing need for technically proficient workers. Society was expecting schools to prepare its youth, but the schools were based on a classical educational pattern. This societal impetus influenced the thoughts of Runkle at MIT, Woodward and Dewey (Bennett, 1926).

Other schools of applied science and engineering, which built on the "learning by doing" precepts of the first cycle, also appeared throughout Europe. A significant response in the United States was the Morrill Act of 1862, which established land-grant colleges for the study of agricultural and mechanical arts in each of the states (Bennett, 1926).

The Third Long Cycle

The third cycle, the second industrial revolution, began about 1870 (Ayers, 1990a). Major technological breakthroughs of this era included the development of steel, the widespread application of the internal combustion engine, the creation of networks to transmit electricity, and the evolution of a manufacturing system based upon mass production and interchangeable parts. In the third cycle as never before, much of the technological innovation was devoted to the development of consumer products and services: interurban trams, telephones, and household appliances.

Educational response. By the time of the 1920 census (U.S. Bureau of the Census, 1975), employees in the manufacturing sector outnumbered agricultural workers in the United States for the first time. The crossing of the employment curves, as in Figure 1, signalled the need for a change in educational direction. While the need for educational change was clear, the direction that the change should take was hotly contested. The social and education turmoil of this era is well documented (Barlow, 1976; Bennett, 1937; Glatthorn, 1987; Luetkemeyer, 1987). In highlighting some of the concerns of the day, Law (1982) observed that:

> In the last decade of the 19th century, marked by unrestricted capital speculation, violent clashes between labor and industry, social unrest and political turmoil, there was a mounting wave of criticism regarding the elitist posture of the public high school. In a period when private and

> public secondary schools combined served only 6.7% of the age group, and colleges 1.5% of theirs, the inherent failure of the public school system had become a burning issue. (p. 19)

During this period of social upheaval, the Smith-Hughes Act, which was passed in 1917, marked the beginning of federal funding for secondary vocational education in the public schools. Passage of the Smith-Hughes Act could only be accomplished through the formation of a remarkable coalition comprised of diverse special interest groups (Hillison, 1987). Bennett (1937) observed that the Smith-Hughes Act was likely the best compromise possible, given the turmoil of the time. Even critics of the Act, such as Law (1982), conceded that no other legitimate alternative seemed possible.

Innovations

The crises of this period were addressed by the promulgation of the seven cardinal principles which were adopted by the NEA and which formed the basis of the comprehensive schools of the next several decades (Kozak & Robb, 1991). These principles, when combined with the Smith-Hughes Act and the guidance movement, formed the educational structure that effectively launched a reformed educational approach to address the societal needs of the time. Included in these new reforms were industrial arts, as distinguished from manual training, manual arts, and vocational education -- especially as developed by Bonser and Mossman at the Speyer School of Columbia University (Bennett, 1937).

The Fourth Long Cycle

While the fourth long economic cycle did not have a clear starting or ending point, Ayers (1990b) located its origins in the depression of the 1930s and its end in the mid 1970s. The leading economic sectors in this cycle included the automobile, electrical and electronics, chemical, and aerospace industries. Ayers noted that, in spite of the array of technological developments, only television, semiconductors, and electronic computers were new technological innovations of this era.

Educational response. Glatthorn (1987) described four major approaches to curriculum development that were popular during the period, 1917 to 1974. The major societal strains involved in accommodating the shift to the industrial era were relatively well stabilized by the time of the passage of the Smith Hughes Act and the establishment of support for formal programs of vocational education in 1917. A relatively stable period followed in education until about 1940. Three identifiable curriculum orientations (developmental conformism, scholarly structuralism, and romantic radicalism) appeared in succession as the industrial age gave way to the service and information ages. Coincidentally, 1974 marked the shift to a new curriculum orientation, privatistic conservatism (Glatthorn, 1987), and the approximate transition point between Ayers' fourth and fifth cycles.

Bell (1973) identified 1956 as the date when number of white collar workers surpassed total employment of blue collar workers for the first time. Toffler (1980) also noted 1956 as the approximate beginning of the Third Wave. The educational impact of these transitions was eclipsed on October 4, 1957, when the U.S.S.R. successfully launched the first space vehicle into orbit around the earth.

