DOCUMENT RESUME

ED 027 403 24 VT 007 734

By-Martinson, John, And Others

The Feasibility of Teaching History of Technology in Vocational and Pre-Technical Secondary Schools.

Frederick Burk Foundation for Education, Daly City, Calif.
Spons Agency-Office of Education (DHEW), Washington, D.C. Div. of Adult and Vocational Research.; San Francisco State Coll., Calif. Center for Technological Education.
Bureau No-BR-6-2011
Pub Date 30 Sep 68
Grant-OEG-4-7-002011-0489
Note-49p.
EDRS Price MF-$0.25 HC-$2.55
Descriptors-Curriculum Development, Curriculum Research, Educational Strategies, *Feasibility Studies, *History, Inservice Teacher Education, Instructional Design, *Prevocational Education, *Secondary Grades, *Technology

To determine the feasibility of teaching history of technology as part of the secondary school curriculum, an investigation was conducted with three major steps: (1) A team of advisors was consulted, (2) An inventory of the elements necessary for introduction of history of technology into secondary schools was obtained, and (3) Three alternative strategies for development of instructional materials and curriculums were formulated. Course patterns examined were a general course in United States and world history, specialized courses on the history of technology, and interdisciplinary courses incorporating material when relevant. Some recommendations were: (1) to improve teacher understanding of the history of technology, (2) to improve teaching materials available on the subject, (3) formation of a coordinating committee, and (4) development of a research program to determine the content and depth of training. The appendixes contained: (1) "Technology and Culture" by M. Kranzberg, (2) History of Technology: The Problems of Definition and Scope, and (3) A Bibliographic Letter to a High School Teacher (Hypothetical). (DM)

BR-6-2011
PA-24
OE-BR

# THE FEASIBILITY OF TEACHING HISTORY OF TECHNOLOGY IN VOCATIONAL AND PRE-TECHNICAL SECONDARY SCHOOLS

AUTHOR: John Martinson

U.S.O.E. GRANT NUMBER: OEG 4-7-002011-0489, The Vocational Education Act of 1963, P. L. 88-210, Section 4(c)

GRANTEE INSTITUTION: Frederic Burk Foundation for Education
at
San Francisco State College
75 Southgate Avenue
Daly City, California 94015

DATE OF REPORT: September 30, 1968

SPONSORED BY: San Francisco State College
CENTER FOR TECHNOLOGICAL EDUCATION
75 Southgate Avenue, Suite 17
Daly City, California 94015



The Project Reported Herein was Supported by a
Grant From
U.S. Department of Health, Education, and Welfare
Office of Education
Bureau of Research
Division of Adult and Vocational Research

U.S.O.E. GRANT NUMBER: OEG 4-7-002011-0489

# THE FEASIBILITY OF TEACHING HISTORY OF TECHNOLOGY IN VOCATIONAL AND PRE-TECHNICAL SECONDARY SCHOOLS

INVESTIGATORS: John Martinson and Morris Lewenstein

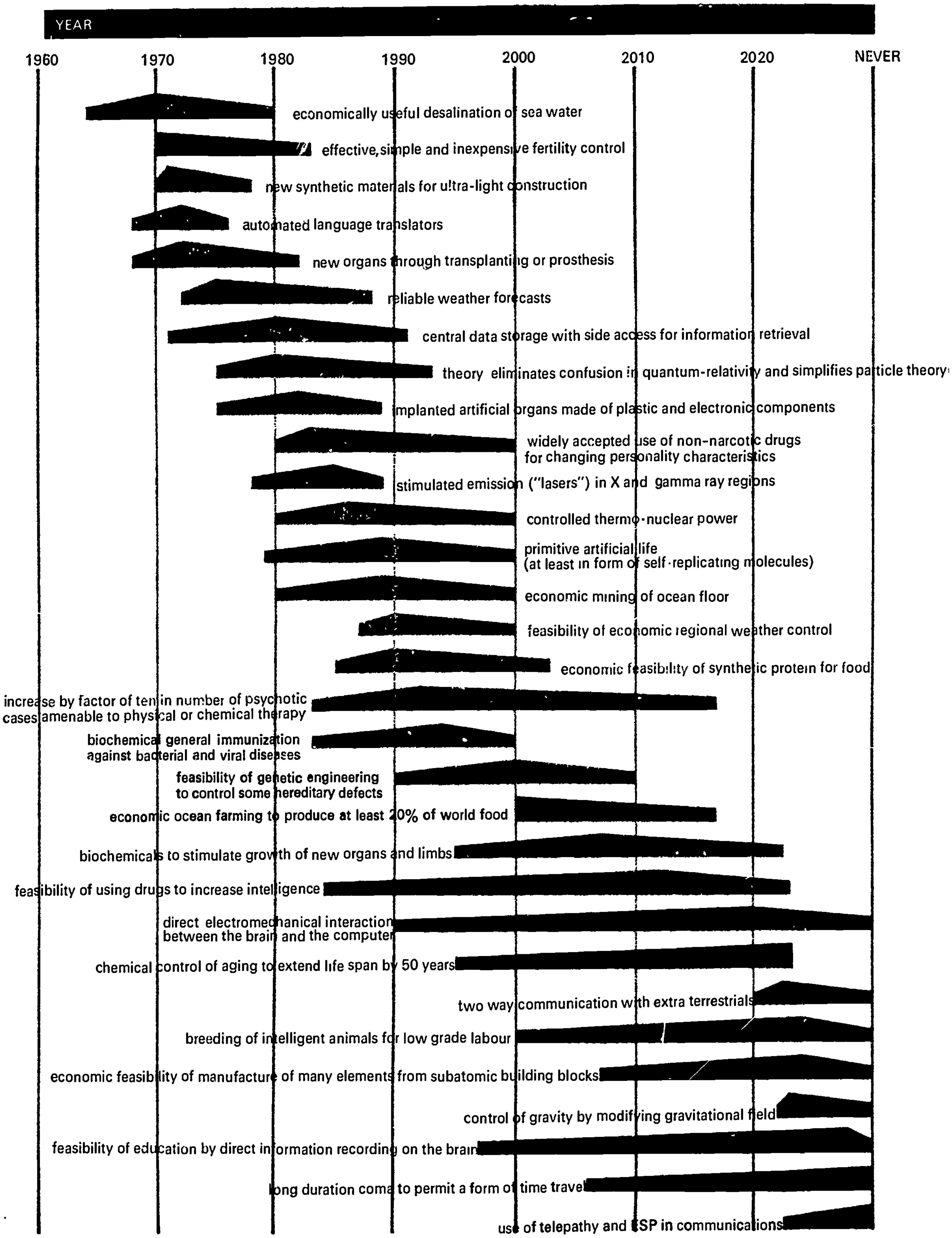
With the assistance of the following consultants:
Dr. George Gibson, Fellowship Coordinator at the Elutherian Mills-Hagley Foundation
Dr. Melvin Kranzberg, Professor History, Case Institute of Technology
Dr. George Rawick, Associate Professor of History and Anthropology, Michigan State University - Oakland campus.

AGENCY: Frederic Burk Foundation for Education
at
San Francisco State College
75 Southgate Avenue
Daly City, California 94015

DURATION: October 1, 1966 - March 31, 1967

TABLE OF CONTENTS

The major breakthroughs outlined below are those expected by a panel of 20 experts interviewed in a study conducted by the RAND Corporation. The uppermost point of each colored bar represents the median date thought likely for any breakthrough. The length of the bar represents estimates of the "middle half" of the panel; in each case one quarter of the panel gave dates previous to the start of each bar and one quarter gave dates beyond the end.




This particular form of the chart is taken from Science Journal Vol. 3, No. 10, October 1967

## SUMMARY

The graphic display on the opposite page summarizes the consensus of opinion of 20 experts when asked by the RAND Corporation to estimate the time be which certain scientific and technological breakthroughs can be expected to have occurred. Whether or not economic regional weather control actually becomes feasible by 1990 or genetic engineering brings some hereditary defects under control by the year 2000, a review of such a chart lends support to the contention that the forty year olds of the 1990s (today's teenagers) will be making decisions in the midst of a technological environment quite unlike the one today's forty year olds are responding to. Aware of the impact of technology on contemporary society, it behooves professional educators to ask themselves how well they are preparing their students for the kinds of decisions they are likely to be facing thirty years hence. Concerns such as these form part of the basis for the present study.

The study concerns the teaching of History of Technology in secondary schools and especially those schools with vocational or pre-technical programs. The immediate background to the work reported here includes a number of years of development of pre-technical curricula. This work has been described in detail in the proceedings of a conference* and will not be discussed at length here. Two points, however, need to be made concerning existing pre-technical programs: 1) the integrated teaching team used successfully in a number of programs has generally not included a social studies or history teacher, and 2) there is great awareness among educators of the need to prepare career technicians for the possibility that technological developments may require them to adjust their career plans through retraining or other means. It is our belief that teaching History of Technology in secondary schools could be a significant way to attack problems in both these areas.

Within the educational community and elsewhere there is widespread consensus concerning the need for the general populace to understand better the technology with which they constantly interact. It seems not unreasonable to assume that the ability to view this technology from an historical perspective with an understanding of its evolution would contribute to this end. But however desirable it may be to increase understanding of technology through a study of its history, educators in secondary schools must ask themselves, "Is it feasible?"

The findings of this study support an affirmative answer to that question.

---

*-Curriculum Programs in Action. Proceedings of a conference on pre-technical education, conducted by the Center for Technological Education, San Francisco State College, and the Center for Studies in Vocational and Technical Education, University of Wisconsin, 1967.

1. Centers of scholarly activity in History of Technology presently exist which can provide a small but growing number of researchers at the base of a wider educational effort.

2. A number of teacher training institutions (particularly in the field of industrial arts education) are broadening the role of historical studies in their educational programs.

3. Legislation and federal programs for the support of new curriculum developments in secondary schools exist though they have not yet been used to develop history of technology programs.

4. A small number of high schools have begun experimenting with the introduction of History of Technology materials and the initial results are definitely encouraging.

5. A significant number of resources likely to be useful to secondary teachers already exist, though some of these are unconventional and most are not organized so that the classroom teacher can make immediate use of them.

Our recommendations for future activity are presented in some detail later in this report. They can be summarized, however, in outline fashion, as follows:

1. Summer institutes for history teachers and others should be established at universities which are strong in the area of History of Technology.

2. Experienced Teacher Fellowship Programs should be established for those teachers who wish to do advanced work in problems of relating History of Technology to the secondary school curriculum.

3. Improved materials for classroom use should be made more readily available to secondary school teachers.

4. A coordinating committee or council with a function analogous to the Joint Council for Economic Education should be organized representative of all groups concerned with History of Technology in secondary schools.

5. A research program to determine what can reasonably be taught about History of Technology within various proposed curriculum patterns should be undertaken.

