Big Era 9
Paradoxes of Global Acceleration
1945 - Present

Landscape Teaching Unit 9.5
The World at Warp Speed: Science, Technology, and the Computer Revolution
1970 - Present

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World History for Us All
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Why this unit?

Scientific and technological change over the past thirty-five years has accelerated at an ever-increasing pace. This change brings advances which spread around the world, increasing global interaction and, for many, improving the quality of life. This unit highlights two main ideas: 1) specific achievements in communications, transportation, health, medicine, and **agriculture**; 2) how the confluence of these achievements has transformed and challenged traditional economic, social, and political structures, often in unexpected ways.

The economic and social dislocations of the 1970s convinced many commentators at the time that we were entering an era where increasing world population and diminishing resources would lead to a downward spiral. These fears did not come to pass, however, owing in large part to many of the developments in science and technology that began during the 1970s. The first personal computer, the Altair 8800, was introduced in 1975. The first programming language for this computer was also the first product of Microsoft (then Micro-Soft). Though the development of the Internet and the information-sharing world that came with it had to wait another twenty years to emerge, the seeds of change were planted in the 1970s.

Scientific developments in the sciences, medicine, and agriculture did not have to wait so long. Technological advances in these areas began improving the quality of life for millions of people by the late 1970s. Advances in cardiac technology, critical care, medical imaging, health care computers, and the use of genetic engineering have brought rapid change to the world of medicine. More accurate and quicker diagnoses, more effective treatments, and increased **life expectancies** were just some of the obvious benefits.

This unit will challenge students to consider the moral and ethical issues that have emerged as a result of these advances in science and technology. In addition, the uneven dissemination of the technological and communications **revolutions** has resulted in great disparities in who has access to these new tools.

Unit objectives

Upon completing this unit, students will be able to:

1. Analyze how revolutions in communication and information technology have contributed to the acceleration of social change.
2. Assess the impact of biotechnology on human society and the **ecology**.
3. Trace the development of the new physics and its implications.
4. Identify key medical advances over the past two decades and their implications for longevity and social policy.
5. Identify new trends in the twenty-first century and analyze divergent opinions regarding them.

Time and materials

This unit is best done in a week of forty-five minute classes. If time is limited, students can do any of the lessons on their own. Materials required are included in this unit.

Author

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The historical context

World War II stimulated scientific research and technological innovations that greatly advanced human well-being and **standards of living**. The sponsorship of research by **governments** and the military during World War II created a new scientific model. Teams of scientists working on large-scale, government-funded projects became the norm in the period from 1945 to 1970. The development of the transistor to replace the large and cumbersome vacuum tubes (the ENIAC computer of 1946 used 18,000 of them) is considered by many to be one of the greatest inventions in modern history. The further development of the silicon chip, or integrated circuit, helped to set the stage for Intel, which brought these advances together with the introduction of the microprocessor in late 1971. The late 1970s and 1980s saw the emergence of Apple Computer and the Microsoft Corporation and a shift from the hobbyists who had helped shape the early personal computer movement, giving it a more commercial and business-oriented focus.

The scientific and technological advances which the power of the microchip allowed were critical to the computer revolution. The rapid social changes of the 1960s and early 1970s, however, also factored into this revolution. While seen by many as a distraction from the large-scale scientific developments of the era—such as the space race that culminated in the first moon landing in 1969—the counterculture helped to plant the seeds for the computer revolution. During the 1960s, computers were machines created to solve mathematical equations, for "computing." How that impersonal world of IBM mainframe computers gave way to the accessible, user-friendly technology of today owes as much to counterculture influences as it does to the expensive interventions of government and large corporations. Computer technology has turned out to be a creative and freeing tool for individuals around the world.

In medicine, new technologies using laser and ultrasound were developed, helping to advance surgical techniques, while CAT scans and MRI technologies helped doctors to build multi-dimensional images of organs or of different regions of the body. Doctors have come to use these new tools to detect tumors, diagnose injuries, and collect other specific medical information. The Human Genome Project (HGP) began in October 1990 and was completed in 2003. The goal, still unfolding, has been to discover all the estimated 20-25,000 human genes and make them accessible for further biological study. The implications for further transforming health and medicine are tremendous.

Along with this freedom, however, have come many challenges. Legal and ethical questions about intellectual property rights have a relatively long history in computer culture. The legal entitlement that enables someone to exercise exclusive control over the use of intellectual property has been challenged by both the open source and the free software movements. Although philosophical differences separate these two approaches, both propose that projects should be open to anyone and everyone for contributions, before or after the actual programming. Both also hold that this more open style of licensing allows for a superior software development process and, therefore, that pursuing it is in line with rational self-interest.

