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ABSTRACT

This paper recounts the history of technology in the public schools from the early textbooks of the 19th century to the technology and society (STS) movement of the 1960s-70s. Technology and society have been a concern in education but moved into the mainstream in science education and technology education. To a lesser degree this influence is seen in social studies and language arts instruction. The paper outlines how the STS movement currently is advanced in science education, social studies, and technology education. The paper describes the move toward standards-based instruction and how technology components are seen in the standards movements. Current curriculum initiatives are discussed including National Science Foundation funded projects such as "Technology for All Americans" and "Discovering Science and Technology through History." The paper concludes with a discussion about the perennial challenges of educational reform and future implications. (EH)

Education about the History of Technology in K-12 Schools.

by Dennis W. Cheek

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"Education about the History of Technology in K-12 Schools"

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Overview of Past Efforts

Technology, as a distinct focus of the K-12 curriculum within schools, has had a long and checkered history. Textbooks from the 19th century contained considerable portions devoted to man's [sic] achievements in the arena of technology. Technological artifacts, complete with diagrams, graced many textbooks and schools engaged students in constructing simple machines and technological devices. By the late forties and early fifties of the twentieth century, public education turned its back largely on technology and school subjects such as science and the social studies began to be dominated by a conceptually-driven, content rich focus on disciplines as known by skilled practitioners. This was the era of the so-called "alphabet soup" curricula with a heavy emphasis on science as known by, although not necessarily as practiced by, working scientists. Social and cultural dimensions of science were downplayed with a few notable exceptions such as "Project Physics," and technology was presented exclusively as a handmaiden of science.

Two notable exceptions to these general trends in the sixties and seventies emerged. The Jackson's Mill Industrial Arts Curriculum, developed by a team of teachers and university faculty centered at the Ohio State University, began to move industrial arts into the modern era with an emphasis on design, sociocultural contexts, and the interrelatedness of technological systems. The history of technology per se still was largely absent from this innovative curriculum for secondary schools. Key elements of the Jackson's Mill curriculum remain embodied in materials developed by contemporary organizations such as the International Technology Education Association.

The second notable exception was the production of the Man Made World by E. Joseph Piel and colleagues at the State University of New York at Stony Brook published by Prentice Hall. This first serious 20th century venture to blend science and technology is a serious manner for secondary education was adopted by some schools on the forefront of educational innovation but largely ignored by most of the school systems in the United States. Features of the book and its accompanying laboratory materials were influential, however, on the emerging science, technology and society (STS) movement in K-12 schools and provided some of the first extended treatments of technology as a field of study for secondary schools. The Man Made World moved technology as a venue for student learning out of the industrial arts/vocational education wing of the high school and into the science wing – a notable achievement in itself.

The K-12 STS Movement

The K-12 science, technology and society (STS) movement, beginning in the sixties and picking up speed in the seventies, spread from epicenters in private schools in New York City and states like Wisconsin into what has become a mainstream movement in science education and technology education. To a much lesser degree, it has been an influence in social studies and English language arts instruction. By the early eighties STS themes could be found in the standard middle-level science syllabi of New York State's Regents system and in a host of curriculum frameworks and standards documents in a variety of states and large school districts. The STS movement recognized the importance of technology, although it frequently emphasized the science content and context, and gave less time and emphasis to the technology and society aspects of the interrelationships.

STS and Science Education

STS in K-12 science education has tended to take two somewhat different paths in America. Some of the most vocal early advocates of STS education for the K-12 science classroom, e.g., Robert Yager of the University of Iowa, Jon Harkness from the Wausau School District in Wisconsin, and Roger Bybee of BSCS, have emphasized STS as a way to teach science. In this approach, STS is a way to stimulate student interest in science through the use of local and community STS issues which lead students into more in-depth investigation of scientific ways of understanding the world as they attempt to solve or take informed positions on these issues. Even a cursory reading of contributions from this school of thought reveals a paucity of attention to the substance of technology or the substance of society (as reflected in rigorous social studies content).

A second path which has yet to gain wide numbers of adherents in the U.S. context, has been to more strongly couple technology and science as two distinct ways of knowing and doing and involve students in activities that demand both technological adaptation and innovation and the explicit use of scientific concepts and principles. This path has been advocated by STS proponents like E. Joseph Piel and Tom Liao of State University of New York at Stony Brook, Rustum Roy of Pennsylvania State University, and Dennis Cheek of the Rhode Island Department of Education. It should be noted that this path is the predominant path taken by STS in primary and secondary schools throughout most of the rest of the world. Even in this arena, however, if the focus of analysis is placed on the history of technology, there is much room for improvement. Only cursory attention to historical issues can be found in materials produced reflecting these twin emphases of science and technology. In-depth study of the sociocultural contexts of technological development remains notably absent from STS materials.

