A shift in teaching methodology: From Instructor Led to Student Driven Multimedia Instruction

Patricia Ryaby Backer
San Jose State University

Abstract

Multimedia can be a powerful tool in exploring the nature of the world around us, including its technological systems. This paper describes the design, development, and evaluation of self-paced multimedia and web-based modules that are used in an advanced General Education (GE) course in the College of Engineering at San José State University. The design and development cycle of these modules began in 1994 and spanned nine years. The General Education course, Technology and Civilization (TECH 198), is designed to introduce students to the realm of history and usage of technology in society and to increase their awareness of both the uncertainties as well as the promises of the utilization of technology as a creative human enterprise. The goal of these multimedia modules is to have the students use technology as they explore its impact on our society over time. Although the web and multimedia materials were developed by one instructor, they are used by all instructors in this class in different ways. The continuous improvement of the multimedia is driven by the evaluation of the multimedia by students and other faculty. Each year, the multimedia and web-based modules are revised to reflect the evaluative input gathered from the various constituents (students and faculty). The evaluation process and the subsequent revisions of these materials have created a new type of resource analogous to an e-book but including a rich environment of video clips, audio clips, text, and graphics. Another shift is in the sharing of expertise. In the twice yearly meetings focused on course development, input from faculty content experts is integrated into the multimedia modules for the subsequent revision.

Introduction

In university settings, the field of technology has been expanded in the last ten years with courses that focus on the interactions of technology and society. These courses are presented in various ways; some focus on the ethics of technology while others take an artifact-based approach. In many cases, however, these courses expand technology to a greater student population through either General Education or as required courses in other disciplines. In broadest terms, these courses can be classified as science, technology, and society (STS) courses.

The Department of Aviation and Technology at San Jose State University (SJSU) has offered a STS course under the university's General Education curriculum since 1981. This course, *Technology and Civilization*, has been housed in three different General Education areas. It began as a course in the Social Sciences area and was categorized under Social Issues. In 1992, SJSU dramatically revamped their General Education (GE) program. GE was divided into lower

division GE, which a student could complete a local community college or at SJSU, and upper division GE, which had to be completed at SJSU. All the classes in the upper division GE had to be interdisciplinary and include an extensive writing requirement. *Technology and Civilization* was granted advanced GE status as a course in two Areas: Earth and the Environment and Cultural Pluralism.

SJSU revised the GE program again in 1998; this revision required that the university's Board of General Studies certify all courses. The focus was put on designing the courses to ensure that the students met the student learning objectives for the GE area. The general education program at San José State University[1] is different from many in the United States. Instead of specifying a specific series of courses as part of the General Education (GE) of each student, SJSU has five Core GE areas (Skills, Science, Humanities & Arts, Social Sciences, and Human Understanding and Development). In addition, every SJSU student must take Advanced GE courses in four areas: Earth & Environment; Self, Society & Equality in the U.S.; Culture, Civilization & Global Understanding; and Written Communication. Any department may propose a course for any area of GE. Beginning in Fall 2000, *Technology & Civilization* (Tech 198) was approved in the Advanced GE Area, Culture, Civilization & Global Understanding where it remains an approved course today. The department decided to move it from Earth & the Environment to Culture, Civilization & Global Understanding because the course no longer fit within the revised goals and student learning objectives of its original GE area. The preliminary development of these multimedia modules was described in a previous article.[2] This paper focuses on the ongoing assessment and development of this multimedia.

Design and Development of the Multimedia Modules

The design and development phase of this multimedia course spanned nine years, from June 1994 to August 2003. During this period, six distinct versions of the multimedia modules were created. The software used for this multimedia was Macromedia Authorware. At each stage of the development process, the modules were evaluated by all the faculty teaching the course as well as by students in the course. The significant changes and the evaluation for each version are discussed in the sections below. Figures 1 and 2 display the summaries of changes for each version of the multimedia.

Versions 1 and 2

The first two versions of this multimedia development could be described as exploratory. During these versions, the content of the multimedia was developed along with the navigational structure and the organization of the material. The most significant difference between the Units 1 and 2 multimedia related to the navigational structure. Unit 1 was primarily linear while in Unit 2 the information was chunked into sections and the navigation was between the sections of information. Students reading this multimedia could not go back to the previous sections nor could they continue until they had read all the parts of this section.

In contrast, students were given more control over the navigation in Unit 2. Students could move from one section to another and also they were given cues as to the amount of the content in each section.

Figure 1. Summaries of Changes for Unit 1. The nature of science and technology

Version	Major Changes
Version 1 November 1994	Six sections: What is Science and Technology, What is Scientific and Technological Literacy?, The Scientific Method, Attitudes Toward Technology, Technology Dependence and Technology Traps, and Impact of Technology on Society. Each section predominately linear, some contain a menu screen. All sections loop back to the menu screen. Limited student control over videos. Files named numerically. Each part contains a cumulating class activity.
Version 2 August 1999	Minor revision. Same basic structure as version 1. Added navigation pull-down menus. Changed fonts to sans-serif. Added student login to track information. Files given more descriptive names.
Version 3 Nov 2000	Redesigned color scheme and fonts. Added controls to all videos; controls allow students to pause, play, and stop videos. Redesigned class activities.
Version 4 June 2000	Seven sections: What is Science and Technology was divided into two sections: What is Science? And What is Technology? Completely redesigned the structure to follow the "look" and structure of Unit 2. Less linear, information is grouped into larger chunks with page numbers in each chunk. Added a new pull-down menu with option to view the text in each section as a text file. Revised the class activities and added a few links to web sites. Revised colors and fonts so that entire unit has a consistent color scheme. Recaptured all video clips at higher resolution and converted to QuickTime format. Changed all movie clips from movie icon to QuickTime media with control bar.
Version 5 May 2001	Minor revision. Same basic structure as version 4. Revised content of several sections.
Version 6 August 2003	Minor revision. Revised class activities and updated content