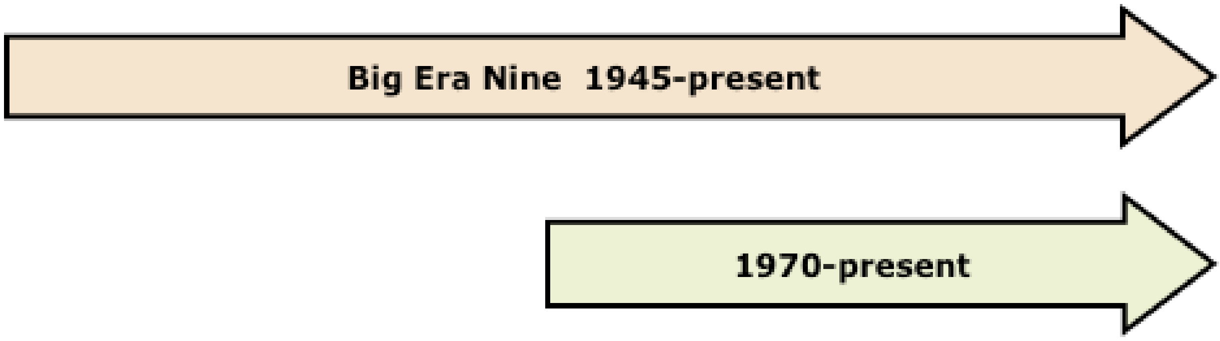
Science and medicine have also seen their fair share of controversies. Medical ethics issues relating to death and dying, reproductive rights, research, the distribution and utilization of research and care, and the questions about alternative approaches to medical care have emerged and, in many cases, have posed unforeseen challenges to the advancement of new technologies in medicine.

An entrance to Microsoft Corporation's campus in Redmond, Washington

Photo by Derrick Coetzee (2005)

Wikipedia Commons

This unit and the Big Era Timeline



Lesson 1
Is It Always Nice to Share?

Preparation
Ask students if they have ever downloaded music or software from the Internet. Discuss whether it is ever OK to download copyrighted material without paying a fee—in other words, to download illegally.

Introduction
Read the brief background essays in Student Handouts 1.1 (An Early History of the Personal Computer Industry) and 1.2 (Bill Gates, Open Letter to Hobbyists, February, 1976) and discuss the points of view of both Bill Gates and the members of the Homebrew Computer Club.

Activities
Students working in groups begin to create a timeline called "Advances in Science and Technology" using the information from Student Handout 1.1 that will be worked on in the course of the unit.

Read the essay in Student Handout 1.3 (Freedom or Property Rights? Napster and the Question of Digital Rights) and discuss music file-sharing and the ethical issues related to doing it illegally.

Debate the following proposition: Profit-seeking corporations should always be able to require payment from users of copyrighted material available on the Internet. After assigning debate teams, students should carefully research both sides of the topic.

- List arguments in favor or against the idea being debated.
- List likely arguments that the opposing team might make either for or against.
- List counter-arguments that discredit the arguments of the other side.

The debate should include an affirmative and a negative team and follow a sequence similar to the one listed below:

Affirmative team	**Time**	**Negative team**	**Time**
Opening statement	3 min.	Opening statement	3 min.
Rebuttal	3 min.	Rebuttal	3 min.
Questions	5 min.	Questions	5 min.
Summary	3 min.	Summary	3 min.

Assessment

Ask students to write a brief reflective essay discussing their viewpoints about the topic before the debate and after, and evaluating which evidence they found to be most compelling.

Lesson 1

Student Handout 1.1—An Early History of the Personal Computer Industry

In 1968, Doug Engelbart and his group of researchers at the Stanford Research Institute presented a live public demonstration of the online computer system, NLS, on which they had been working since 1962. The public presentation at the Convention Center in San Francisco, which author John Markoff called “the computing world’s Woodstock,” saw the public debut of the computer mouse and other innovations including hypertext, object addressing, and dynamic file linking. These developments, though not immediately pursued, eventually formed the basis of the personal computers in use today.

During the 1970s, groups of hobbyists, many of whom were involved in the field of electrical engineering or computer programming, began to meet regularly to exchange ideas. The first meeting of the legendary Homebrew Computer Club was held in March 1975 in Menlo Park, California, in the garage of one of its members. Fred Moore, the founder of the club and a counterculture activist, believed that his club “should have nothing to do with making money.” The important thing was to share ideas in an atmosphere of openness and personal growth. This was part of the 1960s social idealism in which Moore and many Homebrew members believed. Club members came to the meetings to talk about the first true personal computer, the Altair 8800, and other technical topics. From its ranks came the founders of many microcomputer companies, including Steve Jobs and Steve Wozniak, the famous Apple founders.

The Altair 8800 was sold as a kit through *Popular Electronics* magazine and, though the designers intended to sell only a few hundred to hobbyists, they were pleasantly surprised to sell over ten times that many in the first month. Today the Altair is widely recognized as the spark that led to the personal computer revolution of the next few years. The internal design became the standard, and the first programming language for the machine was Microsoft’s founding product, Altair BASIC. Developed primarily by Microsoft co-founders Paul Allen and Bill Gates, Altair BASIC became the most-used computer programming language in the world by the early 1980s.

In 1975, however, Altair BASIC set off a controversy that continues today. When Gates and Allen finished Altair BASIC, they wanted to sell it. But just before it was shipped, an engineer made copies of the program and sent them off to friends at the Homebrew Computer Club. This made the twenty-year old Bill Gates furious, and in February 1976 he wrote the famous “Open Letter to Hobbyists,” which was aimed at the computer community and which denounced piracy. The hobbyists, for their part, were outraged because they thought he was charging too much for software that should be inexpensively or freely available. The division between profit-seeking publishers and supporters of free software really began at this point.