STS and the Social Studies

The STS movement within K-12 social studies in the United States can generally be characterized as much talk but very little action. There have been several attempts to promote STS education in the social studies through the efforts of a now dissolved Science and Society Committee within the National Council for the Social Studies (NCSS); the explicit mention of STS as one of six essential themes in the social studies in the Curriculum Standards for the Social Studies promulgated by NCSS; the work of the Social Studies Development Center and ERIC Clearinghouse for Social Sciences and Social Education at the University of Indiana; and a series of products from the Social Sciences Education Consortium in Boulder, CO (SSEC). The latter organization has produced the most substantive STS curriculum materials for the social studies – two hefty binders filled with STS lessons designed explicitly for social studies classrooms. SSEC also received funding from the National Science Foundation (NSF) in the early nineties to produce a two volume work focused on "Teaching About the History and Nature of Science and Technology" in collaboration with the Biological Sciences Curriculum Study (BSCS). Social Education, the flagship publication of the National Council for the Social Studies, has carried substantial articles from time to time about STS education in the social studies. Once again, however, a person sensitive to the history of technology would be disappointed with virtually all of the documents promulgated for the social studies classroom. While some historical trends are mentioned, there is little in the way of rich attention to the historical development of technology and technological systems.

Technology Education

The final major arena within K-12 education where attention to technology has thrived has been technology education. The modern technology education movement, as represented by the International Technology Education Association (ITEA) headquartered in Reston, VA, emerged from the American Vocational Education Association. ITEA has commissioned, published, and distributed a variety of publications focused explicitly on technology education for K-12 schools, including their flagship publication, The Technology Teacher. Historical treatments have tended to be somewhat superficial, although the truism that every artifact has a history is a well-known theme in materials developed for use in the technology classroom.

Moving Toward Standards-Based Instruction

Today in American education, we live in the era of the ascendancy of standards-based approaches to curriculum, instruction, assessment and professional development. Alignment of these four key elements of K-12 education is not only anticipated, but also required in many states, and actively promoted across a wide range of educational reform movements. There remain important tensions between national, state, and local control of the school curriculum and it is fair to say that many times implementation of standards within the nation's classrooms often bears only a fleeting resemblance to the new realities envisioned by the creators of standards in various content areas.

Project 2061 and the National Science Standards

The American Association for the Advancement of Science (AAAS) launched Project 2061 in the mid-eighties with a series of blue-ribbon panels. They produced white papers on what an American high school graduate should value, know, and be able to do across the very wide spectrum of human endeavor that is represented in the membership of AAAS. The project took its name from the fact that a student in today's elementary school will be alive to see the return of Halley's Comet in the year 2061. AAAS embraces within its membership scholars not only in the traditional science disciplines but also engineering and allied fields, social sciences, history and philosophy, education, and the arts. Science for All Americans, published in 1989 by AAAS, summarized the key findings of the blue-ribbon panels into a succinct narrative portrait of what a student should know, value, and be able to do to be considered "scientifically literate." The history of technology and the nature of technology are treated within the Project 2061 Science for All Americans document. They also receive attention in the companion Benchmarks for Science Literacy which AAAS released in 1993. The "Benchmarks" as they are known colloquially, contain numerous curriculum standards (benchmarks) at grades K-2, 3-5, 6-8, and 9-12, which address technology, and the history of technology, in a substantive and substantial manner. The Benchmarks are probably the most extensive attempt at the national level to create a set of curriculum content standards, which cut across numerous fields of human endeavor. They provide wonderful challenges for school districts and schools to creatively weave together different traditional subjects within schools in interesting and interdisciplinary ways. Unfortunately, the project has such a strong connection with science, due to its sponsor, that it has made markedly little headway in school subjects outside of science education. Once again, however, we have to note that the content of school curriculum materials and the standards advocated within the Benchmarks are still marked by a great gulf. Hopefully, continuing curriculum development efforts will address these deficiencies.

National Science Education Standards, emanating from the National Research Council and produced by a consortium, which included AAAS and the National Science Teachers Association, were issued in 1996. Considerable debate ensued over how "technology" should be treated within the standards as they were being created, e.g., as a stand-alone subject connected to science; as an element of science education; as educational technology alone. The final decision was to mention technology at appropriate points and emphasize its connections to science and to contemporary societal issues and concerns.