The first versions of Units 1 and 2 were used in lecture courses from 1994 to 1998 as presentation modules. During the summer session 1999, Version 2 was field tested in one section of the class with 14 students. The students were randomly assigned to two groups: Group 1 completed the multimedia module on Unit 1 (The Nature of Science and Technology) and Group 2 completed the multimedia module on Unit 2 (Technology and Work). The summer session was organized into a one-week class with eight hours of class each day. Day 1 of the class was devoted to Unit 1 and Day 2 of the class was devoted to Unit 2. On their randomly assigned multimedia day, the students were sent to a computer laboratory where each student was assigned a computer and given a CD-ROM. They stayed in the computer laboratory and

completed the multimedia. In lieu of their "regular" classwork, they completed the online class activities at the end of each section of the multimedia and submitted these to their instructor.

Figure 2. Summaries of Changes for Unit 2. Technology and work

Version	**Major Changes**
Version 1 June 1995	Three sections: History of Technology and Work, Nature of Work in the 20th Century, and How does Technology Affect the Workplace? Each section contains a menu screen. All sections loop back to the menu screen. Less linear, information is grouped into larger chunks with page numbers in each chunk. Navigation pull-down menus. Added student login to track information. Files named numerically. Each part contains a cumulating class activity.
Version 2 August 1999	Minor revision. Divided into four sections. The History of Technology and Work section was split into two files: The Industrial Revolution and Industrialization of Society. Same overall content structure as version 1. Added student login to track information. Files given more descriptive names.
Version 3 November 2000	Reorganized completely and divided into eight parts: The Industrial Revolution, Industrialization of Society in the 19th Century, Workplace of 1900, Scientific Management, The Development of the Assembly Line, Consumerism in the West, Nature of Work Today, and How Does Technology Affect the Workplace? Added Previous Section and Next Section buttons to all content chunks (allows students to reread a section without restarting from the beginning). Added more content to the sections. Added controls to all videos; controls allow students to pause, play, and stop videos. Changed font. Redesigned class activities. Added additional video clips. Recaptured all video clips at higher resolution and converted to QuickTime format.
Version 4 June 2000	Minor revision. Added a new pull-down menu with option to view the text in each section as a text file. Revised the class activities and added a few links to web sites. Revised colors and fonts so that entire unit has a consistent color scheme. Changed all movie clips from movie icon to QuickTime media with control bar.
Version 5 May 2001	Minor revision. Revised content in two sections: Nature of Work Today and How Does Technology Affect the Workplace?
Version 6 August 2003	Minor revision. Revised class activities and updated content

All the students were given pretests for both Units 1 and 2 before either class instruction or multimedia instruction began. On the last day of class, the students were given the posttests for both units. The pretest and posttest for Unit 1 (The Nature of Science and Technology) had eight questions that were selected by faculty teaching the course as representative of the information

covered in the unit. The pretest and posttest for Unit 2 (Technology and Work) had 11 questions also selected by faculty.

Students in the two treatment groups had an equivalent mean age (27 years) and similar amounts of time reported as spent on computers each day (3.09 hours/day for Group 1 versus 2.95 hours/day for Group 2). In performance, the two treatment groups appeared to be distinctly different. Based upon the ANOVA for Unit 1, there was no difference in student performance when comparing the multimedia-based instruction with the traditional classroom instruction. The students taking the multimedia-based instruction for Unit 1, in fact, did worse on the posttest than those students in the traditional classroom. However, since the students in Group 1 had consistently worse overall performance than students in Group 2, this result is inconclusive. The results from Unit 2 were different than those of Unit 1. The results showed that both groups had significantly higher scores on the posttest than on the pretest. An ANOVA comparing the pre- and posttest scores showed an F value of 39.84 ($p < .001$). As for Unit 1, Group 2 (the students taking the multimedia for Unit 2) performed better on the posttest than did Group 1 although the difference was much less (M=7.7 for Group 1; M=8.4 for Group 2).

The qualitative evaluation of the multimedia modules was examined to see if there were any commonalities that indicated why the Unit 2 multimedia was more successful. Ten of the 14 students completed a qualitative evaluation of the multimedia modules. All 10 students liked the multimedia modules for the class. As one student stated, "I liked the video interactions, they allowed me to comprehend the material better." Another student noted, "I found the multimedia portion of this class to be very impressive. I really enjoyed the freedom and convenience of the CD ROM. The content allowed me to gain specific knowledge on specific subjects that I would not have otherwise known about." Overall, the students taking the Unit 1 multimedia found they had a harder time navigating through the material. Since Version 2 of the Unit 1 multimedia presented the material in a linear fashion, the students did not know where they were in the course of the lesson. Also, they noted that it was difficult for them to review previous material. The students who took the Unit 2 multimedia complained about the amount of material in each section.

