A Course Investigating Technology in World Civilization

William R. Loendorf
Eastern Washington University
School of Computing and Engineering Sciences
Department of Engineering Technology and Multimedia Design

Abstract

An interdisciplinary course has been created that explores a historical perspective of the development of technology in a global context. This junior level course traces the interconnected events and cultures in which technology developed. It investigates how technologies are inter-related and how cultural factors affect the acceptance or rejection of technology. The intent of the course was to enhance the student's understanding of how technologies developed and why.

The social, political, economic and cultural impacts of technologies are explored to determine their positive and negative affects. In this context the two biggest technology drivers of agriculture and war are studied in detail. Through innovations agriculture was able to produce more food allowing populations to grow. While new inventions created more effective and devastating weapons of war used to kill and destroy.

Numerous questions or mysteries of the past are addressed. For example, why did similar inventions appear in different parts of the world almost simultaneously? How did information and technology spread from one place to another and why did they fade away in one place only to resurface later in a different place? How and why were inventions or innovations diffused or borrowed from one culture adapted to suit the needs of another?

Teaching methods include lectures, discussions, videos and written assignments. The assignments require students to identify and apply the knowledge obtained from the course to both historical and today's technologies. The students are challenged to be creative and innovative in their solutions to the problems presented to them.

The material covered helps the student to understand and recognize our dependence on technology and its invasive nature into our lives. Technology is such a big part of our lives today that we often take it for granted. In fact, it is had to imagine exactly what our lives would be without it. Therefore, it is important to understand how this occurred and what the ramifications might be. In this course the students study the past development, use and affects of technology in order to be better prepared for the new technologies of the future!

Introduction

Technology influences every aspect of our lives today, but we often forget that it profoundly affected the lives of past generations dating back to the beginning of civilization. Perhaps not to today's extent, but the impact was still dramatic.

New inventions or innovations produced more food, created new processes and tools, made life easier and made war more devastating. This course traces the evolution of technology and its impact on civilization from the creation of elementary tools up to today's latest devices and even looks into future technologies.

This interdisciplinary course satisfies the University's International Studies graduation requirement. As a result, students from all disciplines across campus regularly take the course leading to a great diversity of backgrounds and specialties. Perhaps this explains the wide spectrum of opinions, comments and ideas expressed both in class discussions and written essays. Whatever the cause, it has become an important component of the class.

Course Objectives

The course has two main categories of objectives that: (a) promote awareness of technological development, and (b) provide a rudimentary understanding of the social, political, economic and cultural impact. These two main objectives were then expanded to create a more comprehensive list for the student.

Upon completion of the course a student:

1. Can recount the interconnected events and cultures in which a technology developed.
2. Can describe how technologies are inter-related.
3. Can critique technologies based on: system aspects, applied knowledge, specific goals, organizational forms, winners/losers, etc.
4. Can describe a world technological problem (weapons, fuel usage, public health, etc.) from both a developing nations and technologically advanced nations viewpoint.
5. Can recount the development of major technologies historically.
6. Understand and can cite examples of technological dialog and diffusion.
7. Recognize occurrences of "technological determinism" and "social constructivism."
8. Can cite examples of cultural factors affecting the acceptance or rejection of a technology.
9. Can discuss issues relating to technological advance and cultural lag.
10. Can describe how the "convergence theory" has affected the world's nations and brought them closer together.
11. Understand the dilemmas relating to halfway technologies.
12. Recognize our dependence on technology and understand its invasive nature.
13. Understand the use of appropriate (Western) technology in developing world cultures.
14. Recognize that engineers of previous millenniums were very smart!

In addition, these objectives were designed to respond to the Accreditation Board for Engineering and Technology (ABET) [1] requirements listed in its Engineering Criteria 2000.

This course is primarily concerned with the following components of Criterion 3, Program Outcomes and Assessment:

(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life long learning
(j) a knowledge of contemporary issues

Course Structure

The four credit course (quarter system) meets four days a week for an hour. The vast majority of the class sessions are lecture oriented with class discussion strongly encouraged. Up to six videos are utilized to augment the lectures and written material from the textbooks.

We are extremely fortunate today to have numerous videos available from sources like The History Channel, The Discovery Channel, PBS, BBC and others. The selected videos show the students detailed information on: the Great Wall of China, ancient inventions, ancient weapons, the gun's history, the industrial revolution, railroads, printing, transportation, communication, the environment and other great inventions. By using videos, the process of independent innovation is explored along with the possibility that many inventions were related or somehow connected.

