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The Future History of Industrial Technology

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Introduction

Industrial technology (IT) is approaching a junction in its journey from conception, incubation, early development and full development, and health as a discipline. Faculty who nurtured IT programs through the early years of development are retiring in large numbers. Zargari, Patrick, and Coddington (2002) found that 23% are expected to retire within five years. Fearful that these faculty will be difficult to replace, some institutions have developed Ph.D. programs to develop the faculty for the future (the Indiana State University led consortium of 6 institutions, Eastern Michigan's recently approved program, and the existing programs of Iowa State and Northern Iowa are prominent examples). The faculty emerging from these new programs will not have the same experience and training as the retiring faculty. Zargari, et al, show that 75% of IT faculty hold degrees in the three areas of industrial arts (17%), IT (24%), and Vocational & Trade (34%). Most retiring faculty experienced the transition from *Industrial Arts* for the preparation of teachers to what has become IT for the preparation of technologists. New faculty coming from the Ph.D. programs will have studied technology and technology management. As they develop their expertise, they may see little connection to Industrial Arts or the history of Industrial Arts (IA). Nor may they see much connection between what they do and vocational education. They will connect with the history of technology and the history of technology management (TM). As this occurs, there could be a shift in the historical underpinning of IT. These new faculty may look back beyond the approaching junction and identify with a different trail than the one that was taken. The question of this study is: Will these faculty hold a different view of the history of IT and TM? This paper is submitted as a kind of aerial view, a brief view of the historical landscape and the areas where the historical trails are most likely to be seen. This aerial survey leads the author to conclude, from the evidence, that NAIT should be a significant factor in the history of IT and TM to these students.

The Trail Taken

Very briefly, the trail taken or existing history of IT, generally, leads us back in time to 1989 when NAIT received approval from the United States Department of Education (USDE) to be the accrediting agency for industrial technology programs (Israel, 1995, p. 64). The efforts of two people in particular stand out: C. Kicklighter and A. Rudisill. According to Kicklighter "It was 8:45 p.m. on Friday, October 27, 1967 in Springfield, Missouri. These 58 institutions [listed in the side bar of the reference] will be forever listed in our history, as it was then and there that 125 representatives from these schools voted unanimously to organize into a formal body, later known as the National Association of Industrial Technology" (C.E. Kicklighter, letter to NAIT members, August 30, 1999). Before this, Charles Keith who is recognized as the founder of NAIT, had organized the First Conference in 1965 with a group of faculty which two years later became NAIT (Israel, 1995). Before the first conference one can trace the movement through industrial education; the work of Olsen, Wilber, Warner, the Industrial Arts Division of the American Vocational Association in 1932 led by Selvidge, through to Richards, the establishment of the American Vocational Association in 1926 to the pragmatic philosopher John Dewey, and before that the Sloyd

system of education (Martin & Luetkemeyer, 1979).

The Junction

NAIT defines Industrial Technology as "a field of study designed to prepare technical and/or technical management-oriented professionals for employment in business, industry, education and government" (National Association of Industrial Technology, [NAIT] 2000, p.1). It is the faculty membership of this group who will be replaced with graduates from the new programs. The largest Ph.D. program, by current enrollment (141 students enrolled in January, 2003) is the Indiana State University led consortium program of Technology Management (B. D. Dallman, personal communication, January 21, 2003). It is these graduates, more than any other group, who will interpret and define the historical underpinnings of the study of Industrial Technology as they fill the void left by the retiring faculty. What will they have studied? It is reasonable to assume that they will be expected to have studied management, technology, and the impact of management and technology on society. It is these areas which will form the historical landscape and reveal the areas the trails are most likely to be.

As one studies management, technology, and related social issues, various patterns of theory emerge. The Ph.D. graduates from these new programs may fuse some of these patterns to develop some coherent theoretical approaches to IT and TM that differ to the approach that evolved from industrial arts. The author's observations and aerial search for trails will be restricted to these three areas: management, technology, and related social issues.