Implicit in all these recommendations is an understanding of the role of historical scholarship generally as a foundation for the educational innovations advocated in this study. When the total funds available today for graduate training and advanced research is examined, it is immediately apparent that the amount devoted to history and social science is a very small fraction of the whole. Within the field of history the amount of money or scholarly man-hours available for History of Technology is again a very small piece of that very small pie. Long-range solutions to the problems posed by this study will eventually be dealt with only if society takes research in the historical and social field as seriously as the physical and biological disciplines are now considered.

This study is concerned with an historical discipline. Yet, as the chart facing the first page suggests, our concerns are equally future oriented. This seeming paradox is resolved in our concern for the education of young people. In the development of their latent capabilities for decision-making the "future" becomes tangible. While we have focused especially on the problems of pre-technical education, this should not be viewed as a narrow concern with the world of work and preparation of students for an early entry into it. Today's students will contend with the world of work for many years during which the very nature of "work" as we presently understand it will probably undergo great changes. Rather, we prefer to think of secondary education as preparation for decision-making, i.e., laying the basis for a whole range of later decisions but pre-determining as few as possible of them during the secondary school experience. In a pre-technical education program it can be argued that the broadest possible understanding of technology and the way it evolves may be among the most practical kinds of knowledge to offer for "vocational" purposes. If the world of work develops in response to the changes predicted by the RAND Corporation experts, decision-making of a fairly high level of sophistication seems likely to be required of tomorrow's technicians as well as all the other forty year olds of the 1990s.

## INTRODUCTION

### Tasks for a Feasibility Study:

Scholars interested in the history of technology seek to understand the processes of technological change; they seek not only to describe these changes but also to understand the conditions under which they occur and the effects they have on the ways of man. There can be little question that this field of historical scholarship yields insight into conditions and problems of contemporary life and aids in our understanding of them. The question of whether or not it is feasible to teach some of this understanding to secondary school students as part of the formal school curriculum is therefore an appropriate one.

The feasibility of teaching the history of technology as part of the secondary school curriculum should not be confused with the question of whether it is technically possible. Of course it is possible. There is a body of substantive content available, and it is as possible to teach concepts and generalizations concerning technology and technological change as it is to teach any other kind of concept or generalizations drawn from historical studies. Many individual teachers have been doing this in their history and social studies classes for a long time. Questions of feasibility should not focus on whether an identifiable body of substantive content exists, or whether students have the psychological abilities to learn. They have been studied and answered in the affirmative elsewhere. Other more immediately relevant questions must be of concern here if one is to attempt to judge the feasibility of teaching the history of technology in secondary schools. These questions include: How much about the history of technology should be taught? Which elements of it deserve greatest priority? Where in the curriculum might it be incorporated or taught? and, How might it be organized for teaching purposes? What resources are available for teaching such a subject well? What obstacles stand in the way of the immediate achievement of the goal? and, What steps can be taken to remove these barriers? The rest of this report will be concerned with formulating answers to these questions.

### Some Curriculum Issues:

Attempts to answer the questions How much about the history of technology should be taught? and Which elements of the subject deserve greatest priority? cannot be divorced from wider and more inclusive issues related to curriculum making in the social studies. Traditionally, the disciplines of history and geography have dominated the choice of content in the social studies at the secondary school level, except for material dealing with the United States constitutional system taught in civics courses. Now this pattern is being challenged by those who want more content drawn from economics as well as the behavioral sciences—anthropology, sociology, psychology, and behavioral political science—both concepts and other intellectual tools developed by these disciplines, to be incorporated into the high school curriculum. It should be obvious to any informed observer that the high schools cannot teach all that is known about man, his institutions, and his ways of living in the past and in the present in various geographical locations around the earth. Choices must be made. Even if advocates of the newer subjects were not clamoring for these to have a place in the curriculum, and the traditional subjects continue to dominate the school offerings, the facts of history and geography are infinite. To organize them in meaningful patterns requires focusing on some episode or areas to the exclusion of others; the problems of choice cannot be eliminated nor easily solved. If more time is to be spent in classrooms teaching about the history of technological change, inevitably less time can be devoted to teaching whatever else is now being taught.

Closely related to the question of what topics or questions ought to be included in the curriculum is that of how it can best be organized for teaching purposes. Some educators argue that it ought to be composed of an array of traditional school subjects, each based on the conceptual framework and stressing the methodological tools of a traditional scholarly discipline, i.e., the curriculum should be made up of separate courses in history, geography, economics, sociology, etc. An opposite point of view, which encompasses many varying themes, is that the social studies curriculum ought to be interdisciplinary; it should draw together concepts and generalizations from several social science disciplines to be taught in a synthesizing frame of reference within one course or course sequence, it should aim to develop better understanding of a wide range of specific problems in personal and community life, and it should try to develop effective thinking patterns which are considered as one method of intelligence, the parts of which cannot be designated as "belonging" to any single disciplines.

## METHODS

The procedures used in this study involved three main kinds of activities:

1. A team of consultant-advisors knowledgeable in the field of History of Technology were assembled to guide the principal investigators and review results as the study progressed;

2. One of the co-principal investigators conducted an inventory of the elements considered necessary if History of Technology is to be introduced into secondary schools;

3. The second principal co-investigator, using the information gathered in the course of the inventory and with the counsel of the advisors, developed three alternative strategies for the development of instructional materials and curricula.

The collection of information for the inventory was accomplished principally by visits and interviews with relevant individuals supplemented by correspondence. Visits were made to a number of universities and related research centers where work in curriculum development or History of Technology was in progress as well as high schools where innovative projects related to History of Technology are being developed. Institutions visited and sources of information included the following:

American Association of Museums
American History Association
American Industrial Arts Association - NEA
Museum of History & Technology - Smithsonian Institution
University of Maryland - Industrial Arts Department
Elutherian Mills - Hagley Foundation
Harvard University - Program on Technology and Society
Massachusetts Institute of Technology - Vocational Education Project
Educational Services Inc. - 10th grade course on Impact of Science & Technology being tested in six Boston schools
University of Massachusetts - NDEA Summer Institute for History Teachers
State University of New York at Oswego - Industrial Arts Department
Kent State University - Industrial Arts Department
Stout State University - American Industry Project
Ohio State University - Industrial Arts Curriculum Project
Committee on the Study of History - Newberry Library, Chicago
Museum of Science & Industry - Chicago

National Council for the Social Studies - NEA
Case - Western Reserve University, History of Technology Program
Society for the History of Technology.

## RESULTS AND FINDINGS

### Three Approaches to the Teaching of History of Technology:

The present state of curriculum research in social studies education offers no conclusive evidence that partisans of either approach are correct in their views of the best ways to develop a well educated person who understands his social environment and can think effectively about it. The United States Office of Education is currently financing research to test hypotheses related to both theoretical models. In actual practice, most school districts offer both types of courses, some called history and geography, and some devoted to Exploring the Community or examining the Problems of American Democracy. Regardless of which approach an individual teacher or group of teachers favor, the problems of choice remain. Those who favor history courses, organized on chronological frameworks and stressing the development of historians' methods of analysis must decide upon which historical episodes they wish to focus. Those who favor interdisciplinary approaches must also decide how much time they wish to devote to the study of any one topic. More specifically, those interested in teaching more about the history of technology must argue the potential value of such learning relative to the value of learning about other topics or problems.

These considerations, combined with a recognition of the wide range of curriculum patterns currently in practice in a multitude of locally controlled school districts, make it unwise to consider the feasibility of increasing or improving teaching the history of technology within any single master or ideal plan. It will be more practical and effective to consider efforts to achieve this goal within three distinct patterns of course offerings. These are:

1. General courses in United States History and World History.
2. Specialized courses devoted to History of Technology.
3. Interdisciplinary courses organized on a non-chronological basis which incorporate material from history of technology when they are relevant to the problems or topics for study.

Each of these patterns of course development is based on a defensible rationale for curriculum building and offers prospects for good educational results. Some efforts are being made to teach ideas drawn from the history of technology within each of these three patterns in some American high schools today. Obstacles are present in the total school situation which obstruct efforts to teach this content as effectively as it might be taught in all of the patterns. Suggestions can be made for removing the obstacles and improving the teaching within each of them. A more detailed analysis of each, the rationale on which it is based, and how instruction might be improved within it, is therefore in order.

General Course in United States History and World History:

The most obvious place to teach about the history of technology, one might think, is in the general history courses already in the high school curriculum. All but seven of the fifty states require at least one year of American history or a combination of American history and government taught in the high school, usually in the junior or senior year. World history, although less frequently required of all students is a popular school offering for 9th and 10th graders. In many schools it is the only social studies course offered at one grade level.

General courses in United States (or American) history are, of course, usually required by law as a means to teach about the nature of American constitutional government and to develop attitudes of civic loyalty, but they and companion World history courses may serve other educational goals as well. Not only do they develop familiarity with a great many historical facts and thus develop students' literacy and abilities to learn through further reading and other activities, but they also can help students develop their understanding of a variety of aspects of life around them and how things got to be the way they are. Comparative studies of different historical episodes allow students to generalize about processes of historical change and development and to gain a better understanding of concepts associated with other disciplines—concepts such as revolution, inflation, technology, and technological change. In addition, they provide opportunities for high school students to learn the intellectual skills of the historian, to ask relevant questions, and to gather, evaluate, analyze, and synthesize data as they seek to formulate and test their ideas.

There are many opportunities to teach about the history of technology in these courses already existing in the high school curriculum. A brief examination of almost any text book available for the general American history course reveals it contains much material dealing with the history of technology. Beginning with descriptions of scientific and technological changes in Europe which preceded and accompanied the Age of Exploration and Discovery, the textbooks present information about the levels of technology available to Americans during the Colonial Period, the early and late 19th centuries and at several distinct times during the twentieth century. World history textbooks contain the same for the various historical epochs described in them. These texts not only list or describe the technological change which took place; they also describe and analyze the circumstances which led to change and the effects of advancing technology on the ways people labored and lived. They also generalize or offer student readers information from which they can develop and test generalizations like: Invention is a cumulative process which builds on the discoveries already made by others or, technological process contributes to economic growth. Supplementary reading materials and audio-visual aids which offer additional information about the specific technological changes discussed in the textbook are often frequently available also, although not on a very systematic basis. The problems of locating and budgeting for the purchase of these materials, plus assembling, filing, and storing them so they are easily available in the classroom when needed, have not been satisfactorily worked out in most school systems.

To ascertain that opportunities to teach about the history of technology in general history courses do exist is no guarantee that they are always exploited. The number of subjects, topics, concepts, and ideas that might be pursued in a general history course is infinite. Every classroom teacher, or school faculty that cooperatively develops its own course of study, must make choices, and the textbook which is published to be sold to a large number of teachers who have differing values and instructional goals is not always the best index of what is being effectively taught in the classroom. Some teachers do take time in their courses to focus on levels of technology and the economic and social changes which result from technological advances at various times in history, but many do not. Many ignore completely or "skip over lightly" textbook chapters dealing with technology. Many who do teach about events involving important technological feats such as the building of the Panama Canal or the construction of the Western railroads in American history are likely to focus on the political events which made these possible rather than on the fundamental engineering and construction achievements themselves.