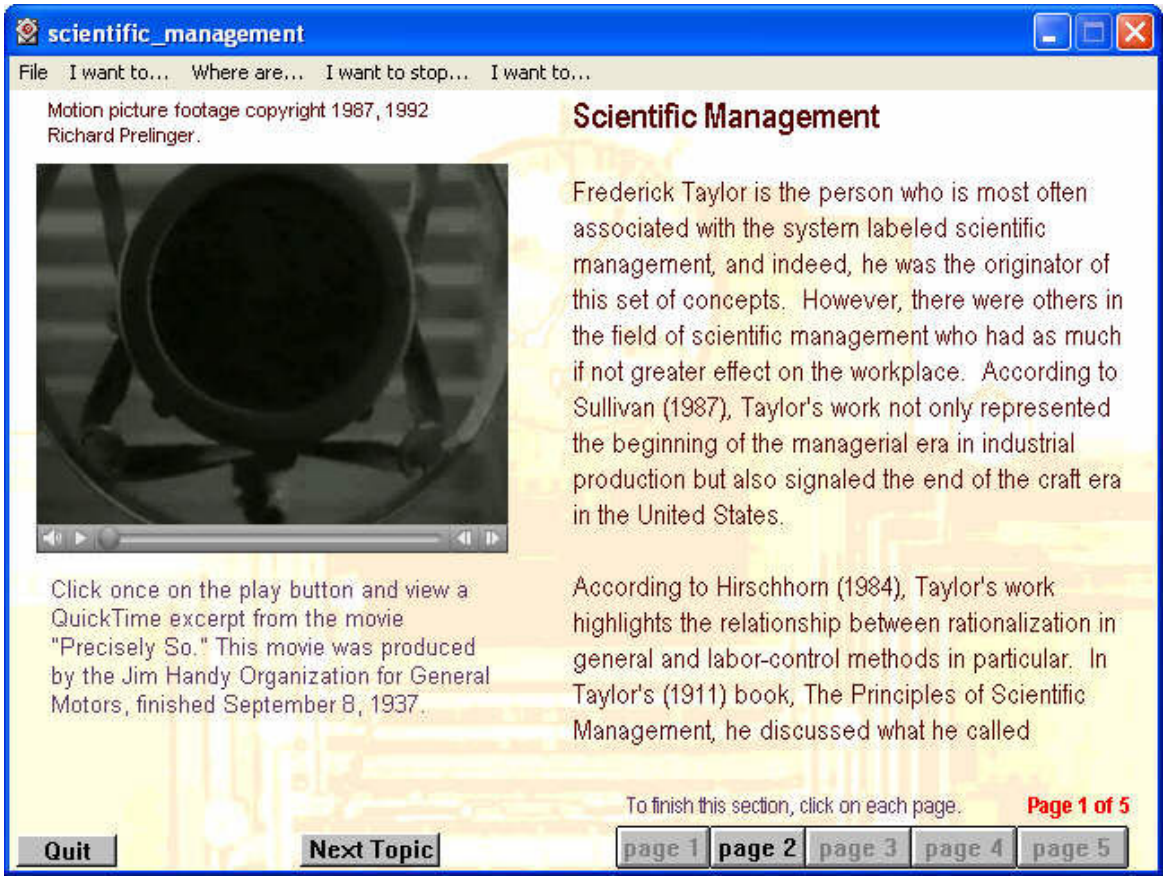
Version 3

Overall, there appeared to be several issues related to two multimedia design issues: navigation and narrative structure. To increase student control of the learning environment, controls were added to all video clips in both Unit 1 and Unit 2 that allowed students to pause, play, and stop videos. Also, each section in Unit 1 and Unit 2 included a class activity at the end so that the students could achieve closure on each topic.

It was evident from the qualitative and student outcomes that the navigational structure of Unit 2 was better than that of Unit 1. However, a problem still existed with the narrative structure. Because the information was not presented in a clear, organized manner, the students' learning was adversely affected. As Laurillard[3] pointed out in her research, "learners working on

interactive media with no clear narrative structure display learning behaviour [sic] that is generally unfocused and inconclusive" (p. 231). The chunking of information is interlinked with the narrative structure of multimedia. Because the teacher-storyteller is remote from the student-listener, the design of the multimedia and the chunking of its content need to be more robust.

Figure 3. Screenshot of "Scientific Management" in Section 4 (Scientific Management) of the Unit 2 (Technology and Work) multimedia



At this time, it was decided to complete a structural change of Unit 2 to address both the issues of chunking and narrative structure before making any substantive revisions to Unit 1. The three existing sections of Unit 2 were reorganized completely and divided into eight parts: The Industrial Revolution, Industrialization of Society in the 19th Century, Workplace of 1900, Scientific Management, The Development of the Assembly Line, Consumerism in the West, Nature of Work Today, and How Does Technology Affect the Workplace? The content in each section was revised so that the students could reread a section without restarting from the beginning. Figure 3 displays a screenshot from the Version 3 of the Unit 2 multimedia module. This reorganization provided a better narrative structure and, at the same time, increased learner

control. As Steinberg[4] found, increasing learner control can make the learning experience more motivating as well as increase student learning.

Version 3 was used in the Winter 2001 class as a replacement for the in-class instruction. Since all the students in the class used the multimedia modules, their performance was compared with a previous Winter 1999 class (taught entirely in a "traditional" lecture mode). The Winter 2001 class (M=84), on average, achieved higher grades on the final exam than did the Winter 1999 class (M=78), but the results were not significant. Overwhelmingly, the comments were positive about the multimedia modules. There was one significant student suggestion for this version of the multimedia. The students wanted the ability to print out the text easily. (Since this multimedia was constructed using Macromedia Authorware, students could not "cut and paste" the text on the screen as they were accustomed to doing on the Web.)

Versions 4 and 5

Version 4 was the last major revision of multimedia modules for Units 1 and 2. The work for this revision centered on Unit 1. Based upon the feedback from Version 3, Unit 1 was completely redesigned to follow the "look and feel" and structure of Unit 2 (see Figure 4). The new Unit 1 was less linear and the information was grouped into chunks with page numbers in each chunk. The existing six parts for Unit 1 were re-divided into seven sections: the old section *What Is Science and Technology?* was divided into two sections: *What Is Science?* and *What Is Technology?* Also, all the video clips for both units were recaptured at higher resolution and converted to QuickTime format in Unit 1. A new pull-down menu was added with an option to view the text in each section as a text file. (This was done to address students' complaint that they could not easily print the text.) Also, the class activities were revised and a few links to Web sites were added. All the movies in both units were changed to allow student use of a standard Quicktime control bar. The multimedia was ported to the Macintosh platform so that students could use either a Windows or MAC computer to view the material.