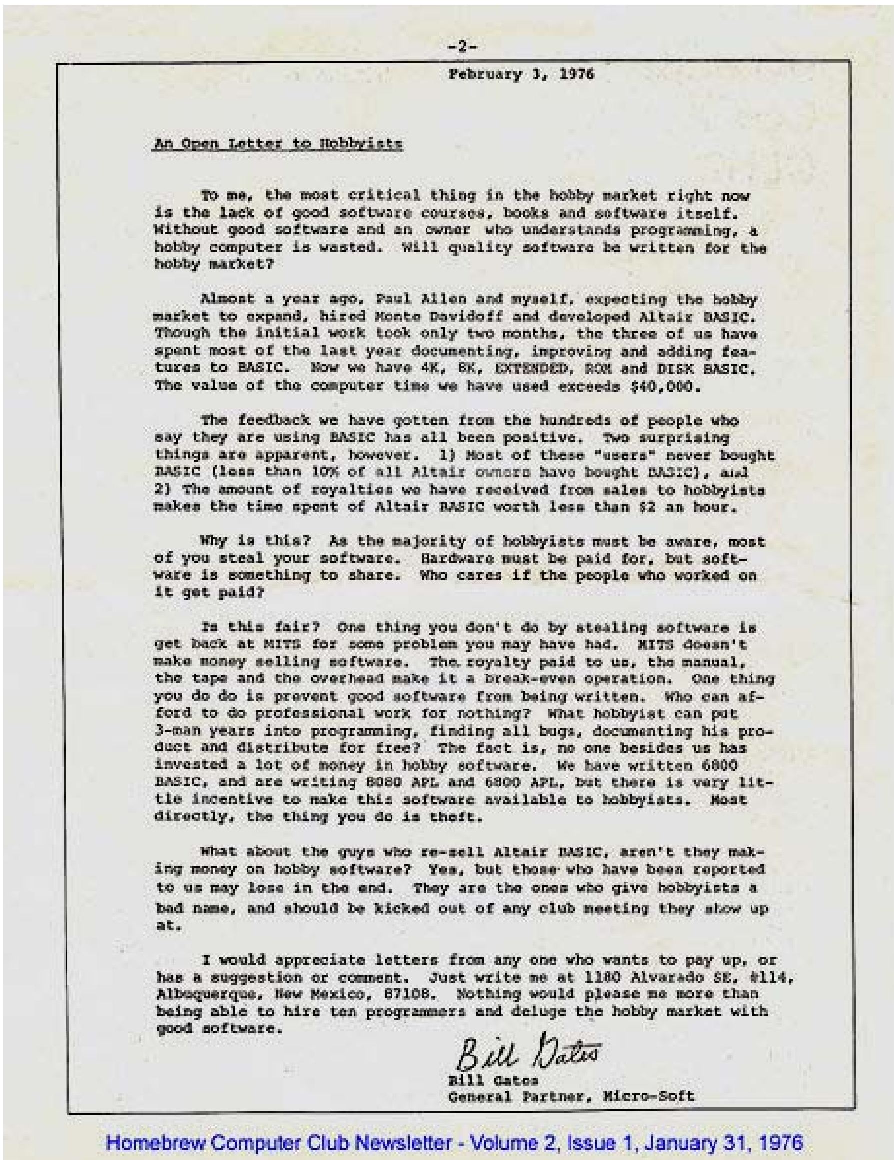
Sources: John Markoff, *What the Dormouse Said: How the 60’s Counterculture Shaped the Personal Computer Industry* (New York: Viking, 2005); MouseSite, The Demo, http://sloan.stanford.edu/MouseSite/1968Demo.html; Richard Koman, “An Interview With John Markoff,” The O’Reilly Network, 20 July 2005, http://www.oreillynet.com/pub/a/network/2005/07/20/johnmarkoff.html.

Lesson 1

Student Handout 1.2— Bill Gates, Open Letter to Hobbyists, February, 1976

As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid? … Who can afford to do professional work for nothing? What hobbyist can put 3 man-years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one but us has invested a lot of money in hobby software. … Most directly, the thing you do is theft. …

Bill Gates, General Partner, Micro-Soft



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February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #114, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates

Bill Gates
General Partner, Micro-Soft

Homebrew Computer Club Newsletter - Volume 2, Issue 1, January 31, 1976

Source: Bill Gates, "Open Letter to Hobbyists," Wikipedia, http://en.wikipedia.org/wiki/Open_Letter_to_Hobbyists.

Lesson 1

Student Handout 1.3—Freedom or Property Rights? Napster and the Question of Digital Rights

Napster is an online music service that was originally a file-sharing service created by Shawn Fanning. He wanted an easier method of finding music and devised a clever method to do so. Fanning first released the original Napster in the fall of 1999. It was the first widely-used peer-to-peer music (or P2P) sharing service, and it made a major impact on how people, especially university students, used the Internet. A P2P computer network is a network that relies on the computing power and bandwidth of the participants in the network rather than concentrating it in relatively few servers. The power it gave to individual users and the community-building features of Napster made it an overnight success.

At the time Napster was released, there was a general belief that the quality of new music albums had decreased. Many people said that albums contained only one or two good songs, along with many low-quality "filler" songs.

People praised Napster because it enabled them to obtain hit songs without having to buy an entire album. Napster also enabled people to obtain older songs, copies of music they had already paid for in another format, unreleased recordings, and songs from concert bootleg recordings. With the files obtained through Napster, people frequently made their own compilation albums on recordable CDs for free, without paying any royalties to the artist/composer or the estate of the artist/composer.