Management

As they review the published material on management, the Ph.D. students will, in all likelihood, learn that there is no single and clear approach to management. This is because as one reviews relatively widely read books on basic management theory, such as textbooks with multiple editions (Lewis, Goodman & Fandt, 2001; Stoner & Freeman, 1992; Weihrich, 1993), one becomes aware of the various approaches to managing. For example, one approach, generally called management science, emphasizes mathematics; another approach generally called social systems, emphasizes interpersonal and group behavior. Indeed Harold Koonze, throughout his career, wrote about what he called the management theory jungle. In 1961 he identified seven patterns of management analysis; by 1988 he had added five more (Koonze & Weihrich, 1988). He stated that with knowledge of these patterns "you can at least identify the point of view from which any book or article on management has probably been written" (p. 37). One of these approaches he identifies as the sociotechnical systems approach which emphasizes the influence that the technical system has on the organization and how it operates. It is likely students will identify more closely with this school of management thought than with others, and the sociotechnical systems approach shall be presented in more detail.

Technology

The use of the term "technology" is pervasive in education and society. One does not have to review widely read books to be aware of the various approaches to technology. For example, on the one hand, the name of one of the most prestigious engineering programs in the nation is Massachusetts Institute of Technology (MIT). The *U.S. News & World Report* annual ranking of engineering schools offering a Ph.D., ranked MIT first in its 2000 ranking (2000, p.132). The same publication ranked Rose-Hulman Institute of Technology first for best undergraduate engineering programs. On the other hand, many high schools, trade/vocational schools, and community colleges have hands-on manual skill development programs called technology programs. Steele (1989) is one who would not object to this broad use of the term in identifying programs. He states: "The spectrum of work I propose to include under the rubric of technology goes all the way from basic research to product service (p.9). He further states that:

> If one observes the way the term *technology* is used, two common themes emerge. First, it tends to be a crosscutting term, a term that is less easily pigeonholed than *science* or *engineering* or R&D. As a corollary, it tends to be less polarizing. Although many scientists would probably not be happy to be called "technologists," the term probably evokes less unattractive status distinctions in their minds than others, such as "engineers." Second, the term is generally associated with capability – the ability to do things. (p.8)

Burke (1978) has discussed connections in technology where one technological development acts as a trigger to more technological development. Innovations are "the result of a sequence of closely connected events extending from the ancient world until the present day" (Introduction). But he is careful in his examples of connections to point out that these possible connections from one development to another are a personal view. Badawy (1993) has even argued that management is a technology. Because of the pervasive use of the term technology, the Ph. D. students may observe many poorly defined trails of historical development for a history of IT or TM but no clear, well-worn trail.

Society

Drucker (1974) writes, "Economists, historians, and sociologists all stress the importance of technology – but then they tend to treat it with 'benign neglect', if not with outright contempt…" (p. 99), and "The absence of any serious concern and study of technology among the major academic disciplines is indeed puzzling" (p. 118). There are some exceptions that Drucker himself acknowledges: White's *Medieval Technology and Social Change* (1962), Landes' *The Unbound Promethus: Technological Change and Industrial*

development in Western Europe; 1750 to the Present (1969). The eight volumes of *A History of Technology* (Singer, Holmyard & Hall, 1984). The Ph.D. students may uncover other exceptions. The quarterly *Journal of Technology and Culture* may be helpful. Galbraith may qualify as an exception with his discussion of the Imperatives of Technology in chapter two of *The New Industrial State* (1967). Thorstein Vebin, another economist, is missing from Drucker's exceptions. Veblin's titles include, *The Engineers and the Price System (1921)*, which includes a chapter called *A Memorandum on a Practicable Soviet of Technicians* and *The Theory of Business Enterprise* (1904) in which he argued a link between technology and social structure. While students in these Ph.D. programs may find important exceptions to Drucker's claim, it is unlikely that a clearly defined trail of historical development of IT or TM will emerge from the study of social sciences. Moreover, exceptions which are uncovered may already be included in the sociotechnical systems approach to management. This shall be presented in more detail.

