0082-1

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0082-2

Curriculum Development Report

DISCOVERING SCIENCE AND TECHNOLOGY THROUGH AMERICAN HISTORY

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When Bruce Sinclair and Merritt Roe Smith took office as president and vice president of the Society for the History of Technology in 1987, one of their key priorities was expanding the audience for the history of technology. They chose a group of SHOT members to consider means of accomplishing this goal, and on behalf of the society that group applied for a curriculum development grant to the National Science Foundation (NSF), which was seeking curricula that would attract women and minority students to science, math, and engineering. We proposed that SHOT members work with middle and high school teachers to write an interdisciplinary curriculum aimed at bringing science and technology into social studies classrooms.

It has been six years since we submitted that grant proposal, and those of us involved in the project believe not only that we have devised a useful and sophisticated curriculum—a task we hope to persuade others to emulate—but also that we have learned important lessons about the nature of scholarship. The following report begins with a brief explanation of how curriculum development relates to other forms of historical scholarship and concludes with an introduction to the curriculum as it will be published.

The Collaboration

From the beginning the SHOT-NSF project has been collaborative in ways that scholars often idealize but rarely experience. Those involved included the SHOT members who took part in the initial brainstorming sessions—especially Susan Douglas and Roger Simon, who wrote drafts of the grant proposal; those who served as principal investigators—myself, Gail Fowler Mohanty, and Laurence Gross; SHOT officers who helped at every step of the way—particularly Alex Roland and Bruce

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Seely; consultants who attended our workshops and listened and talked respectfully to the participants—Carroll Pursell, Merritt Roe Smith, Gail Cooper, and Selma Thomas; the graduate and undergraduate students—primarily but not solely from Brown University—who took care of accounting, clerical work, and research; and of course the teachers and SHOT members who actually wrote the curriculum.[1] Bruce Sinclair provided the project's guiding intellectual force. Together we developed the ideas outlined in this report, a collaboration that served as the model for the cooperative process that produced the curriculum. I firmly believe that the fruitfulness and reward of collaborative effort was the most important lesson we learned.

At the outset our motivation, at least partially, was a matter of hubris—we *knew* that historians of technology had important ideas to share about the improvement of secondary school curricula; what we could not foresee were the contributions that those we would meet would bring to the project. The historians involved were forced to reconsider the ways they conceptualize their work; quite definitely we shared in the project's benefits.

In truth, we were quite unprepared for the professional and intellectual payoff. As scholars, we have traditionally aimed at two different audiences. We write for each other, on the pages of *Technology and Culture* and in the academic monographs we publish, and at the same time most of us earn our living explaining history to college students and museum goers. We believe that the two enterprises are mutually supportive. But could we push forward the bounds of knowledge by working to explain the history of technology to eighth graders? It turned out that we definitely could. During the development of the curriculum, we learned things about the social construction of technology and technological products, about the intersections of race and technology, and about technological change—important things that none of us knew before we started. We found that speaking to an audience of

[1]In addition to the principal investigators—Susan Smulyan, Brown University; Gail Fowler Mohanty, Slater Mill Historic Site; and Laurence Gross, Museum of American Textile History—these were Carolyn Goldstein, University of Delaware; Steven Lubar, National Museum of American History; Patrick Malone, Brown University; Sandra Norman, Florida Atlantic University; Robert Rosenberg, Thomas Edison Papers; Bruce Sinclair, Georgia Institute of Technology; Mark Etheridge, Rowland Hall–St. Mark's School, Salt Lake City, Utah; Carlita Kosty, Rayburn Middle School, San Antonio, Texas; Diane Rosenberg, The Park School, Baltimore, Maryland; Thomas Anderson, P. K. Yonge Laboratory School, Gainesville, Florida; Michael Hughes, Methuen High School, Methuen, Massachusetts; Alan Stauffacher, Monroe High School, Monroe, Wisconsin; William Rahr, Sammamish High School, Bellevue, Washington; Marilyn McClain, Palmetto Middle School, Miami, Florida; and Dick McQueen, Clayton Valley High School, Concord, California.

middle and high school teachers and students necessitated learning different skills (and entailed different headaches) yet brought intellectual rewards very similar to the rewards of teaching in our traditional settings. And this kind of scholarship yielded additional benefits as well.