Its technology allowed music fans to easily share MP3 format song files with each other, thus leading to the music industry's accusations of massive copyright violations. "We love the idea of using technology to build artist communities, but that's not what Napster is all about. Napster is about facilitating piracy, and trying to build a business on the backs of artists and copyright owners," said Cary Sherman, senior executive vice-president and general counsel for the Record Industry Association of America (RIAA). In December 1999, the RIAA sued Napster for copyright infringement. The recording industry accused Internet piracy of causing a drop in CD sales, but a survey by Forrester Research in August 2002 reached a different conclusion. The company said that frequent digital music consumers were not buying fewer CDs and that the 15% drop in music sales over the previous two years owed more to the recession and competition from the booming markets of video games and DVDs.

The publicity and word-of-mouth attracted more Napster users and inspired the web community to start building its successor if Napster should be shut down. Although the original service was shut down by court order, it paved the way for decentralized P2P file-sharing programs, which have been much harder to control. The ever-widening availability of broadband has made file-sharing even more prevalent, since, with increasing download speeds, the distribution of entire movies and other large files is possible.

While most people agree that artists should receive compensation for their creative labors, others see the battles waged between advocates of open access to music and the power of the record industry as a reflection of a much larger battle emerging in modern society. Lawrence Lessig, a professor of law at Stanford Law School and founder of its Center for Internet and Society, argues that, while new technologies always lead to new laws, never before have the corporations used fear created by new technologies, specifically the Internet, to shrink the public domain of ideas. At the same time, corporations use the same technologies to control more of what we can and cannot do with culture. As culture becomes increasingly digitized, more and more becomes controllable. According to Lessig, “As life moves increasingly onto the Net and the capacity to control every aspect of our cultural capital increases almost to perfection, the question is whether there is an affirmative right of access, to use and remix.” He believes that in the future we will see more copyright limitations. In addition, computer codes will be legally able to limit the number of copies people make and digital rights management technology will allow corporations to charge fees for the most basic Internet activities we now use freely and take for granted, unless people fight for open access.

Sources: Lawrence Lessig, Stanford University Law School, http://www.lessig.org/; Jeffrey Rosen, “Roberts v. The Future,” *New York Times Magazine*, 28 Aug. 2005: 24-50; Sean McManus, “A Short History of File Sharing,” http://www.sean.co.uk/a/musicjournalism/var/historyoffilesharing.shtm.

Lesson 2
Everything Bad Is Good for You

Preparation

Read Student Handout 2.1 (The History of Video Games) and discuss video games with students and how they affect our lives. Ask what they like best or least about them. Then have students complete Student Handout 2.2 (Survey on Student Media Use) on their use of various media.

Introduction

Analyze the data from the previous day's survey (Student Handout 2.2) and interpret and evaluate the results with students. Then read Student Handout 2.3 (Everything Bad Is Good for You?) with students and discuss.

Activities

After researching the topic, students should write an editorial about whether limits should be put on access to various forms of media. They might argue for/against government controls or for more parental controls. Remind them that the editorial page is where the facts of our complex world are synthesized into analysis and opinion to help society figure out solutions to its problems. The goal of a good editorial is both to educate and to persuade. Teachers may wish to review some online or newspaper editorials with them before they begin.

Students continue work on "Advances in Science and Technology" timeline.

Assessment

A Scoring Guide should be used that examines:

1. The quality of research evident in the editorial.
2. Use of editorial voice (not first person—I, me, my).
3. Editorial explained the issue and was persuasive.
4. Editorial supported opinions with facts.
5. Editorial used transitional words and phrases and had an introduction, body, and conclusion.

Lesson 2

Student Handout 2.1—The History of Video Games

A Brief Overview

In 1966, Ralph Baer, an American engineer, created a simple video game called *Chase* that could be displayed on a standard television set. In 1968, he developed a prototype that could play several different games, including versions of table tennis and target shooting. In 1972, the first video game console for the home market, the Magnavox Odyssey, was released. Built using mainly analog electronics, it was based on Ralph Baer's earlier work and licensed from his employer. The console was connected to a home television set. It was not a large success.

It was not until Atari's home version of *Pong* in Christmas of 1975 that home video games started to take off. The success of *Pong* sparked hundreds of clone games, including *Telstar*, which went on to be a success in its own right, with over a dozen models. The coin-operated arcade video game craze had begun.

The arcade game industry entered its golden age in 1978 with the release of *Space Invaders*. This game was a runaway blockbuster that inspired dozens of manufacturers to enter the market and produce their own video games. The golden age was marked by a prevalence of arcades and new color arcade games that continued until the 1980s or 1990s.

If the 1980s were about the rise of the industry, the 1990s were about its maturing into a Hollywood-style landscape of ever-increasing budgets and increasingly consolidated publishers, with the losers slowly being crushed or absorbed. As this happened, the wide variety of games that existed in the 1980s faded away, with the larger corporations desiring to maximize profits and to lower risk. With the increasing computing power and decreasing cost of processors, the 1990s saw the rise of 3D graphics, as well as "multimedia" capabilities through sound cards and CD-ROMs.

Corner arcades, where many video games had been played up to this time, declined in the 1990s, giving way to large amusement centers dedicated to providing clean, safe environments and expensive game control systems not available to home users. These are usually based on sports, like skiing or cycling, as well as rhythm games like *Dance Dance Revolution*, which have carved out a large slice of the pie.