A New Look at the Past

The faculty emerging from the new programs will have studied managing, technology and society. They may well have studied various approaches to managing; they may well have dealt with the pervasive nature of technology and have little theoretical guidance from social scientists.

As they explore the history of management, technology, and technical management, the students may uncover markers more significant to them than the aforementioned markers identifying the trail taken by retiring faculty in transitioning from IA to IT. They can go back in history as far as they wish for a useful starting point. If a melding of management and technology is necessary as a starting point, it may be the combining of bureaucracy and technology to build the pyramids (Evans, 1976) or the combining of superior weapons as a technological advantage combined with management techniques of agendas in war throughout the middle Ages. Useful markers would be the beginning of the industrial revolution and the emergence of the factory system, Watt's improvements to the steam engine combined with the business practices of his partner Matthew Bolton. The first marker in the U.S. may be Alexander Hamilton's report on manufacturers in 1791 where he states the importance for the U.S. government to encourage manufacturing (Spiegel,1960). Ten years after Hamilton's report, gauges and standards emerged with Eli Whitney's interchangeable parts for guns germinating modern manufacturing practices (applying technology and management). If the social side must not be ignored, a useful marker may be the unfortunate boy Ned Ludd of Leicester, England, who in 1811 after receiving a magistrates ordered whipping for not exerting himself at work, took a hammer to his knitting frame (Hammond and Hammond, 1995) marking the beginning of the Luddite movement and greater consideration of the social reaction to technology.

Historical trails leading up to the 20th Century converge. From an aerial view it's an oasis in the desert or a clearing in the forest that most trails will lead to. Three people mark this convergence. Henri Fayol in France arguing that management is a teachable theory, Frederick Taylor's work on what was to become known as scientific management (Drucker points out that Taylor "in all probability also coined the terms 'management' and 'consultant' in their present meaning" [1999, p.6]), and the reorganization of the administrative structure of the Dupont Company mark this convergence. As historical viewpoints on management, technology, and society converge at this point, the important historical underpinnings of IT or TM will reside in developments since this time, not before.

Why do Fayol, Taylor, and Dupont mark this convergence? Henri Fayol was a French mining engineer. His work in trying to operate coal mines efficiently led him to principles of management and the management activities of planning, controlling, coordinating, commanding, and organizing which are still essentially accepted as the principles and activities of managers today (Fayol, 1961). Although Fayol's major work was not translated and made widely available until 1949, he had generated the awareness that management principles could be studied and applied. Taylor was a machinist and then an engineer before his investigations into workplace efficiency (Kanigel, 1997; Nelson, 1980; Wrege & Greenwood, 1991). These investigations led him to being generally regarded as the "father of scientific management" (Copley, 1969; Taylor, 1967). Dupont was an organizer. Chandler and Salsbury (1971) state of Pierre Dupont: "Pierre not only was the builder of two of the nation's leading industrial enterprises, (Dupont & General Motors) but played a pivotal role in spreading the techniques of modern corporate enterprise within the American economy" (p.xxi). He "actually made the critical decisions and devised and formulated so many of the practices of modern big business" (p.xxi). Dupont's innovations were not without a trail; Schumpeter (1934) points out that Rockefeller, Carnegie, Frich, Swift, Duke, McCormick, and the Guggenheims were innovators in organization in the decade or two prior to the turn of the century (1934). But Dupont did it within the corporate organization structure rather than the previously preferred partnership structure. These three people Fayol, Taylor, and Dupont mark the beginning of modern management, technological, and organizational thought and practice.