In curriculum writing, one speaks to students through their classroom teachers, and their understanding of the material is essential. This brought the SHOT participants in the project into a novel form of collaboration with the middle and high school teachers who participated. Beyond this group, at national and regional conferences we met large numbers of people who also practice history, people who have interesting ideas about its nature and how it should be taught.[2] I do not want to romanticize the process of collaborative curriculum writing, for we often disagreed. There were fights between the historians and the curriculum specialists, between the college teachers and the middle and high school teachers. *They* wanted us to simplify everything, to come up with monocausal explanations, to specify exactly what each unit would teach students. *We* struggled to hang on to complexity; we feared that the act of writing down and testing students on concepts we had taught would mean simplifying so much that we would no longer be telling the truth. The arguments were fierce.

But so were the rewards. I first began to realize this when we presented some of our substantive materials to groups of social studies teachers and they showed genuine excitement. I came to understand that through this project, and projects like it, professional historians can reach out effectively to large numbers of young people—even more than read the labels in the National Air and Space Museum, more than take a professor's U.S. history survey at the largest state university in the course of an entire career. For example, at just one meeting, the annual meeting of the Texas Council for the Social Studies in 1992, we presented our ideas to some of the 3,000 wonderfully enthusiastic teachers who attended.

I feel as if I have discovered a new form of public history, one that reaches huge audiences, puts me in contact with new colleagues, and helps me to think about complex issues in the history of technology. This is work we should encourage each other to undertake, work we should value highly, work that SHOT should be ready to support. I hope, then, that "Discovering Science and Technology through American History" will be a pilot project for other collaborative efforts in history and pedagogy.

[2]Conferences at which we made presentations included annual meetings of the Texas Council for the Social Studies and the National Council for the Social Studies as well as the Focus on Teaching Day sponsored by the Organization of American Historians.

0082-5

The Project

"Discovering Science and Technology through American History" is a supplementary curriculum, innovative in both its content and development, that was funded by the National Science Foundation and initiated by SHOT in collaboration with a group of middle and high school teachers in social studies, science, and vocational education. The aim was to develop materials that bring science, math, and engineering concepts into the social studies classroom, and a primary goal is to interest women and all students of color in those subjects. The modular curriculum units focus on textile technology.

I write about this project with some degree of humility, as one participant among about twenty teachers. Some of us were experts in the history of technology, some of us were "master" teachers (in truth if not necessarily in title) with many years of experience in diverse classroom settings. Most came to the project with a genuine interest in learning from the others involved. I myself learned a great deal.

The curriculum is composed of eight independent units that examine the history of textiles, the technology and science used in their production, and their consumption. These units are titled (1) Preindustrial Clothmakers, (2) Early Industrialization, (3) True Colors: Dyeing in Three Centuries, (4) Cloth and Clothing during the Civil War, (5) The Queen of Inventions: Sewing Machines in Homes and Factories, (6) Modernizing Cotton, (7) Synthetic Fibers, and (8) Fashion and Style.

We chose to focus on textiles for several reasons. First, we believe that teenagers have a natural interest in clothing and textiles *and* that textile technology has played a crucial role in American industrial history. In addition, the process of cloth production has been based on important scientific principles from an early period (even when the producer did not clearly understand the underlying principles) and, in the last fifty years, science has revolutionized textiles and apparel. Because the textile and apparel industries have been central in the economy and in everyday life since the 17th century, the topic can be related easily to other areas of American history.

Every unit in this curriculum deals with some aspect of cloth or clothing production or use. The modules drop in and connect to the traditional American history course as taught in middle and high schools. On the one hand, teachers could select certain of the many activities offered within every unit or present some units and not others, or simply read the materials and integrate the concepts as they choose. On the other hand, in schools where it is possible, this curriculum could be a separate interdisciplinary course (semester or yearlong) either

introducing the history of technology or providing a new view of American history.