Several important factors account for this frequent neglect of technology in the general history courses. One is that proper teaching materials are often not available. The text may mention the development of the Bessemer and open hearth processes for making steel, or Faraday's contributions to the development of the electric dynamo, but these are mentioned too briefly for student readers to get any real understanding of the technological principles involved, how the new processes differed from older ones, and how they have continually been improved until the present. The same criticism can be leveled against textbooks for many other topics in history. Characteristically, they say too little about too many things. In the area of teaching about technology, the criticism is particularly relevant. If the teacher depends upon the material in the textbook alone, the end result is likely to be verbalism without understanding. To do this job well, more teaching materials are needed, not only detailed readings, but visual tools also—pictures, charts, diagrams, and if possible, actual working models of machines and other artifacts.

This lack of effective teaching tools is not the only or even the most important reason why the history of technology is slighted in general history courses. The enterprising teacher who is convinced this is what he wants to teach is usually able to collect much of what he wants in the way of teachers' materials in addition to library resourses. Much of it is available in pamphlets and pictures (both moving and still) distributed by private corporations. General magazines, museums, and student-made exhibits are good supplements to this. However, many if not most teachers of general courses are not sufficiently motivated or prepared to take advantage of what is available. They don't see that such material is especially relevant to the courses they think they are supposed to teach.

The second reason for the omission of material on the history of technology in general history courses is related to the way teachers define "history." Most college history departments and graduate schools of history have traditionally emphasized political history, the record of activities of governments. College survey courses in the history of Western civilization are conveniently divided into epochs marked by the rise and fall of empires, kings and other rulers, or treaties marking the end of international conflicts. United States history courses focus on the development of the American political institutions and events surrounding debates carried on and decisions made in the nation's capital. Although there is plenty of evidence available that the variety of subjects coming under the scrutiny of historical scholarships is now increasing, academic change comes slowly. The undergraduate curriculum for history majors, hence the program for training secondary school history teachers, is still dominated by political history. Teachers in the schools want to teach the history they know. Since they know little about the history of technology, it is easy for them to neglect it or ignore it completely in their teaching. Clearly if something is to be done to remedy this situation, one place to start will be to find a way to make the teachers themselves more aware of the history of technology.

Even if all teachers were educated to understand more about the history of technology, and they were ready and able to try to teach some of what they learned to students in their classes, some proponents of increasing the emphasis on this topic in general history courses would inevitably be disappointed. The reason, which actually constitutes a third reason why more is not already being done, is that the demands on the general history courses are simply too great for teachers to satisfy the demands or requests of all who ask for more treatment of their special subject within them. Those interested in teaching the history of technology are not the only ones who are asking that more attention be paid to their subject. Curriculum development projects carried on under the auspices of various learned societies[1] are busy demonstrating that concepts from anthropology, economics, and sociology should and can be taught through the vehicle of history courses[2]. Various economic interest groups—labor, business management, and agriculture want the stories of their development to be taught. Negroes and other minority groups want more attention paid in the American history course to the story of how America became populated and how various racial and ethnic groups have fared in the land. Other citizens' groups desire that more attention be paid in the World history course to non-European peoples and civilizations.

---

[1]American Council of Learned Societies and National Council for the Social Studies, The Social Studies and the Social Sciences, New York: Harcourt, Brace and World, 1962.

[2]Erling M. Hunt, et. al., High School Social Studies: Perspectives, Boston: Houghton-Mifflin, 1962.

It is obvious that all of these groups cannot be made completely satisfied at the same time by one course, regardless of how well educated and resourceful the teacher and how abundant and effective his teaching tools. The present trend in the development of general history courses in the high schools favors the teacher surveying fewer facts and episodes and leading students to study those chosen for inquiry in greater depth so that they may learn to use more effectively the historian's methods of inquiry.[3, 4] This practice accentuates the problem of choice, which continues to be difficult. Each of the groups cited presents a rationale case in favor of including its favorite topic in the curriculum. There seems to be no objective way of choosing among them to construct a course suitable for all students, but each teacher, or school staff, will make their own choices based on their own values and ideas of educational importance. Under these circumstances, some teachers may elect to emphasize content ideas concerning change in one or two out of a possible ten or twelve teaching units making up a general course in World or American history. But unless specific steps are taken to encourage all teachers to do this, many others will continue to neglect this content area in favor of other historical material, defending their actions either on the basis of tradition or of their personal preference to teach other content they deem to be educationally important.

Specialized Courses in the History of Technology:

Courses organized entirely around topics drawn from the history of technology are obviously impractical for all students attending secondary schools. There are too many other subjects, topics, and problems pertinent to the social studies competing for attention in the curriculum. Requiring specialized courses in the history of technology for all students would either make it impossible to offer the general World or American history courses which promote inquiry into a variety of topics and ideas, or it would effectively shut out the possibilities of offering other courses—economics, international relations, Latin American or Asian history, on either an elective or a required basis. Nevertheless, the development of such a course to be offered to a specialized group of students—namely, those enrolled in vocational and pre-technical curricula—as a substitute for other social studies courses in the curricula offers distinct possibilities. It might offer several educational advantages for such a specialized group over the other courses for which it might substitute.

---

[3]Edwin Fenton, Teaching the New Social Studies in Secondary Schools, An Inductive Approach, New York, Holt, Rhinehart & Winston, 1966.

[4]Richard H. Brown, "History and the New Social Studies," Saturday Review, XLVIII (October 15, 1966), pp. 80-81.

A full year's course on the history of technology could be organized around either a chronological or a topical outline. The former would focus on a series of episodes in man's past with special attention paid to how he attempted to utilize his environment with the level of knowledge and technology available to him, and how ways of life changed after new technological tools and ideas were invented and adopted. These episodes would probably drain from the same historical epochs which are frequently used as the bases of teaching units in general World and American history courses—events in ancient Egypt, Greece and Rome; the medieval world, the post-Middle Ages, the Industrial Revolution in the 19th Century; and perhaps concluding with an examination of contemporary technological developments such as air transportation, radio communication, and automated factories. However, emphasis in this course would be on technological developments. Comparatively, less emphasis would be placed on forms of government and changes in political organization, military campaigns (although these, too, might have their technological aspects) and alliances, and general cultural history including developments in literature and the arts. A topical approach would present units which each dealt with particular kinds of technological developments. Typical units might include How Methods of Agriculture (or Transportation, or Medicine, or Housing and Furniture Construction) have changed through the ages.

Both types of courses would of course not only describe actual tools and methods of utilizing them; they would also lead to inquiry into the conditions which promoted or made technological development possible, and into the social effects of technological change. Such inquiries should inevitably lead to a better understanding of economic and political institutions and processes as well as technological change. Still, such courses would have an identity of their own, making them clearly distinguishable from general history courses or other types of more specialized ones.

Specialized courses in the history of technology offered to only some students in the school would offer some clear advantages to both the teacher and the students taking the course. First, it would free the teacher from the awesome responsibility, real or imagined, of teaching about or "covering" all the facts about all the history of the world or the nation and all aspects of man's life in it. Second, it offers teachers an opportunity to relate content in a history course to other interests which students, especially those in vocational and pretechnical curricula, might be pursuing at the same time both in and out of schools. An alert teacher can capitalize on these interests to further the general intellectual development of the members of his class.

The first of these is an important advantage. The present trend in the teaching of high school history courses is to select a few topics or problems for historical study, and to study these in depth, even if this means sacrificing breadth in the course and failure to deal with the same facts and episodes which another teacher treats in his course. This is the approach favored by several curriculum development projects currently financed by grants from the Office of Education. The advantage of having all topics in one course related to the history of technology is that some of the same questions for inquiry can be asked and answered in a series of sequential units. As the course progresses, students can not only develop a better understanding of the specific historical episodes they study, but they are also becoming better prepared to develop and test concepts and propositions concerning the general nature of technological change.

Probably more important for students in the vocational and pre-technical curricula is that the subject matter of history of technology is likely to relate more easily to their needs and interests than some of the content they might be exposed to in general history courses. This is a subject which deals with concrete objects--machines, instruments, buildings, etc.—which were different in the past than they are today. Though they were different, the technologies of the past were based on some of the same principles of mechanics, motion, or other branches of applied science as are involved in contemporary technologies. Hence, there are two reasons why students in technical curricula might be interested. First, the main objects of study are concrete. They can be visualized; with visual aids, they can even be demonstrated. By contrast, systems of social structure, treaty provisions, or unusual economic systems, common content in general history courses, are more abstract and much more difficult to comprehend for students who do not have well developed verbal skills. Secondly, since the technologies of all ages have (in retrospect) been based on similar technical principles, students being taught about contemporary technologies in other classes can be led to see similarities between the present and the past. Interest and learning developed in one class can stimulate and reinforce both in another. A third potential advantage is that once a teacher has captured his students' interest in technological development he might more easily lead them to discover and understand how these were made possible by other historical conditions or in turn how they affected succeeding events—economic, political, military, etc.—than if he tried to develop their interest in these conditions through a more direct inquiry.

Conceived of in this manner, the specialized history of technology courses might serve for specialized groups of students as substitutes for the general history courses required by state law for high school graduation. Or, if the general courses in any school in fact tended to neglect or entirely omit the history of technology, the courses might be offered as additions to the school curriculum, as electives for all who wished to take them or as requirements for students enrolled in vocational and pre-technical curricula. The latter alternative is already being carried out in some schools where the history of technology is taught by a teacher in the Industrial Arts department instead of by a member of the social studies faculty.[5]

---

[5]The American Industry Project, Stout State University, Menomonie, Wisconsin.

When offered for a specialized group of students enrolled in vocational and pre-technical curricula, the history of technology course might be correlated with content in other school subjects taught to the same students by a multi-disciplinary team of teachers. In such a program, the content in all academic studies is selected to relate to the pre-technical or vocational training. For example, if a group of boys are being trained as mechanics, the science teacher would teach the principles of physics and chemistry involved in the operation of internal combustion jet and piston engines; the mathematics teacher would focus on arithmetical problems related to their maintenance; the English teacher might ask his students to write paragraphs about their operation and repair; and the history teacher would teach the story of their development, improvement, and use.

In such a situation, the historical content would be highly selective, but selection is a task of the teacher in any history course. The selection here would be very different from that for a political change oriented general history course, but it could be educationally defensible. It would be so if the students learned more not only about the engines they worked on but also about historical processes and generalizations. If students focused on finding answers to the questions, What changes took place? How did they happen? Why did they happen? and What effect did they have on the subsequent life of people?, students would be learning to think in the historical frame of reference.