The aerial view suggests the way out of the convergence, oasis, or clearing, may begin with only two trails, both intertwined with the automobile industry. Abernathy (1978) suggests the reason for this: "the industry affords an unparalleled opportunity to study technological change over the full range of its development. Few products other than the automobile have left such a highly visible record of their development through a complete course from birth to apparent maturity" (p.8). A more detailed study by the Ph. D.

students may reveal other trails not identifiable from this aerial view. But one trail observed from this aerial view is an organizational trail that leads to an investigation of General Motors. The other trail is the technology trail that leads to an investigation of Ford Motor Company. On the first trail, Pierre Dupont is followed to Alfred Sloan, his successor at General Motors. Although Sloan had a degree in electricity and began his career as a draftsman (Sloan, 1941, p. 4-5) and stated, "I happen to be one of the old school who thinks that a knowledge of the business is essential to be a successful administrator" (1963, p. 4), he set in motion general management theory. He had participated in persuading Pierre Dupont to take over the president's position of General Motors. Chandler and Salsburg state that Dupont had no real experience in the automobile industry, and Sloan himself stated, "Mr. Dupont had no intimate knowledge of the automobile business" (1963, p. 44). Sloan states that he learned much from Dupont (1941,1963) but it was Sloan's organizational design, approved by Dupont, for General Motors that fostered the emergence of powerful functional departments and staff positions.

> *The central management depends heavily on the staff officers. indeed, many of the important decisions of central management are first formulated in collaboration with the staff in the policy groups, and then adopted, after discussion, by the governing committees. Consequently, the staff is the real source of any decisions that are formally adopted by the committees. (1963, p. 341)*

Further pursuit along this trail leads to authors such as Follet, Urick, Drucker, and general management theories.

On the second trail out of the convergence, Frederick Taylor is followed to his scientific management approach and Ford Motor Company. By 1910, Ford machinery was the best in the world (Nevins,1954. p. 464). By 1915, assembly lines at the Highland Park facility were fully installed and the newly created professional, the industrial engineer, was necessary to think about how all the parts come together and just what each assembler should do (Womack, Jones & Roos, 1990, p. 131). Nevins states that:

> the machine process, in short, was generating and perfecting it's own procedures. Plant engineers and production superintendents, knowing little of theory but schooled in machine shop, foundry, and assembly room, to a firm grasp of practical needs, were creating a system of management to meet them. (p. 469)

Nevins continues that Henry Ford and others at Ford Motor Company "may well have learned something from Taylor, but they could also have taught him something" (p. 469). This second trail, Taylor's scientific management and the study of work methods, and the emergence of the industrial engineer may be the preferred of the two trails to take. But this second trail, as promising as it appears, soon branches as major barriers are observed. "Ford's amazing decline and General Motors' just as phenomenal rise in the 1920's and 1930's was at least partly caused by the differences in management structure and methods" (Chandler, 1969, p. 204). Moreover, Taylor's scientific management had been concerned with improving efficiency by analysis of the physical capacity of the worker. A series of studies which have come to be known as the Hawthorne Studies were conducted between 1927 and 1932 and "brought into question…. that there was a simple and direct relationship between physical working conditions and the rate of production…." (Etzioni, 1964, p. 33), and "the discovery of the significance of social factors was to become the major finding of the Hawthorne Studies" (Etzioni, p. 33). This led to the Human Relations School of Management thought.

This school argued that the level of productivity is set by social norms, not physical capacity, as Taylor had argued, and both informal and formal leadership exists in group activity (Etzioni). This school came to emphasize the importance of communications between the ranks. Questions about the ability to communicate away differences between workers and managers led to divisions within the human relations movement. Etzioni points out that management and workers "share some values, especially national ones, whose influence becomes evident in periods of international crisis, but they disagree on many others" (p.41). WW II was an international crisis that delayed action on many of the questions raised and postponed divisions in management thought. From the aerial view, it is as if people wanted to establish separate trails from the human relations trail, but WWII was a barrier to new trails.