Pedagogy

We have sought to produce a content-rich curriculum that would include social, labor, women's, African-American, and ethnic history as well as the history of technology. The college professors and museum curators wanted to share the excitement we felt about these new materials and new approaches with other teachers and believed that the history of technology provides a unique way to explore these subjects. At the same time, we came to understand the severe constraints on the time and energy of teachers in middle and high schools. These two goals—to provide innovative, interesting, and sophisticated content without overburdening busy teachers—sometimes conflicted with each other. This curriculum will not be used by every teacher. We aimed at those who have both a great curiosity about history and the time to learn new material and ways to think about it.

As we worked, we became aware that social studies teachers take only a few history courses in college. We already knew it would be hard to make science and math accessible to historians, but we also found we needed to offer training in history. The teachers who worked on this project were themselves good, if mainly self-taught, historians, and they believed we could use this curriculum to teach teachers as well as to provide materials for students. "Teacher enhancement through curriculum development" remained a crucial concept for us. To this end, we included in each unit a "Teacher's Essay," written by a historian, which lays out the themes of the unit and the new ideas presented. We tried to make these pieces short (although we disagreed on what "short" was), accessible, and interesting. In addition, we included in each module a monograph, usually from an academic history journal. Along with the student essays and the document activities, we think these materials will help teachers learn, or remember, how historians think.

Material presented in the units often draws on a shared historical and scientific methodology that holds that examining a small piece can illuminate the whole. In both the scientific experiment and the historical case study, scholars look at one example in order to learn about a larger field. We have included both experiments and case studies. Students try their hand at dyeing (with chemicals and with plants), and, while we do not expect that they understand the chemistry involved, they learn that dyeing can take place in many settings and is difficult to control. They watch nylon being produced and realize that synthetic fabric is made from petroleum-based chemicals in a laboratory rather than from animals and plants grown on a farm. We ask them to think

about the implications of what they have learned for commerce and for everyday life. Social historians have often relied on the case study—examining a particular locality at a certain time—to understand the power relationships and ways of thinking that exist in the society as a whole. Our case studies include a will and a probate record from the 18th century that show how individuals valued their clothing and cloth-making tools, a play examining one community's response to waterpower issues in the early 19th century, and magazine articles from different eras that express concern over foreign control of dyestuffs.

At the same time that we rely on these methodologies, we also want to explore with students another idea—that any reduction is a distortion, that the scientist or historian who chooses the small part that stands for the whole in effect shapes our knowledge of what happened, and that looking at simplified pieces ignores the interactions, among the smaller studies and between the chosen examples and the whole, and so masks the complexity inherent in the natural and social worlds. To that end, we have often asked the student to serve as the engineer, the scientist, or the historian by designing new machines, imagining themselves as mill builders, conceiving of math problems, uncovering historical evidence (find out, say, why blue jeans are popular), or framing historical questions ("Why were there plantations in the South?" or "What can we learn from looking at machines?").

The units include a wide range of other activities tied to historical themes, most of which emphasize process over results, and all of which ask students to think in complex ways. The student exercises break down difficult historical concepts into simpler building blocks. We hope that teachers and students use the insights gained in several single activities to begin to construct a complicated vision of the past and its importance. Many of the activities center around historical documents and ask students to read, discuss, and comprehend the issues raised by these pieces of the past. We have not chosen the documents because they were "typical" (although they sometimes are) or because they perfectly illustrate our point (historians can rarely find such pieces of evidence) but because they *are* the messy reality of history. As with the science and math activities, we remain as interested in the process as the outcome. Students should understand that history, science, and math happen around them at all times; everyone can and does participate through the choices they make; right answers are difficult to come by and are not as important as understanding. Much of the material is interactive, but we never included anything just to keep students busy. Most of the materials ask students to think about history, math, and science in terms of their own lives, but we try to avoid a "presentist" view that sees the past only in terms of contemporary concerns.