Multi-disciplinary teams of teachers have developed curricula for this specialized groups of students at several locations in the United States.[6] However, in each case, the team was limited to teachers of English, science, and mathematics working with the teachers of vocational skills. Social studies or history teachers have seldom been involved. There may be several reasons for this. First, legal provisions requiring history courses in the curriculum may be interpreted by some to prohibit such a specialized view of history. Second, many school faculties favor a philosophy of education which calls for all students to be enrolled in social studies classes together regardless of what specialized interests they may be pursuing in other curriculum areas. Allegedly, this practice furthers the development of citizenship attitudes of respect for the worth of all individuals regardless of any special talents, interests, or problems they may have. Finally, the kind of multi-disciplinary effort described requires time of a teacher to cooperate and a willingness to give up some independence in choosing course goals and planning course content. This, coupled with the common lack of background in history of technology possessed by most high school

---

[6]Some multi-disciplinary team projects are: 1) The Partnership Vocational Education Project, sponsored by the Ford Foundation, administered by Central Michigan University, Mount Pleasant, Michigan; 2) The San Lorenzo Valley Interdisciplinary Instructional Program, San Lorenzo Valley High School, Felton, California; 3) Project FEAST (Foods Education and Service Training), Oakland Technical High School, Oakland, California.

history teachers may make the arrangement seem to them that they are forced into a position of being a handmaiden to the pre-technical or vocational program rather than a full partner in it. This problem could only be solved by developing teachers who are better prepared in the history of technology so that they will want to teach content from it not because someone else wants them to but because they themselves believe it is important and relevant to the lives of their students.

Interdisciplinary Social Studies Courses:

A third possible way to include material from the history of technology in the high school program is based on a radically different approach to the curriculum. The first two alternatives, although allowing for different selections of content, assume that whatever content is to be taught will be organized in a historical framework. In each succeeding unit, students will be introduced to a chronologically arranged story. The interdisciplinary framework, although it often makes use of historical materials, does not give such a central place either to the historical content itself nor to the chronological framework. Instead, those planning the curriculum begin with an inventory or what the students need to know or can benefit from knowing, and they expect to include in their list knowledge drawn not only from history but from all the scholarly disciplines.

According to this approach, teachers interested in developing a social studies curriculum for vocational and pre-technical students would begin by asking what problems skilled workers are likely to face in their social environment, or what decisions they will have to make in relation to their jobs, their families, and their communities as they move through life. Then, they will try to list what kinds of understanding might be developed which would help such students and workers make intelligent choices. Only then would those responsible for making curricula be ready to tackle the problem of how this understanding might be developed, with what combination of facts, concepts, and generalizations drawn from a variety of disciplines, and with what types of learning experiences in the classroom to make the learning possible.

A sample list of problem areas or topics which might be included in the preliminary inventory for an interdisciplinary social studies curriculum might include vocational choice, finding a job, and rising in the occupational ladder, labor unions and other self-interest organizations in the community; personal budgeting, advertising, and other consumer problems; recreation and leisure-time opportunities and facilities. This list is not exhaustive. Application of only just a little effort would result in a much longer one, and the teacher working within this curriculum framework begins by leading his students to study and understand the contemporary conditions represented in the problem. To do this, he usually utilizes concepts from several social science disciplines as tools to help direct him to relevant factual data and to analyze the data after it has been collected. History, rather than being an introduction to the problem is introduced only after students become acquainted with the contemporary conditions. Only then does history become relevant as the teacher asks his students "How did these conditions come about? or, Have conditions like these ever existed before?, How is the past similar to the present?, To what degree?" The first of these usually focuses on more recent history; the others can be used to lead to a study of any historical period. Together, they make the study of history relevant to the study of a contemporary problem, but they do not control other aspects of that study.

The amount of material from the history of technology that is incorporated into their courses by teachers utilizing this approach to the social studies curriculum will, of course, vary from unit to unit within the course of study. Nevertheless, the opportunities to ask questions leading to the study of historical material by students will be frequent, and their understanding of the world they live in will be enhanced by tracing its origins and comparing it and contrasting it with life at other times in the past. For example, such a curriculum might include a unit on Occupations in which the teacher would try to help students understand the variety of occupations carried on in their community and the characteristics of various jobs, including types of training required, compensations paid (both monetary and otherwise), and ways the work is organized.

Such a study would begin with a canvas of job conditions in the community at present. Since this is a technological civilization, no study of the world of work could proceed very intelligently without a consideration of the role technology plays today and will play in the future. Then, after this gathering of facts about the present, the teacher would attempt to play the image developed in even clearer perspective by asking "How does work and the way it is divided and organized today differ from how it was in the past? Have the types of changes occurring today ever taken place before? If so, how have people reacted to them?, etc."

It is not certain that every teacher would automatically raise such questions in the process of teaching, but to the extent he is aware of the relevance of the answers to an understanding of occupational trends and opportunities today, he can focus attention of his students on specific episodes and events of the past to further their understanding of specific aspects of the present. As in the case of the other two curriculum patterns described in this report, the previous training and experience of the teacher is a paramount influence on what is taught.

In most states, an interdisciplinary course such as the one described would probably not satisfy the legal requirement that all students take a course in American history, a requirement which might be satisfied for a specialized group of students by a course primarily on history of technology. However, such mandatory state requirements for courses in history or history and government are usually restricted to two years of a four-year high school curriculum, usually for the last two years. In most school districts, the interdisciplinary framework would serve quite well as an organizing scheme for freshmen and sophomore courses for those teachers who preferred it and were comfortable working within it.

Under the discussion of alternative two, the specialized courses in history of technology, it was noted that many programs for pre-technical and vocational students look with favor on a team approach to developing a coordinated curriculum for all academic subjects. The interdisciplinary framework for the social studies would lend itself well to this type of cooperative team approach. Units included in the curriculum could be built around topics related to the needs students perceived or could be led to perceive as their own, topics like those already referred to—vocations, family life, consumer problems, etc. The sequence of course development would not depend on the structure of any single discipline, but information (data) concepts, and theoretical structures would be drawn from several disciplines to help students develop understanding of problems which concern them and to help relate this new understanding to what they are learning in other classes as well.

## CONCLUSIONS AND RECOMMENDATIONS

### Suggested Next Steps:

1. To improve Teachers' Understanding of the History of Technology.

Probably the greatest limitation on teaching history of technology to high school students results from the fact that most teachers have only a limited understanding of this subject themselves. Few colleges offer specialized courses in this subject. General survey courses offered by most college history courses tend to focus on political history and do not emphasize technological change. Since teachers tend to regard as important that subject matter that they have studied and come to understand, the first step in developing greater student understanding about technological development is to improve the education of the teachers. This can be done by:

a. Establishment of National Defense Institutes for Advanced Study for teachers of history at colleges and universities which have scholars on their faculties specializing in the history of technology.

b. Establishment of Experienced Teacher Fellowship Programs which will give additional training in history of technology to secondary school teachers at the same centers.

Practically speaking, the Institutes and Fellowship programs can give direct instruction to only a small fraction of the large number of classroom teachers who might benefit from them. Nevertheless, they have an important "seed" function to perform. They can help to create interest in the subject of history of technology both among high school history and social studies teachers and among members of college history departments. The high school teachers receiving the additional training can tell their colleagues of their experiences and utilize their additional training directly in the preparation of units on the history of technology to be taught in high schools. The publicity given to the establishment of the Institutes and Fellowship programs can help to spread the notion that this specialization is a legitimate one in the field of history. All participants in these programs can help to spread this idea by writing articles in professional journals and appearing on programs of professional associations. The long-range goal that these efforts should serve is to increase the amount of attention paid to the history of technology in both survey and specialized courses taught at colleges which prepare our secondary school teachers. Once the teachers have developed their own understanding of the subject they will be more qualified and more disposed to undertake the task of developing a better understanding of technology and technological change among their students.

2. Improvement of teaching materials available for teaching about the history of technology to secondary school students.

Some teachers are already teaching about the history of technology today in all these patterns of curriculum development that have been suggested. Resourceful teachers, especially interested in teaching about this subject, have been able to find reading material and other teaching material available to help them accomplish their purpose.* However, as has already been pointed out, these teaching materials are scattered. Some of it has been prepared to be used in other parts of the curriculum, perhaps industrial arts, English, or science courses, or units developed around interdisciplinary topics. Some of it is in pamphlet form; some of it, especially materials printed by private industry and made available to the public schools, is "fugitive." It is not available after the original printing or production run has been distributed. Some of it is available within only a limited geographical area. If large numbers of teachers are to develop sustained interests in teaching about the history of technology, materials will have to be made available to them on a more systematic basis than is currently the case. To this end, it is suggested that:

a. Resource units on various topics relevant to the history of technology should be prepared by participants in the Institutes for Advanced Study and the Experienced Teacher Fellowship programs suggested. These resource units should review concepts and generalizations to be taught and suggest alternative content samples which could be used to develop an understanding of them. They should also include a set of suggested learning activities and extensive bibliographies of materials available to help students learn. Provision should be made in the budgets of the Institutes and Programs for financing the dissemination of materials that have been prepared.

b. Efforts should be made to interest commercial publishers and producers of audio-visual aids to produce and sell material useful for the teaching about the history of technology. This may be easier to accomplish than it appears now on the surface. In the free enterprise economy, publishers try to publish what the customers will buy. If other efforts are successful to convince large numbers of teachers that history of technology is an important

---

*-Such materials are available from many large corporations and trade associations. For example, materials are prepared and distributed by public relations departments of American Association of Railroads, American Iron & Steel Institute, American Telephone & Telegraph Company, General Motors, United Airlines, etc. In addition, a complete bibliography of such material currently available in annual editions of Educators Guide to Free and Inexpensive Materials, Educators Progress Service, Randolph, Wisconsin.

subject to be taught, if talk on this subject can be stimulated at professional meetings and in professional journals, some enterprising publisher or producer will be ready to step in to fill any void that might exist. If he is successful, others will follow.

3. The formation of a coordinating committee or council composed of persons concerned with improving the teaching of history of technology in colleges and in secondary schools (its interest could later be expanded to include the elementary school curriculum as well).

This group could well be affiliated with the Society for the History of Technology. However, its membership should not be limited to scholars; it should also include classroom teachers, professional educators, curators and education directors of museums, producers of educational material, along with representatives of organized labor, industry, and professional or technical societies. Among the functions and responsibilities of this council would be:

a. This group should stimulate activity aimed at increasing the amount of attention paid to the history of technology in college courses and in secondary schools. Its membership might appear on the programs of professional societies and write the articles for professional journals already suggested as means of creating more interest in this field.

b. This group should publish a newsletter which would report and describe new curriculum projects which have been initiated and developed around the country. It would also print notices and descriptions of new curriculum materials that have been published or produced and made available to the schools. Periodically, it might publish a cumulative, annotated bibliography of such materials.

c. This group could sponsor the development of new curriculum materials. Its members might actually write material to be submitted to a commercial publisher, for example, a pamphlet of edited documents relevant to a topic from the history of technology which could be included in a series of paper-backed problem oriented pamphlets prepared for use in general history courses.

d. This group could arrange for better distribution of resource materials now available. For example, it might initiate an effort for a cooperative venture among museum directors to prepare special traveling exhibits of museum materials that might be allowed to circulate beyond the local territory of the museum.

e. This group could sponsor, or at least encourage action research programs for curriculum development in the area of history of technology. This opens up discussion of a new point which deserves special consideration in the next numbered item below.

