TEACHING THE HISTORICAL CONTEXT OF COMPUTING

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ABSTRACT

This paper describes the author's experience in creating and teaching a course on the history of science and technology within a computer science department. This course is suitable for general education, as an alternative to a programming or other quantitatively-oriented course. Its purpose is to show a progression of technological achievements and scientific discoveries that ultimately culminates in today's world dominated by the computer. Offering this history course to the broader university community reinforces the message that computer science is an interdisciplinary problem-solving field of study.

INTRODUCTION

Computer science is becoming increasingly interdisciplinary. In particular, the 2013 ACM/IEEE recommendations for computer science curricula recognize and support the growth of interdisciplinary programs [3]. At small and liberal arts colleges, the majority of students pursue a Bachelor of Arts degree. To reach out to the majority of students, rather than offering a programming course as the only front door into computer science, offering a course on the history of technology offers an opportunity to attract a new set of students.

The mission statement of this course is that computer science did not appear *ex nihilo*. Computer science is the heir of a great tradition of innovation and curiosity. This course is a historical survey of technology, invention, and science, and how these have affected society. The primary goal of the course is for students to become familiar with major scientific and technological breakthroughs of the classical and modern eras, leading up to the computer.

For an undergraduate survey course, it did not seem appropriate to confine the subject matter to just the history of computer science. Plus, the major impetus to offering this course is to show students how computer science connects to other, more established, disciplines. At the author's institution, no course on the history of science or technology previously existed.

This course has been designed to satisfy the university's general education requirement in history. It cannot count as an elective for the computer science major. However, it can count as an elective for our interdisciplinary (Bachelor of Arts) information technology major. The course is taught at the 200 level. Despite not having a pre-requisite, it does not compete with CS0, because the CS0 course satisfies a different general education requirement, namely mathematics as opposed to history.

BACKGROUND

Not many colleges offer courses in the history of science or technology. The reason is because few historians specialize in this area. To illustrate, according to figures from the U.S. Department of Education, only 4% of the PhDs awarded in history in 2014 were in the area of "the history and philosophy of science and technology" [5]. As a result, faculty specializing in this area of history are rare, and history departments at small colleges are not likely to offer such a course for undergraduates.

To the author's knowledge, we are the first computer science department to offer a general education history course. A study of general education offerings at 75 peer institutions showed that none offered such a course [8]. The inspiration that such a course could succeed was found at Auburn University. There, all students are required to take a course in either world history or in a course on "technology and civilization." One such course is entitled "Technology and the Shaping of America" [1]. However, all such history courses are taught in their history department, as Auburn has several faculty who specialize in the history of technology.

COURSE STRUCTURE

The goal of the course was to cover four content units, each taking about 25% of the course schedule: the ancient world, early-modern science, the industrial revolution, and the development of the computer. Since computer technology today is often geared toward communication, other innovations of communication technology are highlighted in the earlier units of the course. Nevertheless, other technological genres are also studied, including energy, military, transportation, and photography.

In order to satisfy the criteria of a general education history course, it is also necessary to teach students about the way that history is done, i.e. historiography [2] and methods of historical analysis [8]. There are certain lessons that should be imparted to students, such as a respect for intellectual freedom, the fact that certain pivotal inventions have represented a watershed in history, and that throughout time humans have always been using their curiosity and ingenuity to manipulate their environment to make life easier. Over time, artifacts of civilization are created, which become discovered in archeological digs. The artifacts themselves have just as much historical value as primary source literary material [4].

Historical analysis includes having the students consider more than just the basic facts. Students need to pause and consider the evidence of how we have come to know what we know. It is also useful for students to think of history as being "multithreaded." In other words, while scientific and technological achievements are taking place, there are also events taking place in the wider world. For example, Galileo's work was impacted by the Catholic Church's Council of Trent, which was in turn a response to the Protestant Reformation.

Student Activities

During the course, students were assigned 1289 pages of reading (selected among four books) and 26 hours of video to watch. To prepare for a typical 50-minute class session, students would need to read two chapters, or read one chapter and watch one (hour) video. For the most part, the course proceeded like a seminar. Students were e-mailed discussion questions in advance of each class meeting. In all, the course included 327 discussion questions. Example questions include: "How did historians determine the date and origin of the Antikythera device?" and "Has supersonic commercial air travel been a success or failure?" Occasionally during class there would be a brief lesson to explain certain scientific topics, such as the apparent retrograde motion of planets, the four humors of human health, or how to calculate the thrust of an engine.

Homework consisted of two short assignments plus a term paper. An example of a short assignment was to ask students to consult a college catalogue of an engineering school from 100 years ago. Many college catalogues are available on archive.org. Select a department of engineering, and compare how its curriculum has changed between then and now. The term paper was to be 2000 words long. An example term paper assignment was to ask students to find a scientific theory that was refuted after 1945 as the result of more recent scientific evidence.

Laboratory Exercises

One innovative aspect of this course was that it included laboratory activities. No other history course at the author's college includes labs. The motivation for the labs was for the students to actually touch history by using historical replica artifacts of technology. Typical labs included the following activities.