0082-8

Unless social studies teachers are willing to integrate the math, science, and engineering material into their courses, the curriculum will fail. These activities present the biggest challenge to both the writers and the users of the curriculum. Interdisciplinary work is notoriously difficult to pull off. We included exercises that introduce students to math and science concepts without calling on specific knowledge or skills. In schools that have team teaching, these science and math activities should prove easy and rewarding to use. In other settings, social studies teachers might call on colleagues in the math and science (and home economics and vocational education) departments for help (both inside and outside the classroom), *but we want to emphasize that all of the exercises can be done and understood by people with no math or science training.*

I am most proud of the exercises that present engineering as problem solving. Using math concepts, spatial reasoning, and imagination, we ask students to think about machines as tools that help people solve problems and achieve self-defined goals. Students learn that machines are not handed to us with their uses built in, but that we design them and make choices about their use. We hope that girls, in particular, will notice that women have always used technology and possessed technological skills that could be used in engineering. Finally, by encouraging students to formulate their own questions and to improve problem-solving skills, we believe that such activities will build self-confidence. Such confidence remains especially important for students without a traditional science or math background and serves as a base for more learning in these areas.

History of Technology

The history of technology has been fostered by people who believe that this discipline helps us understand the past as well as the present, that how machines work matters, and that technology shapes our lives at the same time that people conceive and organize the technology. We study technology to understand how technological change happens and how it can be controlled; we reject the idea that machines each had to be designed or used in a particular way. By understanding the design and use of machines in the past, we can better understand the machines we meet everyday. A study of technology leads us to the people who interacted with technology—from inventors to workers to consumers, in fields, factories, or the home. Finally, technology has been used by those in power to extend their power, and we cannot ignore that dimension of the interaction between technology and society, especially in a curriculum that seeks to tell women and all students of color that they can become scientists and engineers.

Social historians are fond of reporting that history explains "change over time." When applied to the history of machines, this idea often leads to what historians term a progressivist view of technology. As we read that hand carding, spinning, and weaving gave way to fascinating power machines and we learn about efforts to make the machines work faster or more efficiently, it is easy to think that life, work, and civilization are improving. We hope this curriculum shows that each advance brought new problems; that there are countless technological dead ends and failures for every success; that technological change came about not only to increase productivity but to control workers; that while people sometimes welcomed new machines, often they resisted their introduction; and that technology both offers opportunities and restricts possibilities.

Themes in Textile Technology

As we worked on the curriculum, themes emerged that tied many of the modules together. We found ourselves interested in the nature of invention, how we could illustrate the relationship between race and technology, the importance of women and their work to textile technology, the character of work itself, the way people come to think about and use technology and its products, and the importance of industrialization within American history. These themes not only reappear throughout the curriculum; they are all interrelated as well.

Ideas about invention and innovation have been important in the history of technology. We asked the students to think about several questions. Why would anyone want to invent something new? How does one go about imagining a machine? Why did it matter who invented the cotton gin (or any other machine)? In many ways, ideas about invention lead naturally to an interest in gender because women have been seen as consumers of technology rather than inventors (despite the fact that many women have invented and suggested inventions without receiving proper credit). Is innovation valued and consumption devalued because men do one and women the other? Does running a sewing machine in a factory (or assembling or fixing a sewing machine) take less skill than inventing one? Women have skills in operating and fixing machinery, in spatial reasoning, in math and science, and yet they are not considered proficient in technological matters. We hope that by showing students that women have always used technology, we can convince them that women can enter any technological job.