Technology for All Americans Project

Partly because of the perceived notion that Project 2061 is a science project, ITEA obtained funding from NSF and NASA to produce a set of curriculum standards for technology education, appropriately titled, "Technology for All Americans." The project is just on the verge of releasing its draft of technology standards for K-12 education for a year of public review, hearings, and focus groups. Currently, the writing team for the standards is composed of teachers of technology education in K-12 schools, district and state technology education supervisors, university faculty in technology education, and business and industry representatives. An advisory board consists of representatives from other organizations who have produced national standards documents in the interests of learning from their experiences and connecting technology education to other school subjects.

A historian of technology from the Henry Ford Museum chaired the committee, which produced the Technology for All Americans: A Rationale for Technology Education, which served as an initial public document for the effort. However, a decision was made that all members of that writing committee would not serve on the standards committee. Consequently, there is no current involvement in the project by historians of technology. There has been an attempt to reach out specifically to philosophers of technology, e.g., Carl Mitcham of Penn State and Paul Durbin of the University of Delaware. Preliminary materials, which the author has reviewed, do not seem to give due emphasis to the historical aspects of technology and it is hoped that SHOT members will work to remedy this situation.

Current Curriculum Initiatives

NSF-Funded Projects

NSF has had an abiding interest in the history of science and history of technology as fields of scholarly research. They have had for some time an interest in funding projects, which use the history of science as a vehicle to deepen student understanding of the processes of science. More recently the foundation has turned increasing attention to technology education, due in large part to the advocacy efforts of Dr. Gerhard Salinger and a few other colleagues within NSF. NSF is a co-funder of the ITEA "Technology for All Americans" project. NSF has also funded a series of projects designed to target either technology education (TE), science and technology education (STE), or mathematics, science, and technology education (MSTE). NSF undertook a comprehensive review of middle school science materials they funded in recent years in a study released in February of 1997. One of their overall conclusions was that "The weakest area in the set of materials relative to the science standards is lack of sufficient focus on the history and nature of science." (p. 10) The same comment certainly applies to technology – it was not even considered by the review panel as a criterion for evaluation!

Discovering Science and Technology through History as a Special Case

NSF funded the Lemelson Center of the Smithsonian Institution and SHOT to develop "Discovering Science and Technology through History." This project, directed by Dr. Susan Smulyan of Brown University, is a curriculum for secondary classes, principally in the social studies. Its central theme of textiles, dyeing, and industrialization, was chosen for three principal reasons: 1) industrialization is a major theme in U.S. history and the textile industry was a key component of U.S. industrialization; 2) clothing appeals to teenagers as a subject, while providing ample opportunities to bridge history, social studies, technology, and science, and; 3) such a topic might especially interest young women and minority students.

The project has developed eight curriculum units which includes hands-on activities. These will shortly be released in a field-test version. As a sample of its content, students learn about economics and industrialization by focusing on the Civil War era. Students lay out patterns for uniforms and calculate the cost of mass production. There are primary documents to interpret, graphs and charts to create and understand, and ideas for games, debates, and class discussions. Scholarly articles, historical essays, a bibliography, and a videotape on textile machinery complete the package. It remains to be seen what type of following these materials will create.

A recent article in The Technology Teacher, the lead publication of the International Technology Education Association, recognizes that technology education in K-12 schools has largely ignored the history of technology. A middle school teacher, Nancy Matheny, is quoted as saying, "Teaching technology education without a historical component is kind of like teaching art without delving into art history. Art, like technology, is more than three times as old as writing and contains, in its changing styles and themes, a fifteen-thousand-year-old record of the physical and social evolution of man." (McGee and Wicklein, 1997: 18). The authors conclude that "To truly educate our students without our field, the concept of technology's history must be integral in the technology education curriculum." (McGee and Wicklein, 1997: 18).

It remains to be seen whether curriculum developers of technology education can, or will, rise to this challenge. Beyond the creation of the materials, however, lies the daunting hurdles of implementation of these materials in the K-12 school systems of this nation. Certainly the experience of curriculum developers in the past is insightful, and it is to this perspective that we now turn.

The Perennial Challenges of Educational Reform

Lessons from Project Physics

Philip W. Jackson in 1983 reported that NSF funded fifty-three projects from 1954 to 1975 to the tune of $117 million. Wayne Welch in 1979, using a slightly different method of tabulation, reported a total of $130 million for course content improvement projects and another $565 million for teacher training activities during these two decades. While these numbers appear large, it is important to realize that funding varied greatly within these two decades and that the relative size of these figures is small compared with the over $100 billion spent each year operating K-12 education. Despite, or maybe in part because of, these moderate investments, these curricula had only limited impact in changing classroom instruction and student achievement. Welch (1979:301) noted that "Curriculum does not seem to have much impact on student learning no matter what curriculum variations are used. . . . we at Project Physics eventually concluded that 5% [variance in student achievement of old versus new curriculum] was an acceptable return on our investment since we could seldom find greater curricular impact on the students."