Beginning in the Fall 2000 semester, all instructors in all sections began to use the multimedia modules in their classes. Most of the instructors used the multimedia as self-paced learning while other instructors used the modules as a supplement to in-class discussion sessions. Since all of the instructors used the modules, there was a greater amount of feedback from both the instructors and the students. This dissemination created additional challenges for the instructor and author (who also served as the course coordinator). As Zirkle and Ourand[5] found, teaching a course through multiple delivery formats, in this case multimedia as well as lecture, requires new expertise on the part of faculty. During the Fall 2000 semester, there were several technical issues that needed to be resolved with various faculty. As faculty experience with the multimedia increased each semester, there were fewer problems and less faculty anxiety about using these modules as an integral part of their class.

Figure 4. Screenshot of "The Western Scientific World View" in Section 1 (What is science?) of the Unit 1 (The Nature of Science and Technology) multimedia

Version 6

The last revisions of the Units 1 and 2 multimedia modules, Version 5 and 6, were minor and focused on updating and revising the content in several sections. There were two additional units designed during version 6: a new web-based unit on the history of technology and a new multimedia-based unit on Technology and Gender Issues. This change was driven by a change in the SJSU GE guidelines. Under the old GE Guidelines, Tech 198 was listed under Area R, Earth and the Environment. The department decided to move it from Area R—Earth & the Environment to Area V—Culture, Civilization & Global Understanding because the course no longer fit within the revised goals and student learning objectives of its original GE area. The newly approved Fall 2000 version of this course had seven units: Unit 1—The nature of science and technology, Unit 2—The History of Technology, Unit 3—Technology and Work, Unit 4—Technology and Gender Issues, Unit 5—Technology Transfer, Unit 6—Quality of Life Issues, and Unit 7—Ethics.

Figure 5. Sample Class Activities from the Unit 3 (Technology and Work) multimedia

Unit 3 Multimedia Class Activity Two (from *The Industrialization of Society in the 19th Century*)

Karl Marx saw the new industrialized factory as different from the workplaces that had existed previously. In particular, he noted three trends in these new factories: deskilling, powerlessness, and degradation of workers.
1. Describe each of these three trends seen by Marx (deskilling, powerlessness, and degradation of workers).
2. Based upon your study of the history of the workplace, was Marx correct in his assessment? Please give specific examples to illustrate your response.

Unit 3 Class Activity Three (from *Workplace in 1900*)

Watch this video. (1) List the differences in the work environment shown in this film as compared to work today. (2) In general, what are three major differences between the workplace of 1900 and today's manufacturing plants.

Unit 3 Class Activity Four (from *Scientific Management*)

In order to better understand the effect of scientific management, we are going to look at an pamphlet related to scientific management from 1922. To read the pamphlet, click on its title below. The pamphlet will appear in a separate window. After you are finished reading the article, answer the questions at the end of the article. This response should be sent to your instructor by EMAIL.

"You and your laundry", by Mrs. Christine Frederick
CREATED/PUBLISHED
New York, Chicago [etc.] The Hurley machine co., c1922.Questions for this reading
Your goal is to critically analyze this excerpt from 1922. In your analysis, you must specifically address the following points but please feel free to address other issues.

1. How does this excerpt relate to Taylorism or scientific management?
2. What are the indirect and direct objectives of this essay? What sections of this essay speak to this issue?
3. What message is this pamphlet giving about gender roles and technology?
4. Considering that this article was written in 1922, what does this article tell you about its era?

Both existing multimedia modules were assessed by both content experts and by using embedded questions in each unit. These embedded questions were directly linked to the Learning Objectives for SJSU's GE Area V. For example, Learning Objective 2 for SJSU's GE Area V is: *Students shall be able to identify the historic context of ideas and cultural practices in their dynamic relations to other historical contexts*.[1] Several sections of the Unit 3 multimedia (Technology and Work) use embedded questions to address this learning objective: The Industrial Revolution (Section 1), The Industrialization of Society in the 19th Century (Section 2, Workplace in 1900 (Section 3), and Scientific Management (Section 4). All students in all sections of this class complete the Unit 3 multimedia. Figure 5 displays the sample class activity questions that each student answers in the Unit 3 multimedia. Every year, the faculty teaching this course use the student outcomes from this embedded assessment to revise the course content and decide on the changes that should be made in both the multimedia modules and in the other parts of the course.

Web-based History of Technology unit. The web-based unit on the history of technology was part of a re-conceptualization of this course as a hybrid (self-paced multimedia/Web/in-class) delivery model. When completed, four of the units would be delivered through self-paced multimedia CDs, one would be a web-based unit, and two (Ethics and Quality of Life Issues) would be delivered in a traditional classroom mode. The department faculty had committed to retaining the two in-class units so as to provide more active learning and open-ended inquiry for the students. The key issue for all the self-paced modules was their effectiveness in promoting student achievement of the course's learning objectives. Although this web-based unit was developed by the course coordinator, four other faculty regularly taught this course and all faculty used both the multimedia CDs as well as this web-based unit. It was critical to the success of this web-based unit that all faculty could feel secure in using it in their classes.