After WWII, two trails quickly branched from the human relations school of thought. In 1949 a group of social and biological scientists, who saw the human relations movement as too narrow, met. The term "behavioral scientists" emerged from this group (Miller,1955). Also in 1949, Trist concluded from his research findings that work involved people using technological artifacts, and he proposed a conceptual reframing in which work organizations were envisioned as sociotechnical rather than simply social systems (Trist, 1982). "The social and technical systems were the substantive factors, that is, the people and the equipment" (Trist, p. 23). In this sociotechnical system approach, "The idiom of inquiry was action research" (Trist, p. 24). This was the beginning of the sociotechnical school of management thought. Woodward, (1965) a social scientist, in a landmark study of 100 manufacturing firms in Southeast England which first began as an investigation in problems of organization, wrote:

> *…that meaningful explanations of behavior can be derived from an analysis of the work situation. It seemed that in identifying technology as one of the primary variables on which behavior depends, a step forward had been made in the determination of the conditions under which behavior becomes standardized and predictable. (p. 209)*

Woodward found a link between the technology of an organization and

the management structure. She found the link that Veblin had argued between technology and social structure.

Pava (1986) states that the two central concepts of the sociotechnical systems school of thought in the 1950's were joint optimization of technical and social factors and open systems planning. These "two concepts were revolutionary and provided a fresh viewpoint for originating new organization designs, distinct from that of industrial engineering or behavioral scientists" (p. 202).

The publication of Woodward's work coincides with important work by behavioral scientists: McGregor's *The Human Side of Enterprise* (1960), Herzberg's *Work and the Nature of Man* (1966), Likert's *The Human Organization* (1967), Vroom's *Work and Motivation* (1964), Tannenbaum's *The Social Psychology of the Work Organization* (1966), and Bennis' *Changing Organizations* (1966). Moreover, the emergence of important work of both the sociotechnical and behavioral schools of management thought coincides with the first conference of what was to become NAIT. The NAIT conference concentrated on issues and problems related to the four-year degree programs called Industrial Technology. Keith (1986) states that:

> *Such academic programs had been provided at a number of schools for several decades prior to 1965, especially after World War II, to meet the demands of industry for technical and managerial manpower. Many of these programs had evolved from industrial education curricula as universities realized that their industrial arts graduates were often going into industry rather than into teaching. (p. 1)*

Keith further states:

> *The evaluation of the industrial technology curriculum continued as follow-up studies on graduates and their employees indicated that in addition to technical competency there was also a need for management and human relations skills. The pattern was now set for the industrial technology program of the 1970's and 1980's. (p. 1)*

Clearly some educators, managers, and researchers were looking at the same thing – the importance of the social or human side as well as the technology in managing.

In 1974, Besterfield wrote on the philosophy of industrial technology and stated:

> *Industrial Technology is a technical discipline; however, one of the ingredients of industrial problems is man. The manufacture of a product is the interaction of materials, machines, money, and man with man being primal. General Education subjects such as history, government, psychology, economics, philosophy, and literature provide a background for the understanding of man, and therefore, the ability to better cope with man-oriented problems. (p. 6)*

The sociotechnical school of management thought and the IT programs are parallel paths. One, the sociotechnical school, recognized, through industrial research studies, important relationships between technology, organization structure, behavior, and management. The other, IT, recognized the demand from industry for students who possessed both technology and behavioral skills (the latter possibly due to the teacher education slant of the early programs).