- Multiplication on an abacus. Students were given time to practice the abacus until they could multiply two three-digit numbers correctly in under a minute. At the end of the two-hour lab period, the class held an informal contest to see which student could work the fastest.
- Celestial navigation in the college's planetarium. Actual sextants and astrolabes were beyond the budget of the course. So, using household materials, we created our own quadrants. This device is used to measure how high in the sky a star or

planet is, in degrees from the horizon. The planetarium's software was programmed to show the night sky in some arbitrary point in North America, and the students had to use their quadrants to estimate their location.

- Using a slide rule. Over a period of two weeks, the students learned how to multiply, divide, and compute reciprocals, square roots, cube roots, sines, cosines, tangents, and logarithms. Students also compared their results with an electronic calculator to measure the precision of the slide rule. During the labs, they were able to obtain answers on the slide rule to an error of 0.3%. As with the abacus, we had another informal contest to see who could most quickly obtain acceptably accurate answers to random arithmetical problems on the slide rule.
- Simple FORTRAN programming, using a command-line interface. Because some students had minimal programming experience, these labs were confined to rudimentary calculations, I/O, if-statements, and looping.

IMPLEMENTATION

The first logistical hurdle in making the new course a reality was having it approved for history general education. Until this course was created at the author's institution, no science department had ever proposed a history course. Eight departments had courses satisfying the general education history requirement, but they were all in the humanities or fine arts. The author had meetings with the chair of the history department for advice on creating the course.

In order to cover a wide range of material, it became desirable to assign videos for students to watch outside of class, instead of increasing the reading load. The college library owned many DVDs that were relevant to the course. However, it would have been impractical to keep these materials on reserve in the library, because it would not be possible for everyone in the class to have an opportunity to check them out before the next class. A better solution was have the students watch the videos online. To comply with the TEACH Act [7], a certain protocol was necessary. Before teaching the course, the instructor extracted video files from the DVDs using Handbrake, and uploaded them to a private password-protected Web server, available only to the instructor and students enrolled in the course. During the course, students were able to stream but not download the videos.

The final hurdle was acquiring 25 slide rules for students to use in lab. Slide rules have long been discontinued in stationery stores. A tour of local antique stores yielded very few acceptable specimens. Most slide rules were bought on eBay. The average cost of each was $29.89. The most advanced slide rule we found was the Pickett model N4-ES, manufactured around 1960. It included the most functionality, such as hyperbolic functions, and an easier method to obtain square roots.

RETROSPECT

The course has been taught in fall 2015 and fall 2016. The combined enrollment was 34. Computer science majors made up 38% of the students. Information technology majors made up 32% of the students. Non-majors made up the remaining 30% of the class. Most students who took the course were doing so in order to satisfy the college's general education requirement in history. The vast majority (82%) had already taken another computer science course before this one. Therefore, we have had limited success in reaching out to completely new students.

A survey was given to the students at the end of the term measuring how much they preferred each topic of the course. Students were asked to rate topics on a 1-3 scale. Results are summarized in the following table. Clearly, there was a greater interest in the more recent topics. But students were also interested in the origins of physical science. Among the various genres of technology, communication technology (e.g. telegraph, typewriter) was the most popular. Nevertheless, there was not a significant difference among many of the subjects, and it seems prudent to continue to expose students to a wide range of topics instead of simply eliminating subjects that were only slightly less popular, given the small sample size of the survey.

Table 1: Results of Survey Given to Students at Conclusion of Course

Course Topic	Score (1.0 – 3.0)
Technology before the Ancient Greeks	1.6
Greek and Roman science and technology	1.8
Medieval and Renaissance periods	1.7
Astronomy, including heliocentrism	2.0
Navigation	1.8
Development of physics and chemistry before 1900	2.2
Biology, evolution, microscope, medicine	2.0
Electricity and sources of energy	1.9
Transportation technology	1.9
Communication technology	2.1
Military technology	1.9
Printing, photography, forms of entertainment	2.2
Scientific developments since 1900	2.5
Space race and atomic bomb	2.5
Computer history	2.6

FUTURE WORK

Next year, our department will offer this history course as part of a study abroad experience in the British Isles. Students will see firsthand where seminal moments took

place, such as the *Titanic*'s shipyard in Belfast, the original limelights of British theatres, and Alan Turing's codebreaking at Bletchley Park.

As the course continues to evolve, there will be a continuous desire to freshen the course with new topics. As the amount of material in the course continues to expand, if there is sufficient enrollment, we could split the course in two. The course could be split chronologically, with one course covering earlier versus later material. The course on the later technology could be offered more frequently. Alternatively, we could have one course cover strictly the history of science, and the other the history of technology.

CONCLUSION

This paper describes an innovative service course for computer science departments, on the history of science and technology. It is intended as a general education history course, or as a course for students studying an interdisciplinary curriculum such as the digital humanities. Computer science majors should see value in the course as well. It shows students the historical context of computing. Computer science is presented as recent evidence of people's innate curiosity and desire to improve their world. The course includes sufficient background material on Western and world civilization plus techniques of historiography and historical analysis to qualify as a general education history course. The course has been offered twice, and a third offering is planned in conjunction with a study abroad trip. Student opinion suggests that we consider a greater emphasis on the more recent scientific and technological developments, as these may be more applicable to computing.

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