The introduction of a new unit on the history of technology enhanced the content of this course in many ways. First, this unit addressed the contributions made by people of different cultural groups. Second, this unit, since it was positioned between the existing Unit 1 (The nature of Science and Technology) and Unit 2 (Technology and Work), provides a stronger historical context to this course and subsequent discussions of technology and society.

Originally, the plan was for this new unit on the history of technology to also be developed as a multimedia CD. This plan was changed early in the development cycle. The two existing units make extensive use of video clips as an adjunct to the content in the course. However, since the history of technology module was designed to focus on the history of technology prior to the Industrial Revolution, there were fewer video clips available. Therefore, the development shifted to a web-based delivery system.

The old version of *Technology and Civilization* course began its historical view of technology and science in the Renaissance in Europe. Since technology is much older than modern science, this approach has limited the ability of students to see technology as a precursor to science. The expansion of this course to include a study of technology and culture in the Middle Ages

enhanced both the students' knowledge as well as increase their understanding of the inter-relationships between technology and culture. The new unit on the history of technology also was designed to utilize the SJSU image database of art and cultural images[6].

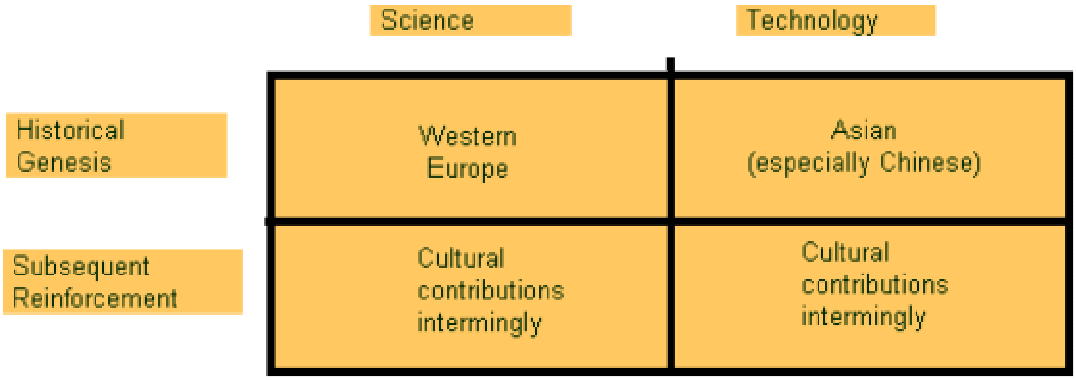
As Tech 198 is now approved under SJSU's Area V (Culture, Civilization & Global Understanding), this course was required to meet the Area Goals and several learning objectives of Advanced GE Area V. This unit was designed to particularly address one of the Area Goals—"Students shall be able to identify the historic context of ideas and cultural practices in their dynamic relations to other historical contexts." In this course, technology is the form of human expression (or ideas) studied. This new web-based unit on the History of Technology focused on how technology developed over time in three different cultures and had three distinct sections: *Technology in the Middle Ages*, *Islam Spain and the History of Technology* and *Chinese Contributions to Technology*.

Each section of this web-based unit was structured in the same way. The first part presented a historical context for the section. This introduction, although not comprehensive, was designed to assist students without a background or appreciation of history. After reading these background history sections, the student should have an understanding of the economic, political, religious and intellectual environment of China, the Islamic world, or the Middle Ages in Europe. The history section linked to existing history materials on the WWW including materials at the University of Calgary[7], Western New England College[8], CUNY-Brooklyn[9], and the Internet History Sourcebooks Project[10].

The remainder of each section focused on selected technologies and the history of their development and use. The section on "Technology in the Middle Ages" explored various technologies that were developed during the Middle Ages in Europe. This section focused on technologies that appear to be natively "European." The study of medieval technology was divided into six sections: Agricultural Tools, The Harnessing of Time, The Use of Iron on the Middle Ages, Weaving and the Textile Industry, and Building Construction. The content of this section was written by the author and included links to other medieval resources on the WWW including The Medieval Technology Pages[11], the Online Resource Book for Medieval Studies[12], and the Internet Medieval Sourcebook[10].

The section "Chinese Contributions to Technology" focused on the many Western innovations that have their basis in China, particularly those in printing (paper, block printing, and moveable-type printing), agricultural technology (irrigation systems), mechanical engineering (clockwork, iron, and lead manufacturing, efficient harnesses), and martial (gunpowder, the precursors to the barrel gun, and cannons) technology. The web-based tutorial used Needham's comprehensive work on China[13] as its basis (see Figure 6). Needham[13] sees the bottom two compartments are being able to take achievements from non-Western cultures. In the case of scientific development, Needham notes many Asian accomplishments which preceded Western developments; however, many times without directly building on them.

Figure 6. Needham's[13] conceptualization of the historical genesis and further developments in Science and Technology, comparing Western Europe to Asian contributions.



The last section, "Islam Spain and the History of Technology," presents the contributions of the Islamic world to modern science and technology, both through the discoveries by Muslim scientists as well other knowledge that was transferred to Europe from other cultures (through Islamic Spain) including the Greeks, Persians, Indian, and Chinese. The Muslims synthesized, elaborated, and transmitted this knowledge to Spain; and eventually, to the entire Western world. In Western Europe at this time, most of the knowledge of the Greeks was lost. It was only through the transfer of Greek knowledge (including Aristotle's philosophy, Ptolemy's geography, Hippocrates' medicine) by Islam Spain that this information ever got to Western Europe.