In 1989, Nintendo released the Game Boy, the first major handheld console. Several rival handhelds also made their debut around that time, including the Sega Game Gear. But, while some of the other systems remained in production until the mid-90s, the Game Boy remained at the top spot in sales throughout its lifespan.

The North American market in video games was dominated by the Sega Genesis after its debut in 1989, with the Nintendo Super NES proving a strong, roughly equal rival in 1991. *Super Mario 64* became a defining title for 3D platformers. In 1994-1995, Sega released Sega Saturn, and Sony made its debut to the video gaming scene with the PlayStation. Both consoles using 32-bit technology, the door was open for 3D games. By the end of this period, Sony had dethroned Nintendo, the PlayStation outselling the Nintendo 64. The Sega Saturn was successful in Japan but a failure in North America, leaving Sega outside of the main competition. Continuing its dominance of the market, Sony launched the PlayStation 2 in Japan in 2001, but the powerful Microsoft soon challenged it with its new system, the Xbox.

Trends in the Video Game Industry

The current industry consensus is that the popularity of computer and video games as a whole has been increasing steadily. The average age of the video game player is now 29, indicating that video games are not largely a diversion for teenagers, as many non-gamers assume. Each year, the theory goes, the generation of kids familiar with arcade and console games becomes one year older (and one year larger). With more disposable income available to the group as a whole, sales should continue to grow, presumably until the entire population has grown up with easily-available video games.

The four largest markets for computer and video games are the United States, Japan, Canada, and the United Kingdom. Other significant markets include Germany, South Korea, France, and Italy. China is not considered a significant market, probably because an estimated 95 percent of video games sold in the country are pirated.

Sales of different types of games vary widely between these markets due to local preferences. Japanese consumers avoid computer games and instead buy video games, with a strong preference for games created in Japan that run on Japanese consoles. In South Korea, computer games are preferred, especially MMORPGs (multiplayer online role-playing games) and real-time strategy games. There are over 20,000 PC bang Internet cafes where computer games can be played for an hourly charge. A MMORPG is a multiplayer computer role-playing game that enables thousands of players to play in an evolving virtual world at the same time over the Internet. MMORPGs are a specific type of massively multiplayer online game.

There is a mistaken belief that video game sales now exceed the revenues of the movie industry. This is untrue. In the United States, video game sales have exceeded the movies' total box office revenue each year since about 1996, but the movie studios trounce the video game publishers when the movies' "ancillary revenue" is counted, meaning sales of DVDs and sales to foreign distributors, cable TV, satellite TV, and broadcast television networks. The game and film industries are also becoming increasingly intertwined, with companies like Sony having significant stakes in both. A large number of summer blockbuster films spawn a companion game, often launched at the same time in order to share the marketing costs.

Lesson 2

Student Handout 2.2—Survey on Student Media Use

Media has a great effect on our everyday lives. Briefly complete the survey below. It is designed to find out approximately how much time you spend each week using various media. Estimate your weekly use by thinking about the differences between your use of media on school days as compared to your use on weekend days.

1. How many hours a week do you spend watching television or movies?

2. How many hours a week on the phone?

3. How many hours a week on the Internet?

4. How many hours a week do you spend playing video games?

5. How many hours a week do you spend listening to music?

6. How much of the time that you spend on these activities is related to education?

7. How much for entertainment?

8. How much to communicate with friends?

9. If you had to give up permanently the use of one of these media, which one would you choose? Why?

Lesson 2
Student Handout 2.3—Everything Bad Is Good for You?

Author Steven Johnson's recent book, *Everything Bad is Good for You*, has raised considerable controversy. His argument is that, contrary to the many studies about the dangerous effects of too much television-watching and video game-playing, today's popular culture is actually making us smarter. He has obviously struck a chord, particularly with parents, and his argument is compelling.

Johnson believes that over the last thirty years, video games and television shows have grown more complex and they have forced us, as a consequence, to use the higher-order thinking skills within our brains, much more so than if we were doing something else, like reading. According to Johnson, games teach abilities in pattern recognition, probability, and understanding relations of cause-and-effect that can be widely applied. He believes that our brains are drawn towards systems that reward exploration of particular kinds of environments. As far as television shows go, Johnson believes many have grown increasingly more challenging. The number of plot threads in television dramas has increased and become more complex. "Flashing arrows" or hints to help viewers follow complex plot twists are also used regularly. Even bad TV, reality shows, for example, is much better than the bad shows people watched in the 1960s and 1970s. Following the strategies of the participants in reality shows and their emotional shifts and turns requires much more emotional intelligence than that required for watching simple sitcoms.

Needless to say, Johnson's argument has found many detractors. Sex and violence permeate popular culture, particularly in video games and films. Study after study has shown that extensive TV viewing is associated with violent or highly aggressive behavior, poor school performance, obesity, early experiments with sex, and the use of drugs or alcohol. In addition, reading has become a less important part of people's daily lives, particularly the kind of reading needed to follow a difficult book. Johnson does not deny these concerns, but he feels that values issues about the content of the media should be addressed by parents, families, schools, and communities. The actual media themselves are not to blame and, in fact, can be valuable in sharpening our mental skills and make us smarter.

The debates about the potentially harmful effects of the media are likely to continue for years to come. Explore these issues in depth by researching on the Internet.

Lesson 3
Health Care: A Right or A Privilege?