Typically two books are used for reading assignments and discussion purposes. They are periodically changed as new or updated texts become available. Excellent example books are available from Alcom [2], Hjorth, Eichler, Khan, and Morello [3], Johnson, Gostelow, and King [4], Pacey [5], Stross [6], Teich [7], Voland [8], and Volti [9].

A series of five written essays based on the readings, lectures and discussions are required. The assignments challenge the students to identify and apply the knowledge obtained from the course to both historical and today's technologies. The students are expected to be creative and innovative in their solutions to the problems and scenarios presented to them.

Multiple formats for the exams have been used ranging from essay, short answer, fill in the blank and multiple choice. Various combinations of these methods were also tried with some success. Since such a large amount of material is covered, the best combination seems to be short answer and multiple choice questions. The five written assignments easily cover the essay aspect.

The student's final grade is determined based on four exams each accounting for 12.5% and five written assignment each accounting for 10% of the total grade. Students are accountable for all exams and written assignments requiring that all be completed in a satisfactory manner. However, a single poor grade on an exam or written assignment does not significantly impact an otherwise good performance.

Class participation is encouraged and considered in the final grade where close decisions are required. In order to discourage absences anything discussed in class (including the content of videos) could and would be included on the exams. Typically it takes a few students a while and a couple of exams to understand. But eventually they realize the importance of attending class.

Course Content

Technology has had a big impact on civilization. It changed the way people lived, how they lived, how they worked, and where they worked. It changed the way wars were fought by introducing new weapons and counter weapons. Technology changed civilization and history in many ways.

It would be impossible to cover in a ten week quarter all of the social, political, economic and cultural affects of technology on civilization. Instead the focus is on a few major categories that encompass a wide variety of subjects. The course content is continually being revised and updated, however some of the typical topics covered include:

Technologies in the Ancient World. It all started with the invention of the stone axe, but what was the next step? Were there other stone tools? What about wood tools? What other crude technologies were utilized and what purpose did they serve? How was fire discovered and used? When and why did metal-working and blast furnaces begin to make a contribution? What was this early iron used for? What part did the stirrup and harness play? Why were early machines invented, what did they do and where were they first used?

Agricultural Development. How did civilization progress from hunting-and-gathering societies to slash-and-burn cultivation and then to settled agriculture? What crops were planted and where did they originate? Why did they make a difference? What tools were used and when did animals and machines begin to help with the work? How was the number of acres used for food production increased? What methods improved the crop yield per acre? What led to irrigated fields and how was the water moved from one place or level to another?

Weapons Development. How did the action-reaction escalation of weapons development begin and why does it continue to this day. Civilization progressed from the axe, to the spear and then to the bow and arrow. Fortifications and body armor surfaced. Catapults and trebuchets were invented as siege weapons. What was 'Greek fire' and what part did it play? Then the discovery of gunpowder changed everything. Now cannons, crude guns and rockets appeared. Traditional military tactics and procedures were altered as one devastating weapon followed another.

Time Measurement. Believe it or not, life existed without clocks. What determined the daily routine and how were activities scheduled? What was life like before clocks? Who invented timekeeping and why? When were the first clocks built and how did they work? Where were they first used? The invention of the clock dramatically changed the attitudes toward work because it allowed the precise scheduling of work activities. In producing a standard product (measures of time: seconds, minutes, hours, days, weeks, months, etc.) the clock made time an important commodity. Time became something that should not be wasted.

Industrial Revolution. Civilization moved from human power to animal power and then to water and wind power. Windmills and waterwheels supplied the energy to grind grain, spin textiles and run other machines. Yes machines! The craft industry utilizing self-employed workers was transformed into an army of employees working in factories. Machine-paced labor led to a form of wage slavery. Guilds and unions were formed. Coal emerged as the main source of energy

only to be replaced by oil. The steam engine powered industry and transportation until it was superseded by the internal combustion engine. Then electricity and all of the devices powered by it changed how and when we worked.

The Environment. What affect did early humans have on the world around them? What happened as the number of humans increased? As new technologies developed what affect did they have on the earth's natural resources? What type of shortages developed and where? How was the depletion of resources handled? Substitutions were made, but what new problems did they create? When and where did pollution begin to be a problem? What was done about it?

Communication. It all began with the spoken word and progressed to the written word. Surprisingly, not all languages had a written counterpart. What happened to those that didn't? Stone tablets were the first form of permanent records. Manuscripts were copied by hand before the printing press was invented. What device was used as the first printing press? Wooden blocks and copper plates were used before moveable type. Then the telegraph revolutionized communication only to be outdone by the telephone. The quest for instant communication continued with the invention of radio, television, and the internet.