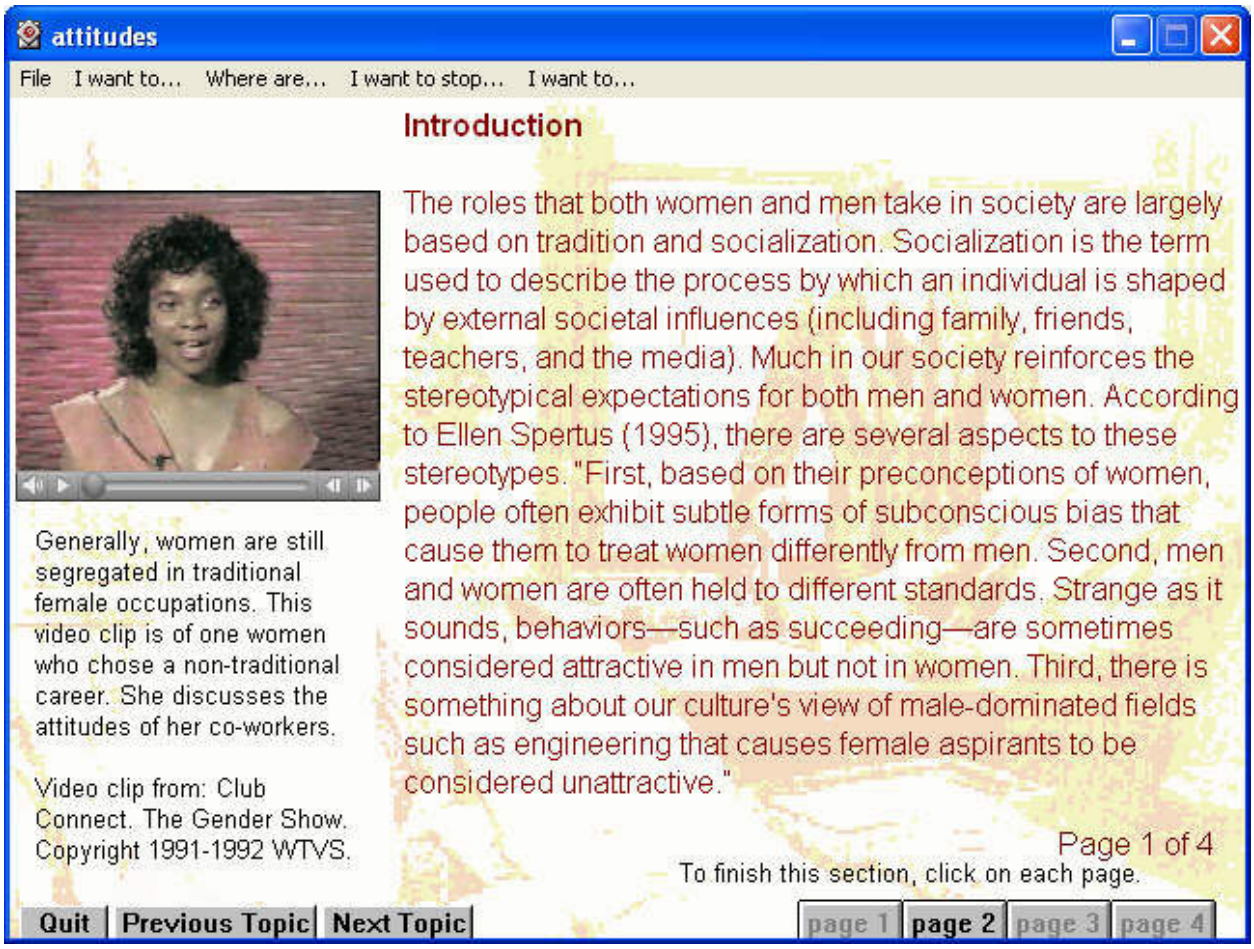
This section was structured in a slightly different way than the other two sections. After the introductory section on the History of Islamic Spain, the author included a section that described Muslim contributions to science and technology in a historical context. This section was added after a review by focus groups concluded that there needed to be a more explicit link between the development of scientific and technological knowledge and the history of both Western Europe and Islamic Spain. Students in this course tend to think of modern science and technology beginning with the Renaissance in Western Europe—they often do not have the historical knowledge as to how most of this knowledge was transmitted to Western Europe. In the remainder of this section looked at specific scientific innovations and technologies that were transferred to Western Europe through Islamic Spain and was divided this into three sections: mathematics, astronomy, and chemistry and medicine.

Each section of this web-based unit was designed to maximize the use of digitized primary source materials. These primary materials included art images such as Picture Arabic Book of Simple Drugs from Dioscorides' Materia Medica (Creation Date: c. 1334), a photo of the Astronomical Clock from Lyon Cathedral in France (Creation Date: 1383), and The earliest printed book found in China (Creation Date: 868). This web-based unit also contained links to text-based sources on the Web. One example, which was included in the historical introduction to the role of Islamic Spain in science and technology, had a link to three different accounts of

the Battle of Tours in 732 (http://www.fordham.edu/halsall/source/732tours.html). Several text primary sources were obtained from the Medieval Sourcebook[29] including a 12th century agreement on profit-sharing in a silver mine and a 13th century account of the effect of war on the woolen trade between Florentine and Flemish merchants and England. Other primary texts were obtained from the Chinese Culture web site at CUNY[9]; one example used in the web-based unit is The Art of Printing (late 16th Century CE) by the Western priest, Matteo Ricci, in which he describes the process of block printing in China.

At the end of the three sections, students were required to answer one class activity. In contrast to the class activities on the multimedia CDs for the first two multimedia CDs, the history of technology class activities was more complex and required that the student synthesize various sources to support their position. The online history of technology web tutorial is available at http://www.engr.sjsu.edu/pabacker/history/.