Preparation

Ask students if they believe the idea that if we have the technological ability to do something we should do it. Discuss with them the idea of "the technological imperative" described in Student Handout 3.1 (Growth of Health-Care Technology) in relationship to death and dying. Would students want to be kept alive if their quality of life was totally diminished? Students might discuss the Terry Schiavo case that was in the news in 2005.

Introduction

Reread the brief background essays in Student Handout 1.1.

Activities

Students will research and complete Student Handout 3.2 (Medical Technology Chart). They will also continue work on the "Advances in Science and Technology" timeline.

Assessment

After reading Student Handout 3.3 (Medicine in the Twenty-First Century), students should brainstorm the controversial topics and choose one in which they are most interested. Then, have them research and write a persuasive essay on the topic. Encourage students to use facts to support their opinions (perhaps including the opposing viewpoint for comparison and contrast), to avoid the first person ("I," "me," or "my"), and to use transitional words to link paragraphs together.

Lesson 3

Student Handout 3.1—Growth of Health-Care Technology

In the past thirty years, health-care systems have seen rapid technological innovation throughout the industrialized world. Advocates see technology as a way to create a better life and believe that technological advancements continue because they benefit society, giving citizens healthier and longer lives. Others, particularly in the US, see society as being controlled by a "technological imperative." This is the inclination to use a technology that has potential for some benefit, however marginal or unsubstantiated, based on a fascination with the technology itself, the expectation that new is better, and financial and other professional incentives. While the debate continues, medical technology continues to advance at an astounding rate. The development and use of modern health-care technology over the last few decades has been phenomenal. This can be seen particularly in cardiac technology, critical care medicine, reproductive technology, medical imaging, and the use of health-care computers.

Important innovations in cardiac technology include the cardiac pacemaker that helps keep the heart's electrical activity paced properly, and the defibrillator, which maintains the rhythmic contractions of the heart to help avoid a heart attack. The first heart transplant was performed by Dr. Christian Barnard in 1967. Heart transplants, as well as numerous other organ transplants, are now performed on a routine basis.

Critical care medicine has seen significant advances, notably in treatment of cardiopulmonary patients, that is, those with insufficient heart and lung capacity. An estimated 20 percent of hospital patients require some form of respiratory therapy or support. Systems for maintaining adequate oxygen levels and mechanical ventilation for patients who are unable to breathe on their own are used routinely in hospitals.

Medical imaging techniques such as nuclear medicine, ultrasound, computer tomography (CT or CAT scans), and magnetic resonance imaging (MRI), allow pictures to be taken of internal bodily organs. MRI has become of fundamental importance in the medical field. In 2003, Paul Lauterbur and Sir Peter Mansfield were awarded the Nobel Prize in Medicine for their discoveries concerning MRI. Lauterbur discovered that gradients in the magnetic field could be used to generate two-dimensional images. Mansfield analyzed the gradients mathematically.

Computers have also changed the way health care is delivered. The Internet has produced numerous opportunities for sharing, obtaining, and discussing information. Some examples of medicine on the Internet are digitized medical journals, public health education, discussion groups, and education. In fact, many patients often research their own medical conditions on the Internet and feel free to question or challenge health care professionals based on their newfound knowledge. This change in access to medical information may have long-term implications for doctor and patient relationships.

Three areas of health-care technology that have received much attention in recent years but do not deal with issues of acute care are reproductive technology, plastic surgery, and eye surgery. The problem of infertility in both males and females has been partially eased in the past few decades owing to innovative techniques such as artificial insemination and *in vitro* fertilization (a technique in which egg cells are fertilized outside the woman's body). Increasingly, plastic surgery, which was originally developed as reconstructive surgery to treat disfigured soldiers from World War I, has given way to cosmetic surgery. Cosmetic surgery is a popular avenue for personal enhancement, as demonstrated by the 11.7 million cosmetic procedures performed in 2007 in the US alone. Eye surgery has also become quite popular, especially refractive surgery, which aims at correcting errors of refraction in the eye, reducing or eliminating the need for corrective lenses.

Sources: Consumer Guide to Plastic Surgery, http://www.yourplasticsurgeryguide.com/trends/charts-graphs.htm; Gregory L Weiss and Lynne V. Lonnquist, *The Sociology of Health, Healing, and Illness* (Englewood Cliffs, NJ: Prentice Hall, 2000).

Magnetic Resonance Imaging (MRI) Scanner

Wikimedia Commons, Photo by User Kasuga Huang

Lesson 3

Student Handout 3.2—Medical Technology Chart

Directions

Complete the chart below by listing key inventions in three fields of medical technology that have transformed medicine over the last few decades.

	Technology	**Inventor**	**When First Used**	**Purpose**	**Effects On Treatment and Care**
Cardiac Care	**1.**				
	2.				
Critical Care Medicine	**1.**				
	2.				

Medical Imaging	**1.**				
	2.				
	3.				

Lesson 3

Student Handout 3.3—Medicine in the Twenty-First Century

The Human Genome Project

This $3 billion project was formally founded in 1990 by the US Department of Energy and the US National Institutes of Health, and was expected to take 15 years. The task was to find the sequence of DNA for every single gene in a complete set of human chromosomes. We call this sequence the human genome. Owing to widespread international collaboration between research laboratories in the US, Europe, Asia, and Australia, and to advances in the field, the task was completed in 2003.