4. Undertaking a research program to determine what can be taught about the history of technology within various proposed curriculum patterns.

Much of the foregoing discussion has been based on assumptions that concepts and generalizations developed by scholars interested in the history of technology can be taught to high school students effectively, taught in ways so that what is learned will influence the way students perceive what is going on around them in their own world. At present, although these are the same assumptions that underly the teaching of all concepts and generalizations in history courses instituted in the curriculum for general education purposes, they are only assumptions. They have not been verified by carefully planned and systematically conducted empirical research. The conduct of such research is now a requirement for sound curriculum planning and development. The United States Office of Education and various private foundations that have money available to finance educational research should make grants to qualified persons who are willing to attempt to find reliable answers to the following questions:

a. Can concepts and generalizations relevant to understanding our technological civilization and the way in which it has developed be effectively taught to high school students so that they will perceive their physical and social environment differently as a result of having learned them?

b. Within what patterns of curriculum development can these concepts and generalizations be taught?

c. In order to teach such concepts and generalizations effectively, is one pattern of curriculum development preferable for all students, or do results differ according to the interests and learning abilities of the students?

If one assumes that these concepts and generalizations can be taught, and they can be taught within the framework of chronologically organized history courses, empirical verification of these hypotheses as a result of carefully planned observations would offer a tremendous boost to those arguing that more material relevant to the history of technology should be incorporated into the curriculum. On the other hand, if efforts to verify these hypotheses should yield negative findings, educators should certainly be apprised of these results, too. It is time to find out.

Verification of the hypotheses that the concepts and generalizations referred to can be taught effectively, and that they can be taught effectively within the framework of chronologically organized history courses, would not automatically prove that this should be done. Further research into additional questions would immediately become desirable. Investigators would want to ask:

d. What is the relative efficacy of teaching an understanding of technological civilization and the processes of technological change by means of curricula organized around chronological frameworks (history courses) and through interdisciplinary approaches to topic or problem analysis which focus on the present first and only later make inquiry into the past as a means of broadening and clarifying initial understanding?

e. Which aspects and characteristics of technology, technological civilization, and technological change should be considered more important than others and should receive priority for selection to be incorporated into the high school curriculum?

The first of these last two questions is one of means, a question of how to do it. Data can be gathered by a comparison of the results of teaching within two patterns of curriculum organization. The second question, however, is of a different order. It is a question of goals, and how one answers it depends upon his values and his judgments about what else ought to be included in the high school social studies curriculum. A study to find an answer to this latter question cannot proceed only according to the rules of empirical science. It would have to be a normative study, one which would attempt to inventory what kinds of knowledge are most important, knowledge drawn not only from the history of technology but from all the social sciences and the better forms of social analysis and social criticism as well. Only after one has a good picture of all that might be taught—concepts, generalizations, and theoretical models—can he be in a position to put a priority on any of it. A good case can be made for the argument that further development of social studies curricula for vocational and pre-technical students should begin with an analysis of what they need to know or can benefit from learning. After this has been done, the difficult job of assigning priorities can proceed, and then inspired teachers and other competent specialists can proceed to determine what is the best way to organize the curriculum to effectively achieve its goals. Perhaps a good case can be made for following this time table, but it is not the only way to proceed. All of the research questions listed are interrelated. Attempts to find answers to all of them should be encouraged and supported. Nevertheless, the sight of how they relate should never be lost, either by the investigators themselves, or those who develop policy on the basis of their findings. The goal for all is one and the same, to improve the understanding, and thereby the personal and social effectiveness, of all who live in the modern technological society.

# APPENDIX A

## TECHNOLOGY AND CULTURE

By
Dr. Melvin Kranzberg

We live in what has been called a technological age. It is called that, not because all men are engineers and certainly not because all men understand technology, but because we are aware that technology has become a major disruptive as well as creative force in the twentieth century. Notice the emphasis upon the word "aware," for the fact is that technology has always been a creative and destructive force, and the 20th century is by no means unique in that respect. Man has always lived in a technological age inasmuch as his life and culture have always been bound up with technology. The difference lies in the belated recognition in our present time of the significance of the technological factor in human affairs.

Some of you might scoff, saying that ours is abviously more a technological age than past periods by comparing our complex technical devices with the cruder instruments of remote times. I do not deny that the modern tractor-driven plow represents a higher level of technology than the heavy stick with which primitive man—or rather woman—scratched the ground or that the hydrogen bomb is an infinitely more complex—and lethal—mode of destruction than the bow-and-arrow. Nevertheless, the plow stick and the bow-and-arrow represent the advanced technology of an earlier time. In its day the heavy stick with which our primitive ancestors prepared the soil for planting marked an enormous increase in man's ability to wrest a living from an inhospitable and cruel nature, as did the bow-and-arrow when used for food-hunting purposes. When employed for man-hunting purposes, the bow-and-arrow also gave its first possessors a decided advantage over the enemy who still relied on rocks and clubs.

I am reminded of a little cartoon which appeared some fifteen years ago in Collier's magazine. The cartoon showed a cave-man emerging from his cave with a bow-and-arrow. To his companion he says, "This new invention of mine will make war so destructive that men will never make war any more!" Thus throughout history—and even pre-history—technology has been a creative and disruptive force. Man has always been living in a technological age, inasmuch as his life and culture—his very survival—have been dependent upon his technology.

Indeed, man himself is a product of technology. Anthropologists seeking the origins of mankind have attempted to differentiate between what constitutes "almost-man" and the genus man. The chief distinction they can find is that man employed tools, thereby distinguishing him from his almost-human predecessor. Man as we know him probably could not have evolved or survived without tools—he is too weak and puny a creature to fight nature with only his hands and teeth. The lion is stronger, the horse faster, the giraffe can reach farther; what enabled man to survive was his ability to adapt to his environment by improving his equipment for living. As Gordon Childe has pointed out, man's equipment differs significantly from that of other animals, for they carry their whole equipment about them as parts of their bodies. Man has very little equipment of this sort and has discarded some that he started with during prehistoric times; it is replaced by tools, extracorporeal organs that he makes, uses, and discards at will. In other words, the earliest tools served as extensions of man's hand and amplifiers of man's muscles.

This extracorporeal equipment enabled man to adapt to nature and to survive. While the hereditary equipment of the other animals can perform only a limited of operations in a particular environment, man's ability to make both tools and weapons enabled him to adjust his equipment to an almost infinite number of operations in almost any environment.

It is not surprising, therefore, that anthropologists define the human species on the basis of tool-using and tool-making. Modern physiology, psychology, evolutionary biology, and anthropology—all combine to demonstrate to us that homo sapiens (man the thinker) cannot be distinguished from homo faber (man the maker). Indeed, we now realize that man could not have become a thinker had he not at the same time been a maker. Thus we find that technology is perhaps the most basic of human characteristics and activities. For without it we might still be swinging from the trees and not be human beings at all.

Technology has thus helped to condition our past, to determine our present, and it is working to shape our future. Can there be any doubt of its significance in human culture?

If technology is so important to our culture—past, present, and future —how are we to account for the neglect of the study of its development by historians, political scientists, sociologists, humanists, indeed, by the engineers who are themselves practicing technologists? To understand this blind spot on the part of scholars, we must look into the past, as far back as Plato's notion that thinking is man's highest activity whereas manual labor—i.e., technology —lacks dignity and is confined to lower class individuals of inferior capacity. This concept corresponded to the social system of antiquity when work was left largely to the slaves, and it persisted throughout the Middle Ages. Although the monks gladly performed manual labor as a means of extolling God—and we owe many great technological advances to these cloistered brethren—the word "servile," from the same root as "serf," betrays the low esteem in which manual work was held by the medieval aristocracy.

As our modern industrial society came into being, the older aristocratic view of the worker began slowly to change. This revolution in social attitude went farthest in America, where the development of social democracy—caused by the influence of the frontier, the disciples of Frederick Jackson Turner would say—elevated the role of the worker. Indeed, the American myth—from log cabin to the White House—fostered the feeling that manual labor was not a thing to be despised but an indispensible prerequisite for the great American dream of success. What a far cry from the ancient attitude toward work!

As the public attitude toward work changed, so did the prevalent attitude toward technology. The magnificant achievements of the Industrial Revolution in supplying man's materials wants and creature comforts served to develop an awareness of the role of technology in civilization.

Paradoxically, the widespread use and appreciation of the products of technology did not result in greater esteem for the craftsmen or the engineers, the men responsible for this progress. Despite the fact that our civilization has become overwhelmingly dependent on technology, despite the fact that the products of technological development are used and admired, despite the fact that both engineering and craft skills in the industrial arts have become increasingly complex fields requiring highly specialized education, the engineer and the craftsman, even today, have not received adequate recognition for their training and for their contributions to society.

The reason for this paradox is not hard to find: The American success story glorifies the man who <u>began</u> his career by working with his hands; his success lay in progressing <u>beyond</u> that stage, so that he no longer need perform tasks requiring muscle or technical skills. Thus the man whose lifetime work was designing and developing tools for work, or using these tools to create things, did not find his status elevated proportionally to the high opinion held of his products by the public. Although far above the level of the unskilled manual laborer, the modern engineer and the skilled technician still suffer from the anachronistic attitude toward the men who make and work with tools, which is part of our heritage of social attitudes from classical antiquity.

This attitude extends to the industrial arts, which help develop the engineering arts and technical skills required in our highly industrialized society. To an older generation, such training was known simply as "manual training" or "shop," and taught little more than the use of a saw, a plane, and sandpaper—all employed to produce that finest product of the 12-year-old boy: a lopsided breadboard. Today, a vast majority of the public appreciates the importance of the training and skills developed in industrial arts courses. Nevertheless, some of your academic colleagues still tend to look down their noses upon the valuable educational experience embodied in contemporary industrial arts programs.

For the fact is that the academic world has lagged behind popular opinion in its appreciation of the role of technology and of the demands which it makes upon human skills and creativity. Until relatively recent times the world of scholarship has concentrated its attention upon the humanities, particularly the classics. The ivory-towered life of contemplation, stressed by ancient philosophers, seems incompatible with the study of contemporary changes in society, especially those concerned with the feared, and often hated, technology.

Even among engineers there was little concern with the history and sociology of their field. Why bother with the past? Why investigate what has already been superseded? The study of political or intellectual history admitted no such questions; past politics, past philosophy, past literature—all were believed to teach valuable lessons, as well as have intrinsic value. No such claims were made for technology; not only was technology itself viewed as an inferior subject, but the study of its past was considered irrelevant. Besides, technological advances occurred so rapidly that both scholar and student were hard pressed to keep up with the newest developments, let alone peer into the lessons of the past or even to investigate the social impact of their activities.

This neglect of the study of the development of technology and its relations with society and culture has distorted much of our education. Technology is an essential component of our culture, affected by and affecting every other aspect of society. How can political scientists ignore it, if they wish to tell the story of the rise and fall of states, the pressure and power groups within nations, the development of new political procedures, forms, and institutions? How can teachers of literature ignore it, if they believe that literature is a mirror which reflects the texture of a society with all its defects and all its good points? How can historians and social scientists ignore it if they believe that their duty is the interpretation of the changes and transformations of a whole culture? Nevertheless, technology is scarcely given more than passing mention in their work, and the teachers of technological skills are treated with a supercilious snobbism.