The change in workforce demographics, coupled with the response to Sputnik, released a massive burst of school reform and curriculum innovation. Conant's (1959) work reemphasized the need for a comprehensive high school encompassing the arts, humanities, science, math, and vocations. Conant also stressed the need for high standards in the comprehensive high school. Cochran (1970) observed that the 1960s produced more change and modification in industrial arts programs that any previous decade. The Industrial Arts Curriculum Project, American Industry Project, and Orchestrated Systems Approach were some of the better known industrially-based curriculum projects of the era. Further, the study of technology, first proposed by Warner in the 1940s, received increased emphasis through the work of Olson and DeVore (Householder, 1979). Olson's (1973) concepts of interfaces stressed that a static curriculum was inappropriate. These concepts, combined with Maley's (1973) emphases on group synergy, technological development, and research helped provide a foundation for a systems approach where the individual interpreted factors in solving technical problems.

The Fifth Long Cycle

The long cycles described by Ayers (1990b) averaged approximately 50 years in length. They generally began with a cluster of innovations that occurred during the economic slowdown between cycles. The fourth long cycle concluded in the mid 1970s; the fifth long cycle is still evolving. But, as Ayers noted:

> It is now widely recognized, and correctly so, that 'high tech' was the leading sector of the 1980s. Within the present decade, or early in the next one, the computer and telecommunications sectors are almost certain to overtake the auto industry and its satellites as the 'locomotives' of the world economy. Already, computers and related automation equipment have become the dominant form of capital equipment, and software development and maintenance are becoming major sources of employment. (p. 127)

Ayers suggested that the computer chip revolution has yet to have significant impact upon manufacturing and that computer integrated manufacturing (CIM) will "almost certainly turn out to be one of the 'leading sectors' of the fifth technological transformation" (p. 128).

Educational response. Analysis of the educational change that occurred in previous long cycles could be addressed from the comfort of a historical point of view. However, as this essay is written at the transition between two long cycles, as defined by Ayers, and two technological waves as defined by Toffler, the analysis of the present is much more difficult, and the inference of the coincidence of the two wave cycle patterns suggests enormous impact. The early 1980s were characterized by numerous reports that suggested what "ought" to be done in various educational settings. Strickland (1985) noted the relationship between education and national security in the call for educational reform. In reviewing four prominent reports on education (*A Nation At Risk, Educating Americans for the Twenty-first Century, Actions for Excellence, and Making the Grade*) Strickland drew the parallel between the post-Sputnik reaction and the clamor for educational reform which characterized the 1980s.

Industrial arts responded to the realities of the new workforce expectations by pursuing a change to technology education. While many varieties of technology education are currently practiced and proposed, the common features of most programs include: (a) an emphasis on problem-solving capabilities; (b) an interdisciplinary approach that emphasizes alternatives and compromises, (c) the integration of context in an approach to recognize systemic functions, and (d) an assessment of the consequences of technological activities.

Summary of the Impact of Technological Transformations on the Workforce

A useful summary of the impact of technological transformations on the workforce is provided by data on labor force participation in the four sectors of the United States economy. For the period between 1860-1995, Liedtke (1990) reported that:

1. The agricultural workforce peaked in the late 1800s and had declined to less than 3% by 1980.
2. Industrial workers had three employment peaks in this period, around 1860, 1917, and the mid 1950s. However, since the peak in the 1950s, industrial sector employment has declined to less than 20% of the labor force.

3. Service workers averaged about 20% of the work force from 1860 through 1960. Since 1960, however, the proportion of service workers has risen dramatically.
4. Only the information sector of the work force has demonstrated consistent growth over the period. As of 1987, information workers held more than 50% of all jobs.

Combining the long cycle analysis by Ayers (1990a, 1990b), workforce demographics, and the history of industrial education leads to the conclusion that major philosophical and curricular stress points do indeed coincide with the wave cycles of technological transformation. As each wave of economic activity required different skills of its workforce, societal and educational forces attempted to reform to meet the perceived needs. Efforts at educational reform prior to the societal needs largely fell on deaf ears, regardless of the validity of thought.

Further, as the occupational requirements became more complex, the degree of educational ferment accompanying each transition point appeared to have increased. During the early waves of industrial enterprise, the educational response was generally limited to isolated activities of individual innovators. These resulted in such diverse offerings as the *Schools of Industry* and the Mechanics' Institute Movement.

However, dealing with educational change in later industrial waves became increasingly complex as diverse interest groups championed their own interests. The cauldron of educational controversy preceding the passing of the Smith-Hughes Act was clearly without precedent in the United States. Subsequent educational responses have perhaps been as frenzied from the point of view of curriculum development and legislation, but not as bitterly contested. For example, the educational innovation which followed Sputnik seemed to proceed from a collective national purpose. Coping with the age of the information worker has led to substantial reporting and substantial displacement of workers. The corollary, a cohesive reorganization of the whole educational focus, such as occurred in 1917 and 1958, appears to be lacking.