We are proud that this curriculum has reconceptualized the history of technology to include issues of race, traditionally absent from the discourse. For example, we came to recognize that agricultural technology played a large part in the production of cloth. When historians of

0082-10

technology talk about textiles, they focus on factories, which have traditionally employed native white and immigrant workers. Racial prejudice kept African Americans working primarily on farms and in other kinds of factory jobs, and so historians have said that textile history lacked a racial component. We disagree. That factories contained few African-American workers deserves examination, as do those who benefited from their exclusion. Slaves produced yarn, cloth, and clothing on southern plantations even though this piece of history is often slighted in favor of stories about northern factories. Most important, though, we widened our point of view to include southern cotton production as part of textile history. So slavery, and later sharecropping, becomes an important part of the story of northern textile mills; African Americans become part of the history of technology; and technology becomes part of African-American history. Such an inclusionary view should help students of color imagine themselves, like their ancestors, as people who can use and control technology.

This curriculum is concerned with how machines work. We believe that most people find it fascinating (especially now when no one can program a VCR, let alone know how and why it functions) to examine a machine you can understand. The history of textiles has been extraordinarily well preserved, with entire museums devoted to it and examples of various machines and artifacts widely available in local historical societies. Through demonstrations, photographs, and videotapes, students and teachers can see exactly how the technology has operated at various times. One needs an understanding of the workings of machines as a basis for thinking about the interactions of people and machines. Further, understanding how one particular machine works can demystify technology and may give students confidence about understanding it.

When we talk about "how machines work," we mean not only mechanically but also socially and culturally. How do technology and its products come to have meaning within the society? The last unit (Fashion and Style) provides an example of how technology is "socially constructed." The introduction of Lycra and the response of the cotton industry gave new meaning to the terms "natural" and "synthetic," which seemingly come from scientific language and have appeared in other units. We ask students to think about what is fashionable, sometimes even what is sexy, and why, as well as how, that relates to textile technology.

When we talk about the relationship of people to machines, we examine the roles of both producers and consumers. Several units focus on the workers who made and used the machines. What was it like to

0082-11

run a specific machine, what level of skill was involved, and who usually performed the work? Interactions with machines happen in homes and fields as well as in factories, and we stressed this point as well. Our interest in labor history, as well as in the history of technology, brought us to the larger issue of industrialization as a process and as an economic system. We suggest that industrialization began earlier (and perhaps more tentatively) and continued more erratically and for longer than most textbooks indicate. The negative impact of industrialization on workers' lives, on the environment, and on our social, political, and cultural worlds gets a lot of attention. Industrialization made more and different products available for purchase, and the reaction of consumers to these new products also has a place in the history of technology. We discuss what was for sale in colonial stores, who bought sewing machines, and describe how Du Pont marketed nylon stockings.

In the end, we see history—of technology, of labor, of race relations, of women, of industrialization—as a series of conflicts and negotiations. Not until we recognize and examine those conflicts—among members of a group as well as between groups—can we understand why and how change occurred. This curriculum seeks to change how students, particularly women and all students of color, think about technology. We cannot ignore the fact that the relationship between women and minority groups and technology has been socially constructed and full of conflict. We hope that by looking at history as conflictual we will be able to give the students our own sense that things can be changed.

In the words of the original proposal,

> The Society for the History of Technology has become increasingly concerned about the dwindling interest among students in studying science and engineering in college, and about the lack of what has come to be called "technological literacy" among the general population. The Society believes these trends have potentially troubling social, economic, and political implications. Ignorance about science and technology contributes to the nation's inability to compete economically in international markets and compromises the public's ability to participate in, and be informed about, important political decisions.
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> No single project or strategy will by itself reverse this trend. However, one way to address the problem is to reach students in middle and high school and to persuade them that studying science and technology is not only intellectually possible for them, but also fun and exciting. SHOT is convinced that introducing students to these subjects through their historical contexts is an extremely promising way of demystifying science and engineering and of

0082-12

helping students to realize that machines can be understood and managed. Because the history of technology emphasizes how and why people designed and used technological processes over time, and challenges popular myths about technological determinism, SHOT believes that using the historical approach can be especially empowering to students previously intimidated by science and engineering studies.[3]

[3]Society for the History of Technology, "Discovering Science and Technology through American History," submitted to the National Science Foundation, July 1988, p. 17.