The instructions for an entire human are held in 30,000 to 40,000 different genes and all but a small percent of these are common to our nearest relatives, the chimpanzees. The risk of developing many disorders, such as Alzheimer's, diabetes, and heart disease, may well be influenced by our genetic make-up. Greater understanding of the human genome will direct the development of medicines to help treat and prevent diseases over the next hundred years. Advances in genetics will allow treatments to target the genes or specific proteins that cause disease. Gene therapies are being developed that aim to replace faulty genes and so reverse the effects of inherited disorders, such as cystic fibrosis.

Ethics and Medicine

Advances in medical science will not come without a great deal of controversy. New technologies will create many social consequences. While they will create new options for people, they will also stimulate reflection on values and raise social policy questions that must be resolved. Two primary areas of concern focus upon privacy rights and access to care.

In the wake of the attacks on the World Trade Center and the London terrorist bombings, new forms of surveillance technology have been given a greater impetus. Biometric cameras that capture the details of someone's face and other similar scanning devices are already in use. Functional Magnetic Resonance Imaging, or the so-called "brain fingerprinting technique," could be used as a sort of high-tech lie detector. But, if suspects' mental privacy were invaded, would not they have been forced to testify against their will? Does this sort of self-incrimination violate their Fifth Amendment rights?

As medical technology improves, individuals will be able to develop a medical profile based on genetic and environmental factors. This would allow them to be warned of diseases that they are likely to develop in older age. But this profile could also be used to assess a person's suitability for insurance or employment. How can we protect the health rights of the individual?

Many believe that genetic engineering and stem cell therapies may provide cures for diseases such as cancer, leukemia, and Parkinson's, but tampering with genetic materials brings with it great controversy. For instance, genetic screening already allows parents to test for certain abnormalities that embryos might possess and then decide whether or not to terminate a pregnancy based on the information received. In the case of *in vitro* fertilization, scientists could help prospective parents implant in the woman's womb an embryo with a specified range of desired characteristics—a "designer baby," in other words.

As life expectancy rises, a major challenge will emerge in the treatment of the elderly, but economics will continue to shape access to care. The question already affects millions of people worldwide: Who gets treatment and who does not? Those who have money have an ever-increasing number of options for treatment, while people throughout the world continue to suffer from diseases of poverty.

Modern medicine will continue to face new challenges and find new solutions for the twenty-first century, while the ethical and moral concerns of society will continue to shape the development of new medicines and treatments.

Sources: Jeffrey Rosen, "Roberts v. The Future," *New York Times Magazine*, 28 Aug. 2005: 24-50; Gregory L Weiss and Lynne V. Lonnquist, *The Sociology of Health, Healing, and Illness* (Englewood Cliffs, NJ: Prentice Hall, 2000).

Lesson 4
A History of Space and Time

Preparation

If these can be made available, watch segments from the PBS series "Stephen Hawking's Universe." The website to accompany the series is at http://www.pbs.org/wnet/hawking/html/home.html. For Shop PBS, see http://www.shoppbs.org/sm-pbs-stephen-hawkings-universe-3pk-dvd--pi-1823227.html.

Introduction

Read Student Handout 4.1 (Stephen Hawking's Universe). Discuss the new discoveries in scientists' understanding of space and time.

Then, if it can be made available, show the segment from the film *Apollo 13* showing how the people of the US and much of the world were transfixed by the drama of this legendary, near-disastrous space flight. Ask students to discuss these questions: Do space flight and exploration capture the public imagination as much today as they did during the 1970s? Why or why not?

Activities

Read Student Handout 4.2 (A Short History of the Space Program) and discuss. What have been the main achievements of the space program? Why is it important that manned space exploration continue, when non-human flights can achieve many of the same goals?

Sequence Mapping

After students read Student Handout 4.2, have them work in groups to trace the advances in space exploration through sequence mapping. Students should decide which events to include on their maps and then organize them in the order in which they occurred. Students can use words, pictures, or diagrams to show how the order of events took place. Groups should present their maps to the class.

Assessment

Students should continue work on their "Advances in Science and Technology" timeline, including key events in space exploration and the work of Stephen Hawking.

Lesson 4

Student Handout 4.1—Stephen Hawking's Universe

What existed at the beginning of space and time? Where did the universe come from—and where is it headed? What is our place in the universe? Throughout history, imaginative mathematicians and scientists have sought the answers to these fundamental questions. Copernicus, Galileo, Newton, Einstein, and others used direct observation, reasoning, applied mathematics, and new technologies to overturn ideas about cosmology that were once deemed fundamental truths. Their breakthroughs reshaped science's understanding of the nature and structure of the universe. Their work, and that of other important cosmologists, not only provided new explanations of the universe but also raised seemingly paradoxical questions. Did the vast variety and mass of matter that make up the cosmos evolve from nothing but energy? If so, where did the energy that created all of the matter in the universe come from? The history of cosmology is a detective story in which each discovery leads to even more puzzles. Yet each step brings scientists closer to cosmology's ultimate goal—a single theory that takes into account all the forces shaping the universe.

Stephen Hawking
NASA, StarChild
http://starchild.gsfc.nasa.gov/docs/StarChild/whos_who_level2/hawking.html

Stephen Hawking is one of the great contemporary physicists working in the area of cosmology. In many ways he stands on the shoulders of his predecessors Albert Einstein and Edwin Hubble. Einstein is most famous for his general theory of relativity and the equation E=mc2. Published in 1915, it proposed a new way to look at gravity and the operations of the universe on a large scale in relation to space and time. Working from Einstein's theory, Edwin Hubble arrived at the conclusion that at some point in space and time there was a physical beginning to the universe, the "Big Bang," and that the universe has been expanding ever since.