The major controversy seems to focus on educational retrenchment and the re-emphasis upon the traditional academic subjects. Historically, this sort of modification often follows a pattern in which retrenchment of one group eventually leads to a new solution promulgated by another group. For example, the content and emphasis of the baccalaureate degree changed markedly as land grant colleges provided new solutions to the need for practically-oriented programs of higher education. The answers to the problems which have precipitated the current educational reforms are still evolving and are clearly not yet complete.

Lessons from the Past and Implications for the Future

The analysis of historical cycles presents opportunities for addressing present and future educational needs. This analysis suggests a wide range of lessons from the past and offers provocative implications for future educational planning. These inferences and implications include the following:

1. Change in the composition of the workforce is a continual process driven largely by technological innovation.
2. The responses of education have generally been reactive in response to the forces of change, rather than proactive in anticipation of change.
3. The skills required of workers have consistently become more complex. Literacy is no longer an option. Increasing job complexity requires high-order thinking skills and problem solving capabilities in a world of local area networks (LANs), fax, and e- mail.
4. One constant in the evolution of technology education has been the need to demonstrate that the discipline has made a contribution to the economic well-being of the country. Times of retrenchment by traditional educators, who vastly outnumber technology educators, exacerbates this need.

Educators in every era have been convinced that there have never been times like these before. And while this is always true to some extent, perhaps only now has the rate of change reached the point where teaching only cognition (the exchange of information) is in question. Toffler (1990) observed that the information age does not need workers who are essentially interchangeable workers as in the industrial era, but rather individuals with diverse and continually evolving skills. Wright (1990) pointed out more specifically the need for developing students who are:

> Flexible, adaptive, life-long learners who can effectively work in groups. . . . that manual skill and detailed technical knowledge had only marginal value compared to problem solving and creative abilities; and that a broad understanding about technology provides a valuable base for consumer, citizenship and career activities. (p. 3)

Many reports and studies have repeated this call. The conceptual framework for technology education (Savage & Sterry, 1990) placed problem solving at the center of the curriculum development model. This is a significantly different approach than the model of industrial technology education (Hales and Snyder, 1980) which has guided the field in recent years.

In a more specific context, Zirbel (1991), in a needs assessment of the manufacturing engineering technologies, found that only two of the top seven rated competencies were directly related to engineering technologies -- and those two dealt with analyzing processes. The other competencies look familiar to those analyzing workplace trends:

1. Understand the importance of quality.
2. Display motivation, responsibility, and natural curiosity.
3. Communicate clearly and concisely.
4. Work effectively as part of a team.
5. Demonstrate a basic working knowledge of personal computers.

Carnevale, Gainer and Meltzer (1990), in the report of a major study which seems destined to become a classic, proposed seven essential groups of workplace competencies:

1. Knowing how to learn.
2. Reading, writing, and computation.
3. Oral communication skills: listening and speaking.
4. Creative thinking and problem solving.
5. Self-esteem, goal setting, motivation and decision making.
6. Interpersonal skills, negotiation, and team work.
7. Organizational effectiveness and leadership.

What is interesting about the new list of "oughts" is the convergence of various occupational needs with current educational priorities. The common focus is on problem solving, communicating and team work, all in more technological and complex settings.

Conclusions

Finding educational direction at the crossroads of technological eras is clearly no easy task. Scores of educational reports of the 1980s attest to this difficulty. However, each of the cycles which have been examined in this essay eventually evolved its own unique solution. Based on historic precedent, the following conclusions appear likely:

1. Education reform may be two cycles behind changing social and economic circumstances.
2. Education should be less concerned with courses and subjects as static elements and more concerned with the identification of the components of "basic education."
3. Change will occur more rapidly. Change may now be occurring at a pace that makes it difficult to even observe the transition points.

Ayers (1990b) pointed out the difficulty in precisely defining the transition points in the last two waves in a way which highlights this problem.

4. The new "basic" should not be based on a static curriculum. Rather, it should have a proactive ability to anticipate. The new "basic" must diminish barriers between subjects of study (knowledge) and seek to integrate knowledges and experiences to make them more meaningful. While technology education is not construed to be "vocational," it must relate to a competent workforce as a part of basic education required by all prior to the acquisition of job skills.
5. The nation, to remain competitive in a global society and economy, cannot depend on government bureaucracy to lead the change. Historically, all major reformations were preceded by periods of diversity and experimentation. If we face a future of continued rapid change, school quality could become more dependent upon new ideas and experimentation. Conformity and stability of context are not conducive to coping with rapid change. The future will depend upon individual schools and educators who are empowered to innovate rather than conform.
6. Accreditation guidelines and procedures must also change from an emphasis upon meeting standards to an emphasis upon successful motivation and learning.