Transportation. Initially humans walked and carried what they needed. A huge step forward occurred when animals and crude carts were used. Waterways became the prime mode for transportation and trade. Great vessels traveled the world's oceans, rivers and canals. Only to be supplemented by the steam engine powered locomotive and the age of railroad empires began. Then the automobile, mass produced on assembly lines, became the prime mode of transportation. Airplanes then emerged in the further quest for speed to get from place to place.

Diffusion of Technology. How and why did similar inventions appear in different parts of the world almost simultaneously or at different times with no obvious connection? Were they somehow related or independent inventions? Did the accomplishments of one society stimulate the creativity of other remote societies? How did the transfer of technology occur? Why did particular technologies fade away in one place only to resurface later in a different place? How were technologies borrowed from one society and then modified or improved to suit the needs of another?

The Future. What does the future hold for technology? What new technologies are being or could be developed? How will they affect civilization and will they be accepted or rejected? Will their potential benefit outweigh their cost? Are there ways in which to prepare society for the introduction of radical new technologies? Are rapid technological changes good for society?

Numerous other topics could also be investigated and discussed. The course is designed allowing for a great deal of flexibility. The material covered can in many cases even be somewhat tailored to the particular class's interests. In reality, no two classes are ever quite the same.

Course Assignments

This is a writing intensive course requiring that five written projects be completed. The students are challenged to respond to technical and historical scenarios by writing a three to five page essay

supporting their conclusions. They must build a case that strongly supports and backs their decisions stating as many reasons as possible and citing examples. The students are given two weeks to complete their essays with the first project assigned during the initial class period.

The projects are modified, changed or replaced every quarter. This is in part due to the direction the class takes during the discussion of the material. It also reflects the dynamic selection of the material covered in the course. A typical five project sequence is presented below.

A great variety of technologies were created and utilized throughout history. The first project requires the determination of the most important technology, innovation or invention for civilization as a whole and then for society today. Carefully consider all of the alternatives and respond to the following two questions. (1) What innovation or invention (technology) had the biggest impact on civilization throughout history? Why? (2) What innovation or invention (technology) has or had the biggest impact on your life? Why?

In chronicling the development and evolution of technology we have a wonderful opportunity to celebrate human ingenuity, invention, and the leisure time that many of these time and labor-saving devices have afforded us. But are there any new ideas, inventions or gadgets left to discover? The second project looks into gadgets, technologies and inventions that haven't yet been discovered. Your challenge is to be creative, innovative and inventive by answering the following two questions. (1) Innovation is nothing more than finding a better way to do something. Choose an everyday job that you dislike but must perform and be innovative in discovering a new way to accomplish the same task. (2) If you had the resources and the time, what innovation, invention (technology) or gadget would you create? Why?

The goal of the third project is to trace the development of a technology historically. Pick a technology that is part of every day American life (for example: automobile, transportation system, clean water supply system, electrical utility system, telephone system, etc.). Then trace the development of the technology for at least the past 50 years. Some technologies may make more sense to trace for a longer period of time. Collect information about key events or time periods during the development of the technology. Find at least 25 events with at least 5 of them not being scientific or technical in nature (for example, government regulations). Describe the events in chronological order including: the date - when did the development happen, or what time period, the event - what development happened (this may include scientific, technological, governmental, cultural or other events), and the significance - why the development was significant.

The fourth project requires an investigation into the most beneficial and harmful affects of technological innovations or inventions. As we have seen numerous times, a good technology has often unknown (at first) adverse affects while a bad technology has been utilized in some way to improve civilization. Often times they occur together. Answer the following two questions. (1) Which technology has produced the greatest benefit to civilization? Were there any harmful affects? What are they? Why? (2) Which technology has produced the most harm? Were there any beneficial affects? What are they? Why?

Society makes choices about what technologies to adopt or reject. Some of the consequences are good, and some are bad. The fifth assignment is to compare the results of the choices once made. Select one of the following four topics and discuss: how the technology works (de-mystify the technology), the potential gains to the potential risks, the problems associated with the technology and how to deal with them, what laws could be put in place (or are in place) to limit the risks or moral problems, and how would various cultures around the world view the use of the technology. Topic 1 - Biological Technology. Investigate one modern biological technology such as cloning, genetically modified organisms, in vitro fertilization, stem cell research, etc. Topic 2 - Alternative energy source to replace US dependence on foreign oil. Investigate one modern alternative energy technology such as hydrogen, wind turbines, solar, geothermal, etc. Topic 3 - Controlling Weapons of Mass Destruction. Investigate a weapon of mass destruction, the political environment, the control of the use of the weapon historically, and how use of the weapon could be controlled in the future. Topic 4 - Environmental Threats. Investigate and determine the greatest environmental threat facing the world today, what countermeasures need to be implemented, where will the resistance come from, and what will the solution cost.