As time passes and the curriculum changes in industrial technology continue, they will take us farther away from the industrial arts roots of our past. Good curriculum planning requires hard questions on the appropriate balance between technical and behavioral or social coursework. The Ph.D. graduates will soon be the ones to address this. Some may look more to the path of general management theory and de-emphasize the technical side as human resource development proponents are doing. These students may attempt to identify with a different history of the field's development. Others may look more to the paths of engineering and de-emphasize the behavioral or social side as proponents of engineering-type programs are doing. They also may attempt to identify with a different history of the field's development. Still others may look to what Pava (1986) has pointed out, that combining technical and social factors "provides a fresh viewpoint for originating new organization design, distinct from that of industrial engineering or behavioral scientists" (p.202). The students may recognize that the history of IT and sociotechnical management are parallel paths. They may recognize that these paths share a solid foundation both as a school of management thought and as an area of study. They may recognize that IT will always struggle with what Steele calls the "rubric of technology" (1989, p. 9) within their area, but they are on a solid foundation of management theory. Central to the historical underpinning of IT, if there is a shift, will be those whose research led to sociotechnical management as a school of management thought such as, Trist, Woodward, and Pava, and those who identified a body of knowledge to be taught such as Keith, Besterfield, Kicklighter, and Rudisill.

The aerial view of the historical landscape suggests that the emergence of NAIT as an organization should be as significant in history to new IT and TM faculty as it has been for our retiring faculty, even if IA history is not considered significant. Ph.D. faculty should have their students learn this history. With knowledge of IT and TM history, the Ph.D. students will be confident about what they are doing and not try to look like general management or engineering types. And they can pass this on to their undergraduate students.

References

Abernathy, W.J. (1978). *The productivity dilemma*. Baltimore: John Hopkins University Press.

America's Best Colleges (2000, September 11). U.S. News & World Report, 106-132.

Badawy, M.K. (1993). *Management as a new technology*. New York: McGraw-Hill.

Bennis, W. G. (1996). *Changing organizations*. New York: McGraw-Hill.

Besterfield, D. A. (1974). An educational philosophy of industrial technology. (from National Association of Industrial Technology, Washtenaw Avenue, Suite 200, Ann Arbor, MI 48104).

Burke, J. (1978). *Connections*. Boston: Little, Brown and Company.

Chandler, A.D. Jr., (1969). *Management decentralization: An historical analysis.* In J. P. Baughman (Ed.), the history of American management (pp. 187-243). Englewood Cliffs, NJ: Prentice-Hall.

Chandler, A. D. Jr., and Salsbury, S. (1971). *Pierre S. duPont and the making of the modern corporation*. New York: Harper & Row.

Copley, F. B. (1969). *Frederick W. Taylor father of scientific management*. Vols 1 & 11. New York: Augustus M. Kelley (originally published in 1923).

Drucker, P. F. (1974). Business and technology. In J. Backman (Ed.), *Labor, technology, and productivity in the seventies.* (pp. 97-121). New York: New York University Press.

Drucker, P. F. (1999). *Management challenges for the 21st century*. New York: Harper Collins.

Etzioni, A. (1964). *Modern organizations*. Englewood Cliffs, NJ: Prentice Hall.

Evans, H. (1979). *The mystery of the pyramids*. New York: Thomas Cromwell Publishers.

Fayol, H., (1961). *General and industrial management*. London: Sir Isaac Pitman & Sons. (Original English translation published 1949).

Galbraith, J. K. (1967). *The new industrial state*. New York: The New American Library.

Hammond, J. L., Hammond, B. (1995). *The Skilled labourer 1760-1832*. London: Longman Group (original work published 1919).

Herzberg, F. (1966). *Work and the nature of man*. Cleveland, OH: World Publishing.

Israel, E.N. (1995). Technology education and other technically related programs. In G. E. Martin (Ed.), *Foundations of Technology Education* (pp. 25-117). New York: Glencoe/McGraw-Hill.

Kanigel, R. (1997). *The one best way Frederick Winslow Taylor and the enigma of efficiency*.New York: Viking.

Keith, C. W. (1986). NAIT history (available from National Association of Industrial Technology, 3300 Washtenaw Avenue, Suite 200, Ann Arbor, MI 48104).

Koonze, H. (1961). The management theory jungle. *Journal of the Academy of Management, 4*, 174-188.