References

Ayers, R. U. (1990a). Technological transformations and long waves. Part I. *Technological Forecasting and Social Change*, *36*, 1-37.

Ayers, R. U. (1990b). Technological transformations and long waves. Part II. *Technological Forecasting and Social Change*, *37*, 111-137.

Barlow, M. L. (1976). The vocational education era emerges, 1876- 1926. *American Vocational Journal*, *51*(5), 45-62.

Bell, D. (1973). *The coming of the post-industrial society*. New York: Basic Books.

Bennett, C. A. (1926). *History of manual and industrial education up to 1870*. Peoria, IL: Bennett.

Bennett, C. A. (1937). *History of manual and industrial education 1870 to 1917*. Peoria, IL: Bennett.

Carnevale, A. P., Gainer, L. J., & Meltzer, A. S. (1990). *Workplace basics: The essential skills employers want*. San Francisco: Jossey-Bass.

Cochran, L. H. (1970). *Innovative programs in industrial education*. Bloomington, IL: McKnight.

Conant, J. B. (1959). *The American high school today*. New York: McGraw-Hill.

Glatthorn, A. A. (1987). *Curriculum leadership*. Glenview, IL: Scott Foresman.

Hillison, J. (1987). The Smith-Hughes Act at 70. *Agriculture Education Magazine*, *59*(8), 4-20.
Householder, D. L. (1979). Curriculum movements of the 1960's. In G. E. Martin (Ed.), *Industrial arts education: Retrospect, prospect* (pp. 114-131). Bloomington, IL: McKnight.
Kicklighter, C. E. (1968). Machine Technology, in Leutkemeyer, J. F. (Ed.) *A Historical Perspective of Industry, 17th annual yearbook of the American Council on Industrial Arts Teacher Education*. Bloomington, IL: McKnight.
Kozak, M., & Robb, J. (1991). Education about technology. In M. J. Dyrenfurth & M. R. Kozak (Eds.) *Technological literacy* (pp. 28-50). Mission Hills, CA: Glencoe/McGraw-Hill.
Law, G. F. (1982). *19th Century roots to the American vocational movement*. (ERIC Document Service No. ED 226145).
Liedtke, J. A. (1990). A synthesis of communication systems and approaches for technology education. In J. A. Liedtke (Ed.), *Communication in technology education* (pp. 178-195). Mission Hills, CA: Glencoe/McGraw-Hill.
Luetkemeyer, J. F. (1987). The Snedden/Prosser social efficiency paradigm of vocational education. *Journal of Industrial Teacher Education*, *25*(1), 31-43.
Maley, D. (1973). *The Maryland Plan*. New York: Bruce
Olson, D. W. (1973). *Tecnol-o-gee*. Raleigh, NC: North Carolina State University.
Savage, E. & Sterry, L. (1990a). A conceptual framework for technology education, Part 1. *The Technology Teacher*, *50*(1), 6-11.
Savage, E. & Sterry, L. (1990b). A conceptual framework for technology education, Part 2. *The Technology Teacher*, *50*(2), 7-11.
Snyder, D. P. (1987). Inevitable forces for change. *Insight*, *4*(7), 1-6.
Snyder, J. F., & Hales, J. A. (Eds.). (1981). *Jackson's Mill industrial arts curriculum theory*. Fairmont, Fairmont State College.
Strickland, C. E. (1985). Sputnik reform revisited. *Educational Studies: A Journal in the Foundations of Education*, *16*(1), 15-21.
Toffler, A. (1980). *The third wave*. New York: Morrow.
Toffler, A. (1990). *Powershift*. New York: Bantam.
U.S. Bureau of the Census. (1975). *Historical statistics of the United States, colonial times to 1970, Bicentennial Edition, Part 2*. Washington, DC: Author.
Van Duijn, J. J. (1983). *The long wave in economic life*. London: George Allen & Unwin.
Ways, M. (1964). The era of radical change. *Fortune*, *64*(5), 113-115, 210, 215, 216.
Wright, T. (1990). Challenges facing educators. *The Technology Teacher*, *50*(2), 3-5.
Zais, R. S. (1976). *Curriculum: Principles and foundations*. New York: Harper & Row.
Zirbel, J. H. (1991). *Needs assessment for manufacturing engineering technologists*. Unpublished doctoral dissertation, Texas A&M University, College Station, TX.