Dilemmas of New Technologies

The course also examines the affect of technology on our lives today as well as looking into the future. The dilemmas of new technologies influence our lives in many ways. Everything from our life at home to our life on the job has changed.

The threat of technology driven unemployment is real and has happened numerous times in the past and will happen again in the future. However, there is a case for optimism because new technologies create new jobs and opportunities. The vast majority of jobs today didn't exist twenty years ago and this trend will continue. Life long learning and continual retraining must become commonplace to insure that workers skills are up to date and relevant for the new jobs being created.

The change in the U.S. economy from manufacturing based to service oriented has profoundly changed the jobs of the future. In the 20th century, a revolution in how work was organized, the development of new materials, and the diffusion of information technology have altered what workers produce and how they work. Few jobs in the future will be directly related to the production of something while the majority of jobs will provide services (like doctors, lawyers, teachers, managers, etc.) or manipulate data to create information.

It is therefore important to understand that change occurs and that things will be different in the future. Of course, it would be arrogant to argue that change has never been more dramatic than it is today. Because every past century has seen dramatic and remarkable change, but not perhaps like the last century. The rate of change seems to be accelerating and it will only get faster.

The goal and objectives of this course are to make the students aware of this process and prepare them for change. By learning and gaining understanding from the past development and use of technologies they will be better equipped for the future. Whatever new technologies and surprises that may bring.

Conclusions, Reflections and the Future

This course investigating technology in world civilization has achieved its objectives of increasing the awareness and understanding of the social, political, economic and cultural impact of technologies on society. Two of the most interesting aspects of the course are the comments the students generate during the discussions and of course the ideas in their essays. It is refreshing to realize that they are learning from the past and excited about the future. Reading their essays, even though time consuming, is a very rewarding and interesting learning experience. Sharing their ideas with the rest of the class always initiates a lively discussion.

Reflecting back on the course itself, it is a joy to facilitate. The course is intended to be dynamic and never the same. The content is always updated and the written assignments always changed. The course must keep pace with the changing times and technologies. This implies additional preparation work for the facilitator, but in the end, it is well worth the extra effort.

The makeup of the course continues to change and evolve. This is as it should be because technology and its influence on society changes at a rapidly accelerating pace. Hopefully this course can keep a step ahead or at least in step with technology and its affects on all of society.

Bibliography

[1] Accreditation Board for Engineering and Technology, at http://www.abet.org
[2] Alcorn, Paul. *Social Issues in Technology:, A Format for Investigation*, 4th ed. Upper Saddle River, NJ: Prentice Hall. 2003.
[3] Hjorth, L., Eichler, B., Khan, A. and Morello, J. *Technology and Society: A Bridge to the 21st Century*, 2nd ed. Upper Saddle River, NJ: Prentice Hall. 2003.
[4] Johnson, S., Gostelow, J. P., and King, W.J. *Engineering and Society*, Upper Saddle River, NJ: Prentice Hall. 2000.
[5] Pacey, Arnold. *Technology in World Civilization*, 4th ed. Cambridge, MA: MIT Press, 2001.
[6] Stross, Randall. *Technology and Society in Twentieth Century America*, Belmont, CA: Wadsworth Publishing Company, 1989.
[7] Teich, Albert. *Technology and the Future*, 9th ed. Toronto, Ontario, Canada: Thomson Wadsworth Publishing, 2003.
[8] Voland, Gerand. *Engineering by Design*, Menlo Park, CA: Addison Wesley Longman, Inc., 1999.
[9] Volti, Rudi, *Society and Technological Change*, 4th ed. New York: Worth Publishers, 2001.

Biographical Information

WILLIAM R. LOENDORF obtained his B.Sc. in Engineering Science at the University of Wisconsin - Parkside, M.S. in Electrical Engineering at Colorado State University, and M.B.A. at the Lake Forest Graduate School of Management. He holds a Professional Engineer certification and was previously an Engineering Manager at Motorola. His interests include engineering management, real-time embedded systems, and digital signal processing.