Koonze, H., & Weighrich, H. (1988). *Management*. (9th ed) NY: McGraw-Hill.

Landes, D. S. (1969). *The unbound promethus; technological change and industrial development in Western Europe; 1750 to the present*. Cambridge University Press.

Lewis, P., Goodman, S., & Fandt, P. (2001). *Management: challenges in the 21st century*. (3rd ed) Cincinnati, OH: South-Western College Publishing.

Likert, R. (1967). *The human organization*. New York: McGraw-Hill.

Martin, G.E., & Luetkemeyer, J. F. (1979). The movement that led to contemporary industrial arts education. In G.E. Martin (Ed.), *Industdrial Arts Education: Retrospect, Prospect*. (pp. 18-42). Bloomington, IL: McKnight.

McGregor, D. (1960). *The human side of enterprise*. New York: McGraw-Hill.

Miller, J. (1955). Towards a general theory for the behavioral sciences. *American Psychologist*,10,513-528.

National Association of Industrial Technology (2000). *Industrial technology accreditation handbook*. Ann Arbor, MI: Author.

Nelson, D. (1980). *Frederick W. Taylor and the rise of scientific management*. Madison, WI: University of Wisconsin Press.

Nevins, A. (1954). *Ford*. New York: Scribner.

Pava, C. (1986). Redesigning sociotechnical system design: concepts and methods for the 1990s. *The journal of applied behavioral science.* 22 (3)m 201-220.

Schumpeter, Jr. (1934) (pp 74-94) *Theory of economic development*. Cambridge, MA: Harvard University Press.

Singer, C., Holmyard, E.J., Hall, A.R., & Williams, T.I. (1984). *A history of technology*. (Vol VIII consolidated indexes). New York: Oxford University Press.

Sloan, A.P. Jr. (1941). *Adventures of a white-collar man*. New York: Doubleday Doran.

Sloan, A.P. Jr. (1963). *My year's with General Motors*. Garden City, NJ: Doubleday.

Spiegel, H.W. (1960). *The rise of American economic thought*. Philadelphia: Chilton.

Steele, L.W. (1989). *Managing technology*. New York: McGraw-Hill.

Stoner, J. A. & Freeman, R. E. (1992). *Management*. (5th ed). Englewood Cliffs, NJ: Prentice Hall.

Tannenbaum, A.S. (1966). *The social psychology of the work organization*. Belmont, CA: Wadsworth.

Taylor, F.W. (1967). *The principles of scientific management*. New York: W.W. Norton. (originally published in 1911).

Trist, E.L. (1982). The sociotechnical perspective. The evaluation of sociotechnical systems as a conceptual framework and as an action research program. In A. H. VandeVen & W. F. Joyce (Eds.), *Perspectives on organization design & behavior* (pp 19-75). New York: Wiley.

Veblin, T. (1904). *The theory of business enterprise*. Reprints of economic classics. New York: Reprinted 1965 by arrangement with The Viking Press.

Veblin, T. (1921). *The engineers and the price system*. Reprints of economic classics. New York:

Reprinted 1965 by arrangement The Viking Press.
Vroom, V. H., (1964). *Work and motivation*. New York: Wiley.
Weighrick, H. (1933). *Management: a global perspective*. (10th ed.). New York: McGraw-Hill.
White, L. Jr. (1962). *Medieval technology and social change*. Oxford: Claredon Press.
Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. New York: Simon & Shuster.
Woodward, J. (1965). *Industrial organization*. London: Oxford University Press.
Wrege, C.D. & Greenwood, R.G., (1991). Frederick W. Taylor the father of scientific management myth and reality. Homewood, IL: Business One Irwin.
Zargari, A., Patick, C., & Coddington, C. (2002, Nov). *Trends and characteristics of industrial technology faculty: who we are, what we do, and where we are going*. Paper presented at the meeting of the National Association of Technology. Panama City, FL.