Figure 7. Screenshot of "Introduction" in Section 3 (Attitudes of, and about, women in technology) of the Unit 4 (Technology and Gender) multimedia



Multimedia Unit on Technology and Gender. In Summer 2003, the author received a SJSU College of Engineering Teaching Excellence Fund Award too develop the multimedia module for Unit 4, Technology and Gender. The new Unit was designed to follow the "look and feel" and structure of the other multimedia units. The five sections for Unit 4 are *Technology and Gender*; *Women at Work before 1900*; *Women at Work, 1900 to today*; *Attitudes of, and about, women in technology*; and *Gender-based technologies*. Figure 7 displays a screenshot from the third section of the Unit 4 multimedia.

The multimedia unit Technology and Gender was used in all sections of the Tech 198 course beginning in Fall 2003. The department has begun to collect feedback from students and instructors on this module and the content will be revised in Summer 2005.

Conclusion

The development process of multimedia modules for a GE course at SJSU was very long and complex and spanned nine years and six separate versions. When first proposed in 1994, the process was envisioned as a one-year project. However, there were many twists and turns along the way. Because of the nature of multimedia, there is the expectation that changes in multimedia material will happen frequently. These changes, whether small or large, can be very time consuming. For example, the relatively small change to add a pull-down menu to allow students to print the text (made in Version 4) took six weeks because of the number and size of the multimedia files.

The original development of the first version of the multimedia modules took longer than had been estimated. Also, there was a significant time gap between the publication of Versions 1 and 2. This delay can be attributed to several factors—fatigue with multimedia being the primary one. This factor is infrequently mentioned in the literature. It takes an extraordinary amount of time to develop fully functional multimedia modules. Another cause for the time delay between versions was a university restructuring of the GE program—this multimedia project was put on hold until the class was recertified for GE. A consistent time constraint existed throughout the life of this project. The author is a professor a teaching institution where the course load is typically four different classes each semester (12 units). This heavy teaching load reduced the amount of time available to work on the multimedia modules during the academic year.

Since the first version of the multimedia was published, there has been more research that has indicated the importance of good interface design in the context of learning (Maddux, Johnson, & Willis[14], Shneiderman[15]). Brown[16] called visual and design principles the forgotten partner in multimedia and Web development. As was learned the hard way through the student feedback to Versions 1 and 2, bad design and organization increases confusion in learners and causes them to "get lost."

Most developers of multimedia assume that media-rich technologies help students form a deeper understanding of the material (Bayne & Land[17]). The qualitative and quantitative evaluations

conducted over the past few years show that this is almost always the case (Backer[18, 19]). The multimedia is "self-paced" and "empowering," to quote two of the students surveyed, but it also behaves in unexpected ways. Students bring their existing worldviews and perspectives to their learning experience, and a multimedia learning environment does not give them the cues they are accustomed to from their professors. This is one reason that this course is a hybrid course rather than a multimedia-only course. A hybrid course balances multimedia learning with discussion sessions with students. This structure allows the students to interact with each other and the instructor about the content and solves many problems inherent in self-paced instruction including high dropout rate, student lack of focus, and difficulty in integrating the presented information into personal knowledge structures.

Most of the existing research shows that there is no significant difference in student achievement using multimedia as compared to "traditional instruction" (see Russell[20] for a review). Therefore, the debate should change to focus on increased access to education. Self-paced multimedia and Web-based courses give more access to more learners. The use of these CD-based modules has allowed students to have more flexibility in completing their GE requirements. This is only one of two advanced GE courses in the College of Engineering at SJSU; therefore, this method of providing instruction provides more options and more flexibility to students in the completion of their GE requirements.

Beyond the effect on the curriculum at SJSU, this mode of delivery provides an opportunity for all STS courses. In this course, these multimedia modules seek to explain the nature and history of technology by using technology. The direct purpose is to provide in-depth course content for all instructors of this course. Indirectly, these modules give students the experience of using advanced technologies to learn about the nature of technology. Although the dichotomy is not directly stated in the multimedia materials, most students comment on the indirect messages about technology and their additional experiences, in this course, with technology as a learning medium.

The multimedia and web-based modules have been used in the class by eight different instructors since Fall 2000. All instructors use the web-based Unit 2 (History of Technology), the CD multimedia Unit 3 (Technology and Work), and the CD multimedia Unit 4 (Technology and Gender) in their classes. All but one instructor uses the Unit 1 (The Nature of Science and Technology). Based upon the feedback from students and instructors over the past four years, these instructional modules are considered a success.

The extensive use in all class sections of short essay class activities in these multimedia modules show the students' abilities to integrate their learning into their lives. There have been long-standing claims in the research literature that students learn faster and retain more information the more they are involved in the learning process (Liu & Hsiao[21], Royer & Royer[22]). Therefore, the more students interact, the more they will learn. From a theoretical perspective, Hamilton[23] saw the curriculum as a process that should not separate what is learned from how it is learned. This duality is the fundamental identity of multimedia.

Since this class has continuous assignments for students, each week they must write about these topics. Our surveys show that students enjoy the self-paced multimedia modules for Units 1 through 4 and their answers to the class activities in these units (20 in total) show an understanding of the SJSU GE Learning Objectives. This course is structured to measure assessment by student achievement of the learning goals for Area V of SJSU's GE program. At the end of each semester, every instructor submits an assessment report to the course coordinator that describes how the student learning goals were measured and how many students met each learning goal.

For the department, the use of these multimedia modules ensures consistency in this course. In essence, the multimedia developer (who also serves as the course coordinator) provides the "lecture instruction" to all sections of the class each semester through the medium of the multimedia. Also, since most of the class activities in the multimedia require essay writing, this helps the department meets its GE writing goal for this course. For the other faculty teaching this class, the use of the multimedia reduces their workload. If they wish, they do not have to meet their classes for approximately 65% of the semester. These instructors are only required to grade the class activities that the students submit. Since SJSU is a teaching institution where faculty members normally teach 12 WTUs, this reduction in workload is significant for the individual instructor. The instructor can then use the "free time" to undertake their scholarly and professional activities. For the instructor, the use of multimedia allows them to provide one-on-one instruction to their students while decreasing their workload. Considering the increased expectations of faculty, this reason alone might be sufficient for using multimedia in instruction.