Yet the fact remains that technology and its twin, science, are the distinguishing hallmarks of our modern Western civilization. It was the Scientific Revolution of the seventeenth century and the Industrial Revolution of the eighteenth and nineteenth centuries, rather than the Renaissance or the Age of Reason, which brought something to our civilization which had been unknown to Greece or Rome or India or China. Science and technology differentiate our society from all that has gone before in human history and all that has taken place in other parts of the world. Nevertheless, the students in liberal arts curricula are still being taught that Western civilization is based solely upon the Judeo-Christian-Greek tradition, and scarcely anything is told them of the role of science and technology in developing our modern society. Of course, the roots of our religious, and moral heritage can be found in Christian theology and Greek ethics, but—and this may be an unpalatable assumption to some—contemporary Western culture is based upon science and technology to a greater degree than it is based upon religious and moral considerations.

If we wish to test this hypothesis, we need merely ask ourselves what "westernization" means to non-western societies. To them "westernization means the acquisition of the products of Western science and technology, not the political institutions, religious faiths, and moral attitudes which the West has developed over the centuries.

Thus, when we speak of the westernization of Japan during the late nineteenth and twentieth centuries, we refer to the acceptance or borrowing of Western technology by Japan. Similarly, many of the underdeveloped nations of the world want to borrow from the West today; but what they desire is not the Western moral and social attitudes. Indeed, they specifically reject these. What interests them are the advantages, chiefly of a material nature, which Western technology can bestow upon them, even though they criticize the West's materialism. Indeed, we in the West ourselves do not honor our moral and religious heritage, and we tend to think of Western civilization in terms of the material advantages derived from an advancing technology. It is not surprising that our Peace Corps, which attempts to bring the "know-how" of American technology to these underdeveloped nations is besieged with requests for people who possess some technical background. This is what the rest of the world wants to borrow from us; this is what the rest of the world admires and respects in culture.

A study of the development of technology does not show us that the progress of mankind is necessarily guaranteed; but it does show us that the possibility of progress is always present in human affairs. In the darkness which surrounds us, some ray of hope for the future is necessary. Granted that technology has now made it possible to obliterate mankind and that it can be used for evil and destructive purposes as well as for good and constructive purposes, the fact remains that while nearly all indices of the level of culture and civilization seem to have advanced not one whit in our century—and some seem to have retrogressed—in only one field can we point indisputably to progress: technology.

If the study of technology can provide us with some hope of the future, if it can show us how men can transcend petty national rivalries and how the human mind can employ its reason for the solution of complex and disturbing problems which have long defied the human intellect and imagination—that in itself is a reason for learning the stody of technological development. This is not escapism from the realities of the present, even though it might appear that way. Rather, by realistic appraisal of the road which man has trod in developing technology to its present eminence, we may gather faith and hope that the other problems which beset us may be conquered by the use of human reason, ingenuity, imagination, and skill. And nowhere do these human traits show more clearly than in the advance of the industrial arts.

---

## APPENDIX B

## HISTORY OF TECHNOLOGY: THE PROBLEMS OF DEFINITION AND SCOPE

What is the subject matter and scope of the scholarly endeavors described as history of technology? It would certainly be useful to have an answer to such a question when deciding how the subject could or should be introduced into secondary school curricula. Useful certainly, necessary maybe, but a satisfactory answer at this time, may also be impossible. Consider the publication of the five volume History of Technology edited by Singer, Hall, Holmyard, and Williams. In discussing the production of that work after its publication, A.R. Hall made the following remark:

> Any history that is not universal can be described as myopic; it is purely a matter of convention that we regard certain kinds of matter as appropriate for constitutional history, diplomatic history, economic history; and the exact content of the history of technology still lacks a conventional definition.[1]

The absence of a conventional definition did not appear to inhibit the editors of that work, nor has there been any noticeable inhibition of the growth of articles and books on the subject since the publication of A History of Technology. It might be argued that when the exact content of the history of technology has been defined it will no longer constitute an area whose first rate scholars operate on the frontiers of knowledge.

For the purposes of secondary school educators it may be more useful to look at the many ways of describing technology. Since 1958 there has been an organized "Society for the History of Technology," and one could imagine that defining the scope of this subject would occupy the time of its members and the pages of its journal (Technology and Culture). Judging from the articles which have appeared in the journal, this was a matter of greater concern in the early days of the organization than at present -- and never a subject settled with any degree of finality. A recent issue (Summer 1966) was devoted to questions concerning the emergence of a philosophy of technology rather than a definition of it.

---

[1] Technology and Culture, Vol. I, No. 4 (1960) p. 316

In an early issue of Technology and Culture Peter Drucker's article, "Work and Tools,"[2] considered definitions of technology. Utilizing the insights of the 19th century biologist, Alfred Wallace, Drucker questioned a definition of technology used by Singer and his fellow editors. In their preface to Volume I of A History of Technology the editors wrote,

> . . . Etymologically 'technology' should mean the systematic treatment of any thing or subject. In English it is a modern (seventeenth century) artificial formation invented to designate systematic discourse about the (useful) arts. Not until the nineteenth century did the term acquire a scientific content and come ultimately to be regarded as almost synonymous with 'applied science'. Professor V. Gordon Childe has given some attention to the scope of technology (p 38). The editors have treated it as covering the field of how things are commonly done or made, extending it somewhat to describe what things are done or made.
>
> (Vol. I, p. vii)

Childe's definition referred to above is as follows:

> Technology should mean the study of those activities, directed to the satisfaction of human needs, which produce alterations in the material world. In the present work the meaning of the term is extended to include the results of those activities. Any technology in this sense, like human life itself, involves the regular and habitual co-operation of members of a human group, of a society.
>
> (Vol. I, p. 38)

"Alterations in the material world," or "...how things are commonly done or ... what things are done or made," these are not main focal points for understanding technology according to Drucker. Rather, he argued, it is the manner by which man has extended his own powers and abilities that forms the essential content of technology. Technology is not the means by which "the conquest of nature" is accomplished so much as the means by which man extends the range and power (or overcomes limitations) of his own genetic or biologic endowment. In more recent years a position similar to Drucker's has been developed and presented even more vigorously by Marshall McLuhan. The subtitle of McLuhan's best known work, Understanding Media is, appropriately, The Extensions of Man.

---

[2] Technology and Culture, Vol. I, No. 1 (Winter 1959) p. 28.

While a number of writers have taken issue with the editors of A History of Technology, two in particular deserve mention because of the contrast in their respective viewpoints. Lewis Mumford and Robert Woodbury expressed their reactions to the Singer volumes in a special issue of Technology and Culture.[3] Mumford wrote:

> To understand the development of technics, one must distinguish between tools (such as knives and axes) and utensils (such as pots and mirrors), between machines (such as potter's wheels) and utilities (such as buildings, dams, and canals). For lack of a clarification of this sort, the book never brings out clearly one of the fundamental facts about early technical civilizations; namely, that their great achievements in architecture, city building, and hydraulic control ...were all of a static nature.[4]

In other writings (notably his City in History) Mumford has criticized analyses of technology which emphasize tools made of inorganic materials while paying less attention to the technology of "containers" (garments, baskets, gourd utensils, etc.). The former are often preserved through succeeding centuries while the latter are frequently made of organic materials and lost to future generations when they disintegrate.

Woodbury's criticism of the Singer volumes is of a different nature and implies a quite different understanding of technology. His principal effort was to demonstrate, by comparison with the work of George Sarton in the history of science, that the Singer volumes were premature. However, in speaking about particular aspects of the work Woodbury revealed his attitude toward the general subject, and he probably reflected the views of a number of his colleagues as well. He wrote:

> . . . Technology also contributes to the "Graphic and Plastic Arts," "Furniture," "Enameling," to fine work in metal, ivory, or wood for artistic purposes, and even to "Domestication of Animals," "Cultivation of Plants," and "Hunting and Fishing," but are these part of technology itself? "Food and Drink," are important to man, but their history belongs in a work of this sort only in so far as they were produced by technological implements, devices or methods. Surely "Whaling" and the "Preservation of Fish" are not technology. And "Cartography," is this technology? ... The editors seem to have made no clear distinction between technology and the arts and crafts.[5]

---

[3]Vol. I, No. 4 (1960)
[4]Ibid. p. 323
[5]Ibid. p. 348

Woodbury then goes on to question the relative amounts of space allotted to these subjects.

> ... Are "Food and Drink," so important technologically that one can give a total of some 225 pages to them and only 17 pages to "Coal"? . . . And does "Cartography" justify over 100 pages in a work in which the "Stationary Steam Engine" gets 17 pages? Surely machine tools since 1850 deserve more than 22 pages, when an equal space is given to "Fish Preservation." In short, the very elements which made possible an Industrial Society are in this book given short shrift in favor of elements of little significance.[6]

Without taking issue directly with any of the views of Mumford, Woodbury, or the Editors of A History of Technology, surely one can conclude that scholarly opinion is greatly divided in the matter of defining technology.

For present purposes it is perhaps enough to understand something of the range of opinions. For example, Carlyle's definition of man as a tool using animal no longer serves well in distinguishing man from other forms of animal life. Man as a maker of tools (homo faber) rather than merely a user is the characterization more generally used today. Yet tool-making alone would be considered an inadequate basis for defining technology by many historical scholars. Mumford's position in regard to emphasis on tool making was suggested above. Another difficulty with a primary focus on tool-making for understanding technology is the problem presented by the body of techniques known to agriculturalists and the practitioners of the healing arts.

For example, consider Jenner's use of the cowpox virus to provide immunity to small pox in the late 18th century. Since his work antedates most scientific work in medical microbiology it seems reasonable to call it a technological rather than a scientific achievement. Yet, if it is granted that one virus is the instrument by which the effects of another are countered, the cowpox virus is not a tool created by homo faber. A similar argument might be made for modern antibiotics. Likewise, if a person uses his own body as a bellows in mouth to mouth resuscitation he may employ a life saving technique (or technology) without having fashioned the bellows instrument. In short, since at least neolithic times agricultural practices and the healing arts have constituted techniques for conserving human resources and extending individual human life. However, much of the knowledge and practice of these techniques is only tangetially or incidentally bound up in the fabrication of tools.

The problem of medicine and agriculture (the biological technologies) in the overall history of technology is emphasized here because of the popular notion that technology is virtually synonymous with engineering.

---

[6] Ibid. p. 348

Whatever theoretical differences scholars may exhibit in their definitions of technology as a field of study, empirically it can be shown that most writing in history of technology as concerned itself with "hardware" from primitive tools to rocket propulsion. It is not unreasonable to believe, though, that custom rather than self-conscious scholarly formulation of the problem is the principal explanation for this.