Welch was deeply involved in the Project Physics effort centered at Harvard University to teach physics with a heavy historical flavor. Some central factors which he believe mitigated change included the unwillingness of course developers (usually university faculty) to listen to teacher suggestions for revisions of the materials; the narrow federal funding timetables which demanded completed projects within a three to four year timespan; an attempt to produce "teacher-free" curriculum; and an overemphasis on the discipline as known by the skilled practitioner rather than the entering novice. In addition Welch noted that, "From the beginning, there were the known challenges of unprepared and insecure science teachers, the inherent difficulty of change, the lack of federal policy for innovations, the natural conservatism of schools, and the threat of a national curriculum. But in the second decade were added the unforeseen problems of declining enrollments at the secondary level, inflation, student unrest, a fading public image of science, environmental concerns, competing demands such as integration, the back-to-basics movement, social concerns, and school reform movements." (Welch, 1979: 292)

The Road Ahead

This paper offers only limited hope to SHOT that it can achieve major transformations about how the history of technology is treated in K-12 schools. A more limited role would be to better support those parts of the system where technology already is welcomed as a subject worthy of study. Certainly the technology education movement as a whole, and the Technology for All Americans project in particular, could benefit from the insights and wealth of information that SHOT members can supply. Portions of the STS movement, particularly those that attempt to equalize the balance between treatment of science and technology are another fruitful venue for SHOT efforts at reaching out to K-12 education. Obviously the informal education sector, about which my collegues today will speak, is also a very fruitful avenue for collaboration.

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Welch, Wayne W. (1976) Evaluating the impact of national curriculum projects. Science Education, 60(4), 475-483.

Welch, Wayne W. (1979). Twenty years of science curriculum development: A look back. In Review of Research in Education – 7, Ed. David C. Berliner. Washington, DC: American Education Research Association.

Appendix I: Summary of History of Technology in Selected Secondary Materials

Gallo, Dennis, Stuart Somon, Neal Robert Swernofsky (1993). Experience Technology. New York: Glencoe Publishers, 384 pp.

Brief overview of history of technology grouped in the agricultural era, industrial era, and information era in chapter 2. No other real attention to historical issues throughout the remainder of the text.

Gradwell, John, Malcolm Welch, Eugene Martin (1996). Technology Shaping Our World. South Holland, IL: Goodheart-Willcox Company, Inc., student text, 281 pp.; Activity Manual, 174 pp.; Instructor's Manual, 154 pp.

Final chapter (14) in text is entitled, "Past, Present, and Future," and considers the beginning of technology, how technology affects us, attacking pollution problems, and the future. Student activities include building a model of an ancient tool; comparing the technologies of today with those of the pioneers; comparing ancient technology with those of today; and tracing the development of a product from its initial invention to changes in it over time.

Listar, Glenn (1987). Technology Activity Guide 1. Albany, NY: Delmar Publishers, Inc., 232 pp.

Thirty-five activities are in the book. First activity is "Planning an Evolution Board" where student is asked to create a diorama showing how a particular technology has changed over time with dates and accompanying descriptive narrative. Activity sixteen has students look at a simple technology time and invites them to add to the timeline other important discoveries that they uncover. They are asked to be able to identify and discuss the importance of each timeline activity.

Pierce, Alan, Dennis Karwatka (1993). Introduction to Technology. St. Paul, MN: West Publishing Company, 535 pp.

After two introductory chapters about the nature of technology and resources and methods of technology, most of remaining chapters have a section on the "history of . . ." This includes chapters on computer technology, energy, communication technology, printing, photography, manufacturing, construction, transportation, generating power for transportation and biotechnology. History is not separated out in chapters on electricity and electronic communication (although it surfaces in discussions on amperage, voltage, resistance, and Ohm's law, telegraph, etc.)

Williams, Charles F., Kamiran S. Badrhkan, Willard R. Daggett (1985). Technology for Tomorrow. Cincinnati, OH: South-Western Publishing Company, 406 pp.

Chapter 2 on "Technology and Change" has brief overviews of history of civilization and technology, production, transportation, health, structures, and communication. Some attention to historical context in chapters on agritechnology.

Wright, R. Thomas (1996). Technology Systems. South Holland, IL: Goodheart-Willcox Company, Inc., 480 pp.

Chapter 1: "Technology: A Human Adaptive System," speaks briefly about what is technology around concepts of it being dynamic, not always good, different from science, and evolving. Chapter 2, "Technology as a System," briefly discusses use of fire and agriculture in section on "Impetus of technology." Remainder of book focuses pretty much exclusively on present era of technology.

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