As more universities consider adding STS courses to their curriculum, the delivery of these courses through multimedia can add depth to the story they are telling about the relation of technology to society. By using the Web and multimedia, student experiences can be enhanced and students can get a richer, more complex view of technology and its effects on our world.

Bibliography

1. San José State University. (1998, Spring). *General education program guidelines*. Retrieved May 15, 2003 from http://www.sjsu.edu/ugs/ge/geguidelines.html
2. Backer, P. R. (2004). Using multimedia to teach a class on Technology and Society, *Journal of Technology Studies*, *30*(2), 70-79.
3. Laurillard, D. (1998). Multimedia and the learner's experience of narrative. *Computers & Education, 31*(2), 229-242.
4. Steinberg, E. (1989). Cognition and learner control: A literature review, 1977-88. *Journal of Computer-Based Instruction, 16*(4), 117-121.
5. Zirkle, C., & Ourand, D. B. (1999, October). *Teaching a course through multiple delivery systems: Some lessons learned*. Paper presented at the Indiana Postsecondary Education Conference, Muncie, IN. (ERIC Document No. ED 435 800)
6. SJSU Digital Art WORLDART Web Database (2002). Available: http://worldart.sjsu.edu/ [2002, June 24].
7. The Applied History Research Group (1997-2001). Multimedia History Tutorials. Available: http://www.ucalgary.ca/applied_history/tutor/ [2002, June 24].

8. Rempel, G. (2000). Lectures for western civilization. Springfield, MA: Western New England College. Available: http://mars.acnet.wnec.edu/~grempel/courses/wc1/lectures.html [2002, June 24].
9. Halsall, P. (Ed.) (1999). Chinese Culture. Brooklyn, NY: CUNY. Available: http://academic.brooklyn.cuny.edu/core9/phalsall/index.html [2002, June 24].
10. Halsall, P. (Ed.) (1998). Internet History Sourcebooks Project. New York: Fordham University. Available: http://www.fordham.edu/halsall/ [2002, June 24]. There are three Internet sourcebooks: Internet Ancient History Sourcebook, the Internet Medieval Sourcebook, and the Internet Modern History Sourcebook
11. Gans, P. J. (1999). The Medieval Technology Pages. New York: New York University. Available: http://scholar.chem.nyu.edu/technology.html [2002, July 2].
12. ORB, Online Resource Book for Medieval Studies (1999). Available: http://orb.rhodes.edu/ [2002, July 2]
13. Needham, J. (1993). Poverties and triumphs of the Chinese scientific tradition. In S. Harding (Ed.), The "racial economy" of science (pp. 30-46).Bloomington: Indiana University Press.
14. Maddux, C. D., Johnson, D. L., & Willis, J. W. (1997). *Educational computing: Learning with tomorrow's technologies* (2nd ed.). Needham Heights, MA: Allyn & Bacon.
15. Shneiderman, B. (1997*). Designing the user interface: Strategies for effective human-computer interaction* (3rd ed.). Menlo Park, CA: Addison-Wesley.
16. Brown, I. (2000). The forgotten partner: The role of visual, graphic and design principles in educational multimedia course instruction. In J. Bourdeau & R. Heller (Eds.), *Proceedings of ED-MEDIA 2000* (pp. 123-126). Charlotteville, VA: Association for the Advancement of Computing in Education.
17. Bayne, S., & Land, R. (2000). Learning in the Labyrinth: Hypertext and the changing roles of instructor and learner in higher education. In J. Bourdeau & R. Heller (Eds.), *Proceedings of ED-MEDIA 2000* (pp. 65-70). Charlotteville, VA: Association for the Advancement of Computing in Education.
18. Backer, P. R. (1995). Technology and civilization: A multimedia course. In T. Sechrest, M. Thomas, & N. Estes (Eds.), *Proceedings of the ICTE 1995 conference* (Vol.2, pp. 566-568). Arlington, TX: International Conference on Technology and Education.
19. Backer, P. R. (2000). Effectiveness of a multimedia general education course. In *2000 ASEE Annual Conference & Exposition Proceedings*. Washington, DC: American Society for Engineering Education. Retrieved May 15, 2003 from http://www.asee.org/conferences/search/20184.pdf
20. Russell, T. L. (2000). *The no significant difference phenomena.* Raleigh, NC: Office of Instructional Telecommunications. Retrieved May 15, 2003 from http://nt.media.hku.hk/no_sig_diff/phenom1.html
39.
21. Liu, M., & Hsiao, Y. (2001, June). *Middle school students as multimedia designers: A project-based learning approach*. Paper presented at National Educational Computing conference, Chicago, IL. (ERIC Document No. ED 462 936)
22. Royer, R., & Royer, J. (2002). Developing understanding with multimedia. *Learning and Leading with Technology, 29*(7), 40-45.
23. Hamilton, D. (1990). *Learning more about education: An unfinished curriculum.* New York: Open University.

PATRICIA RYABY BACKER
Patricia Backer is a Professor and chair of the Department of Aviation and Technology in the College of Engineering at SJSU. She holds a BS degree in Chemical Engineering from Rutgers University, a MA and MS degree from Tennessee Temple University, and a MA and PhD from Ohio State. Her research interests are in the integration of multimedia and web-based learning into technology instruction.