For example, an early issue of Technology and Culture was devoted to articles which examined aspects of the relationship of science and engineering. There has been no comparable effort since to focus attention on the relationship of science to medical practice or science to agricultural practice. (The treatment of agriculture in Technology and Culture has generally focused on agricultural engineering and implements.) This is not an attempt to belabor the editors since other journals and other scholarly societies are especially devoted to the history of medicine and the history of agriculture. Nevertheless, there appears to be no inherent reason or theoretical justification for an emphasis on engineering and tool-making. However natural the reasons for this custom among writers in the history of technology, such a customary practice may not have particular relevance to the problem of introducing history of technology into secondary schools.

Elsewhere in this report questions concerning the relevance of history of technology to secondary education-- particularly vocational and technical education--have been raised. Here the overall scope of history of technology is the main consideration. Another appendix to this report describes bibliographic sources. But, at least two other issues in historical scholarship deserve special mention. These are: (1) internal histories of technology in contrast to relational histories; and (2) the uses of technological evidence in marking the sequence of human events and designating technological "revolutions".

One of the most frequently voiced criticisms of the Singer volumes has been that A History of Technology constituted an "internal" history. This criticism had to be somewhat muted in view of the clear acknowledgement on the part of the editors that such was their intent. As A.R. Hall wrote at a later time:

> . . . This history of technology has inescapable affiliations with economic history and with the history of science, and its relations with social history are hardly less direct. One may well ask: How have the non-technological activities and ideas of a society affected the development of its techniques? And, how have the techniques affected the other activities and ideas? When we were planning our History it seemed to us (and I still think that this view was correct) that we had enough on our hands in

> dealing with technology itself, fairly narrowly conceived; and that it was not incumbent upon us to traverse the work of the economic, social, or scientific historian beyond what was strictly necessary. We felt that though it would be desirable in the future to attempt to set the development of technology in a fuller historical context, such an enterprise would far exceed our limits and be of doubtful validity at the present. Reviewers who drew attention to this restriction in our volumes were quite justified as to the fact, but they did not sufficiently appreciate perhaps that we were not attempting a version of the universal history of man and civilization.[7]

Whatever the advisability (or possibility) of examining technological developments in the context of other human endeavors, this is precisely what the Society for the History of Technology organized itself to attempt. The use of the conjunction in its journal title (Technology and Culture) is suggestive of the purposes of the organization. Furthermore, in every issue the following statement appears in a description of the society:

> Formed at the beginning of 1958, the Society for the History of Technology represents the first systematic attempt to encourage the study of the development of technology and its relations with society and culture.
>
> An interdisciplinary organization, the Society is concerned not only with the history of technological devices and processes, but also with the relations of technology to science, politics, social change, the arts and humanities, and economics.

The officers and advisors of the Society (which include A.R. Hall) would probably agree that their goals are considerably more ambitious than those of the editors of A History of Technology. How realistic the effort to relate history of technology is, in contrast to the narrower focus on internal developments, is something which must wait the judgment of future scholarship. The Society's journal has not been devoid of articles which might be called contributions to the internal history of a particular technology. On the other hand, it is clearly apparent in every issue that the relationship of particular technologies to other aspects of human culture is a subject under consideration.

Awareness of different approaches to history of technology is important to any educator concerned with secondary social studies curricula

---

[7] Technology and Culture, Vol. I, no. 4 (1960) p. 315

but especially so for those involved in vocational and technical education. However, intellectually appealing the relational approach to history of technology may be, a case could be made for greater emphasis on the internal history of particular technologies for those students being trained in the contempory skills of that technology. This is not the appropriate place to make that case. Here, in citing the statements of A.R. Hall and the organizers of the Society for the History of Technology, the effort is merely to highlight a scholarly question which has implications for later curricular decisions. Another such question centers around the means by which sequences of technological development are identified.

Since the 1830's, Christian Thomsen's three-age system for tracing change through successive stone, bronze, and iron ages has achieved widespread (perhaps universal) acceptance. This was not his conception alone, and the manner in which it became accepted forms an interesting chapter in the development of historiography itself. That story has been told by the anthropologist Robert Heizer.[8] While generations of scholars have added evidence to, and elaborated upon, the three-age system this hardly means that problems in understanding the sequence of technological changes no longer engages the energies of historians and other scholars.

A.R. Hall, in the article cited earlier made the following remarks in discussing the decision as to where the volume breaks should come in A History of Technology:

> ... In Europe the collapse of the Roman Empire is almost as epochal an event in technology as in political history. After this chronological division becomes highly problematic. One has to look far ahead to ca. 1750-1800 for a definite boundary line, yet there is no real unity in the stretch from 500 to 1750. A break around 1500, conventional in European history and adopted in our work, is not wholly appropriate to the history of technology; it is straddled by far too many developments in machinery, metallurgical techniques, ceramics, and so on, and not least in science. Perhaps we shall ultimately come to recognize that there is a significant unity in the period from the third to the thirteenth century, and again thence to the seventeenth.[9]

[8] "The Background of Thomsen's Three-Age System, "Technology and Culture, Vol, III, No. 3 (1962) pp. 259-66.

[9] Technology and Culture, Vol. I, No. 4 (1960) p. 315.

Such remarks should serve as a caution against the use of any neat divisions borrowed from other historical disciplines until historians of technology can decide on technological bases what divisions are reasonable. Consideration of the sequence of technological changes, though, leads to the related issue of when (if at all) did technological revolutions occur and how many have there been.

A number of these questions and issues have been summarized by Melvin Kranzberg in his contribution to the 34th Yearbook of the National Council for Social Studies. In that article he wrote:

> Not until the eighteenth century did the Industrial Revolution commence. It was Arnold Toynbee (uncle of the contemporary Arnold Toynbee) who first described the social and economic transformation in England during the last decades of the eighteenth century and the early years of the nineteenth as an "industrial revolution."[10] The term, although not original with Toynbee, served to dramatize the mechanical changes which had occurred in Britain, but it was not long before scholars began laying claim to the title for changes of any magnitude whatsoever from prehistoric times to the present. Thus, claims were put forward for a "first" industrial revolution some five thousand years ago (as in the writings of Gordon Childe); for one in woolen weaving during medieval times; for another "first" industrial revolution in Britain from 1540 to 1640;[11] and for "second" or even "third" industrial revolutions during the later nineteenth century.
>
> Ironically enough, these claims for prior and subsequent industrial revolutions were advanced when the concept of the Industrial Revolution in eighteenth century Britain had itself come under fire. Some scholars have denied its uniqueness

---

[10] Arnold Toynbee, The Industrial Revolution (Boston: Beacon Paperback BP 32, 1956).

[11] John U. Nef, Industry and Government in France and England, 1540-1640 (Paperback edition, Ithaca: Cornell University, 1957).

or its revolutionary character, as did Joseph Schumpeter[12] and G. Unwin;[13] indeed, John H. Clapham in his study of British economic history [14] did not even use the term.

While debate about the causes, consequences, and nature of the "Industrial Revolution" seems far from over, an equally serious discussion continues among historical scholars as to what shall be considered the first technological revolution. An illuminating display of positions which have been taken on this issue can be found in recent issues of Technology and Culture. Peter Drucker's 1965 presidential address to the Society for The History of Technology was entitled: "The First Technological Revolution and Its Lessons", and in it he argued for the technological and cultural primacy of ancient irrigation societies. He suggested that traditional methods of introducing students to the History of Western Civilization through the study of classical Graeco-Roman societies fails to acknowledge fully the cultural and technological contributions of more ancient societies. Specifically, he drew attention to the fact that the irrigation civilization city was:

1. The first to establish government as a distinct and permanent institution, e.g. it conceived man as a citizen by going beyond the bounds of tribe and clan to weld people of very different origins into one community.

2. The place where social classes first developed, i.e., the farmers, the soldiers, and the governing, or originally, the priestly class. (To the end of the 19th Century these three "estates" were still considered basic in society.)

3. The site of the first acquisition, organization, and institutionalization of knowledge, that is, record keeping, calendar making and writing appear first in the irrigation city.

4. The origin of the individual. Outside the city only the tribe had existence.[15]

---

[12]Joseph Schumpeter, Business Cycles (2 vols.; New York: McGraw-Hill 1939)

[13]G. Unwin, Studies in Economic History, R.H. Tawney, ed., (London, 1927)

[14]John H. Clapham, The Economic History of Modern Britain (2 vols.; Cambridge; Cambridge University, 1926, 1932).

[15]Peter Drucker, Technology and Culture, Vol. VII, No. 2, 1966, p. 143.

Drucker argued that these innovations constituted fundamental contributions to Classical and later societies and were integral with the technological achievements which first made civilized (i.e., "citified") life possible.

In the second issue of Technology and Culture following the appearance of Drucker's address, however, two other authors took him pleasantly to task for failing to give due attention to other technological revolutions.

> Donald E. Etz argued that Drucker's first technological revolution--the rise of irrigation agriculture--was not first. It was preceded by a cultivation revolution wherein human societies first learned to raise their own food and raw materials. Furthermore, Drucker's discussion did not indicate the development of the plow and copper and bronze technology--major contributors to irrigation civilizations. Finally, Drucker emphasized the irrigation revolution and the current technological revolution but failed to mention any in between. This overlooks or slights the events of the middle of the 2nd millenium B.C. whose elements include the introduction of the horse, iron metallurgy, and the development of the alphabet.[16]
>
> Similar points were raised by John Meursinge whose main concern was the relationship of technology to human social inventions or institutions and the "human condition" generally. Referring to what Mumford has called the "eotechnic period" in European history, Meursinge states:
>
> "This time black powder, draft animals, free wage earners, and wind and water power were the sources of energy available to technology. Slavery had practically disappeared. In terms of human happiness this was technology's greatest accomplishment since man appeared on earth. Drucker's statement that 'indeed the technology of man remained essentially unchanged until the eighteenth century insofar as impact on human life and human society is concerned' should be challenged, I am sorry to say. The first important changes had already become visible about A.D. 1000."[17]

---

[16] Donald V. Etz, "The First Technological Revolution", Vol. VII, No. 4, 1966, p. 515. See also John Pfeiffer, Horizon, Sept. 1962.

[17] John H. Meursinge, Technology and Culture, "Overlapping Histories of Technology, Vol. VII, No. 4, 1966, p. 517.

These remarks have tried to suggest something of the range of unresolved issues confronting historians of technology, but they do not constitute a discussion of the issues themselves. It should be observed, though, that the arguments for considering neolithic achievements in the domestication of plants and animals as the first significant technological revolution can, in turn, be countered by the example of the invention of language. With considerable certainly we can believe that men had developed sophisticated linguistic skills long before the neolithic period. Since language as a form of social inter-behavior is a necessary pre-condition for virtually all subsequent technological advances, it could be argued that the invention of language is "really" the first great technological revolution. This development was a concomitant of the development of hand tools though in itself it does not represent a tool-making achievement.

Measured by human time scales this undoubtedly constituted a long evolutionary development. Measured in terms of vertabrate or even mammalian evolution, however, the appearance of anthropoid mammals within a 500,000 to 1,000,000 year period who learned (taught themselves?) to communicate with each other might well be called a revolutionary development. Certainly the consequences of this socio-technological achievement for the rest of mammalian life could easily be called revolutionary.

The major articles presented are:

(1) As yet, scholarly consensus concerning the precise definition of the scope of history of technology has not been achieved.

(2) Lack of such a definition has apparently not inhibited the development of the discipline or the output of writers who consider themselves contributors to the history of technology.

(3) While history of technology may not be a discipline unified by general theories or concepts, histories of technologies certainly exist even though there is little consensus concerning the relative importance of particular kinds of technology.

(4) Educators concerned with history of technology in secondary schools should be aware of other issues in the field. These include the way in which sequences of technological achievement are identified and used, the use of the term revolution or the justifications for such usage, and the degree to which history of technology can or should be related to other kinds of historical and contemporary developments.

## APPENDIX C

### A BIBLIOGRAPHIC LETTER TO A HIGH SCHOOL TEACHER (HYPOTHETICAL)

Mr. Robert Merrick
Delta Union High School
Pleasanton, Kansas

Dear Mr. Merrick:

It is indeed a pleasure to learn that you are interested in introducing units in the history of technology into your classes at Delta Union High School. In answer to your request for information concerning basic references, instructional materials, course outlines, and other aids, I'm afraid there is very little that I can refer you to that is already designed or pre-packaged for classroom use. Considerable development work will have to be done before that is the case and we hope that the U. S. Office of Education or private foundations will support such efforts in the near future. Please do not let this situation deter your efforts, however, as there is a great deal which an individual teacher like yourself can do if he wishes to introduce high school students to History of Technology. I would suggest the following sources and activities to you as a way of getting started.

First, you as an individual, should join the Society for the History of Technology. You will then become a subscriber to its quarterly journal, Technology and Culture. For membership information, write to: University of Chicago Press, 5750 Ellis Avenue, Chicago, Illinois. One of the important things you will see in that journal every year is the Current Bibliography in the History of Technology which lists all current work published within the past year. The other fundamental bibliographic tool you will want to know about is Contributions to Bibliography in the History of Technology by Professor Eugene Ferguson of Iowa State University. This is organized topically and covers the literature in particular subject areas over a longer period than does Current Bibliography in the History of Technology.

While the sources cited above will provide solid scholarly back-up for anything you might want to do in your classrooms, they were prepared with the needs of high school teachers particularly in mind. Shorter and more interpretative guides to (and through) the literature exist. One such introduction is Chapter 3 of the 34th Yearbook of the National Council for the Social Studies. The chapter is entitled "The Technological Revolution and Social Reform," by

Melvin Kranzberg and is available from NCSS headquarters at the National Education Association. Another such interpretive bibliographic essay is Eric Lampard's "Industrial Revolution, Interpretations and Perspectives" which is Publication #4 from the Service Center for Teachers of History of the American Historical Association.

There are a great many works in different aspects of history of technology to be found in the bibliographies and essays listed here, but two basic ones should be singled out as "musts" for your own or your school's library. These include the A History of Technology, edited by Charles Singer, E. J. Holmyard, A. R. Hall, and Trevor I. Williams (5 volumes; Oxford University Press, 1954-58), and Technology in Western Civilization, a two-volume work edited by Melvin Kranzberg, also published by Oxford University Press. The Singer volumes are primarily concerned with the evolution of technology itself while Technology in Western Civilization places greater emphasis on the relevance of technological change to political, economic, and social developments.

While I think it is important that you know about or have access to the sources cited above, I think it is fair to say they were not prepared with the day-to-day needs of high school teachers in mind. There is very little material of that nature but one significant exception exists. Educational Services, Inc. (ESI) at 55 Chapel Street, Newton, Massachusetts 02158, has developed materials for a 10th grade course on the Impact of Science and Technology. The three units of the course are concerned, successively, with:

1. An appreciation of the role of technology in history, using as an example the development of the steam engine from its invention to the version perfected by James Watt;

2. The effects of technological change upon social organization, as exemplified by the industrialization and urbanization of Manchester, England; and

3. The development and cultural effects of a great scientific theory, the Darwinian theory of Evolution by Natural Selection.

ESI has developed and tested a considerable body of special materials for classroom use in this project, and the first two units especially contain much History of Technology material for high school students (including an actual working model of the early 18th century Newcomen steam engine). You should write to ESI directly to learn the current state of this project and the availability of the materials.

Your letter did not mention what department of the school you teach in, so I don't know whether to assume you are a social studies teacher or possibly an industrial arts teacher. I think History of Technology could be introduced as relevantly into either department and other departments as well. For this reason, I think you will want to be aware of some current developments in industrial arts education and vocational-technical education. The projects or sources mentioned here do not concern themselves specifically with History of Technology; however, all of them are directed by individuals whose main professional concern is with the education of high school students. Many of them are especially concerned with those students not in college preparatory classes for whom History of Technology may have added relevance.

In vocational-technical education, quite a number of projects are underway in "pre-technical" education—that is, 11th and 12th grade programs to prepare students for occupationally oriented programs at two-year community colleges or technical institutes. Fortunately, there is a single source which will tell you about many of them. It is: Curriculum Programs in Action: Their Administration and Evaluation, which contains the proceedings of a conference on innovative programs in vocational-technical education. The conference was sponsored by the Center for Technological Education at San Francisco State College and the Center for Studies in Vocational and Technical Education at the University of Wisconsin.

If you are not an industrial arts teacher, you may not be familiar with some of the important centers of activity from which curriculum innovations are emerging. Among the most important, the following people and places would have to be included, though this is hardly an exhaustive list.

1. "The Industrial Arts Curriculum Project," Ohio State University, Columbus, Ohio (Edward R. Towers, Director).

2. "The American Industry Project," Stout State University, Menomonie, Wisconsin (Wesley L. Face and Eugene R. F. Flug, Co-Directors).

3. "Montgomery County-University of Maryland Industrial Arts Exhibit," Department of Industrial Arts, University of Maryland, College Park, Maryland (Dr. Don Maley, Chairman).

4. "A New Industrial Arts for Today's Schools," by Delmar W. Olson, Chairman, Department of Industrial Arts, Kent State University, Kent, Ohio.

5. "Dimensions for Exploration" and the course "Man and Technology" at the Division of Industrial Arts, State University College, Oswego, New York (Paul W. DeVore, Director).

The activities of Kent State and Oswego have a much greater focus on the historical dimensions of industrial arts education that the other three, but all have potential contributions to the teaching of History of Technology in high schools. One cautionary word may be in order here—in the popular press and among many scholars technology is often identified with engineering or "hardware" exclusively. This is understandable, but there are also biological and social technologies in which the "hardware" aspects are insignificant or trivial. For this reason, material from industrial developments can be extremely helpful in presenting History of Technology, but they should not be relied upon entirely.

Of course, one of the most important resources for high school teachers of history is the Summer Institute program sponsored by the U. S. Office of Education and conducted at many college campuses. To date, there have been no summer institutes specifically on History of Technology but we hope this situation will change in the future. One of the best ways to get an overall view of the Summer Institute programs is to read the evaluations of them which have been made under the auspices of the American Council of Learned Societies (345 East 46th Street, New York, New York). These are: "Teachers, History, and NDEA Institutes 1965" and "The 1965 History Institutes Revisited," prepared respectively by John M. Thompson and James Lea Cate. Should you wish to attend a Summer Institute, reading these reports beforehand might prove useful.

There are several programs in universities to know about should you want to undertake further study or simply to know where significant work in this field is going on at the present time.

The principal institutions with graduate programs in History of Technology are the Case Institute of Technology (now unified with Western Reserve University) and the University of Delaware. Case Institute has a doctoral program leading to a Ph.D. in History of Technology. The University of Delaware History Department has a graduate program in cooperation with the Eleutherian Mills-Hagley Foundation which awards the Hagley Fellowships to students seeking the M.A. or Ph.D. degrees with an emphasis on American Industrial History. The Hagley Museum is devoted to the industrial history of the United States and Hagley Fellows can gain considerable experience in museology.

While it does not function as a graduate training center, you should also know about the "Program on Technology and Society" at Harvard University. This program was established in 1964 by a grant from the International Business Machines Corporation, to "...undertake an inquiry in depth into the effects of technological change on the economy, on public policies, and on the character of society, as well as into the reciprocal effects of social processes on the nature, dimension, and directions of scientific and technological developments." In the

Fall, 1966, and Spring, 1965, issues of Technology and Culture, the program's director, Dr. Emmanuel G. Mesthene, has described its activities in some detail. While the program has no special involvement with the historical dimensions of technological change, its research activities bear directly on problems likely to concern you.

You should also be aware of the work of the Institute of Early American History and Culture which is made available through the University of North Carolina Press. While a number of its titles might interest you, Technology in Early America: Needs and Opportunities for Study by Brook Hindle is worth special note, since it constitutes a possible guide to future research as well as present activities in universities and elsewhere. You might also be able to use it in planning projects for your own students to undertake.

I think you will see from the above discussion that it is possible to introduce History of Technology in your classes, but it is also evident that you'll have to do a lot of "homework" yourself to assemble materials and plan class assignments. If you are willing to undertake this, the museums and historical societies in your own region would be a good place to look for help. Some of the larger museums in the country have rather extensive publication programs and special aids for classroom teachers. You can profit from an acquaintance with the publications of the Smithsonian Institution inWashington, D. C. and especially its Museum of History and Technology. The School Program of the Franklin Institute in Philadelphia has prepared a number of teaching aids which will be of interest to your local museums should they want to cooperate with you. The Museum of Science and Industry in Chicago has special orientation programs for teachers before they bring their classes to the museum and for a number of industries in the area they distribute quite excellent free literature to school teachers. Their material from American Telephone and Telegraph on Bell's early work on the telephone is especially noteworthy as something high school students can profit from. A related publication in this general area is The Chronicle of the Early American Industries Association. This periodical provides quite specific information concerning a wide variety of technological methods used in early America. It is available from the Association at Box 199, Williamsburg, Virginia 23185.

I hope that this letter will encourage you to begin using History of Technology materials in your classes, even though I have not been able to direct you to texts, workboods, and other instructional materials designed specifically for use in high schools. I think if you will go ahead to do some "pioneering" in this field, you will likely find a surprising number of useful resources in your area. There are quite a few restoration efforts in various parts of the country such as Williamsburg in Virginia or Deerfield Village in Michigan. Something like this in your area could be of considerable value. Businesses and industry will often give considerable help to teachers interested in the development of a technology important in the growth of the particular firm. And don't neglect the hobbyists. Antique auto collectors, railroad buffs, and other special interest groups are, in their own ways, "doing" History of Technology. Model making in these areas can often capture the interests and exploit the skills of your students. You will have to do much of the planning yourself, but I hope you will try to give your students a deeper appreciation of the technological changes bound to affect their lives. You and your students can benefit greatly from such an effort. Good luck.

Sincerely,

John Martinson
Co-Principal Investigator