Scientists generally agree on the Big Bang origin of the universe as we see it today. Fifteen billion years ago there was a momentous event whose nature is uncertain, and the details remain murky. Recently, new theories in relativity and quantum mechanics have been proposed that seem to shed light on these earliest times. The physicist generally credited with bridging the gap between these new theories and the earlier work of Einstein and Hubble is Steven Hawking.

Stephen Hawking was born January 8, 1942, in Oxford, England. He was drawn to cosmology, he has said, because it asked "the really big question: where did the Universe come from?" In 1971, he provided mathematical support for the Big Bang theory of the origin of the universe. While studying at Cambridge, Hawking developed amyotrophic lateral sclerosis, more commonly known as Lou Gehrig's disease. The illness attacks and disables skeletal muscles and affects such basic functions as speech and swallowing. Today Hawking depends on a motorized wheelchair for mobility and, because a tracheotomy injured his vocal chords, he "speaks" through a voice-processing program that responds to words he keys into a specialized portable computer.

Sources: "Stephen Hawking's Universe," PBS Online, http://www.pbs.org/wnet/hawking/html/home.html; "Stephen Hawking," Wikipedia, http://en.wikipedia.org/wiki/Stephen_Hawking.

Lesson 4

Student Handout 4.2—A Short History of the Space Program

The National Aeronautics and Space Administration (NASA), which was established in 1958, is the agency responsible for the public space program of the United States. It is also responsible for long-term civilian and military aerospace research. Following the success of the *Mercury* and *Gemini* programs in the early 1960s, the *Apollo* program was launched to try to do interesting work in space and possibly put humans around (but not on) the moon. The direction of the *Apollo* program was radically altered following President John F. Kennedy's announcement on May 25, 1961, that the US should commit itself to "landing a man on the moon and returning him safely to the Earth" by 1970. Thus, *Apollo* became a program to land humans on the moon. The *Gemini* program was started shortly thereafter to provide an interim spacecraft to prove techniques needed for the now more complicated *Apollo* missions.

After eight years of preliminary missions, including NASA's first loss of astronauts with the *Apollo* 1 launch-pad fire, the program achieved its goals with *Apollo* 11. The spacecraft landed Neil Armstrong and Buzz Aldrin on the moon's surface on July 20, 1969 and returned them to earth safely on July 24. Armstrong's first words upon stepping out of the *Eagle* lander captured the momentousness of the occasion: "That's one small step for [a] man, one giant leap for mankind." Twelve men set foot on the moon by the end of the *Apollo* program in December 1972. NASA had won the moon race with the USSR, and in some ways this left it without direction, or at the very least without the public attention and interest necessary to guarantee large budgets from Congress.

Plans for ambitious follow-on projects to construct a space station, establish a lunar base, and launch a human mission to Mars by 1990 were proposed, but with the end to procurement of *Saturn* and *Apollo* hardware there was no capability to support these plans. The near-disaster of *Apollo* 13, where an oxygen explosion nearly doomed all three astronauts, helped to recapture attention and concern. But although missions up to *Apollo* 20 were planned, *Apollo* 17 was the last mission to fly under that program's banner. The program ended because of budget cuts (in part due to the Vietnam War) and the desire to develop a reusable space vehicle.

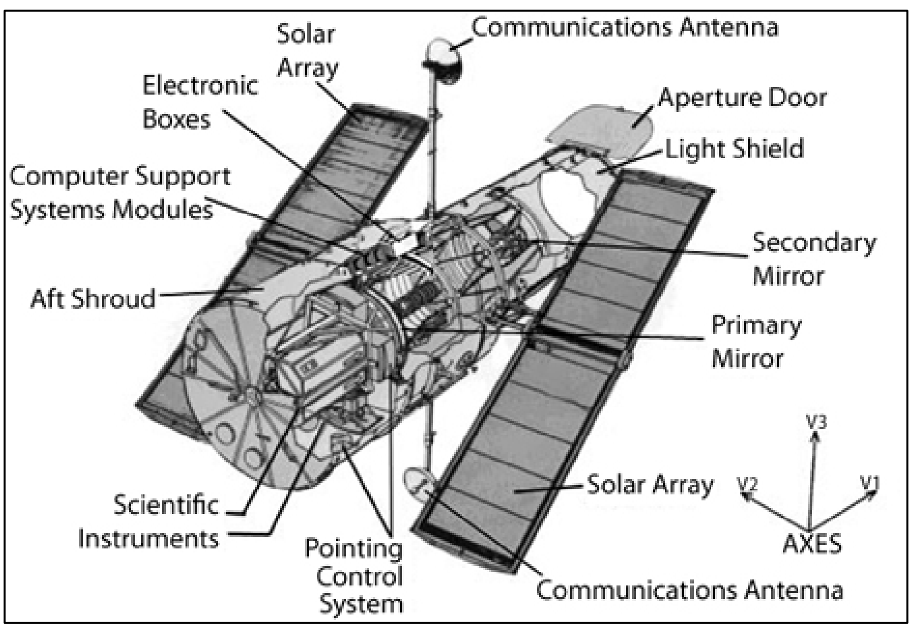
The space shuttle became the major focus of NASA in the late 1970s and the 1980s. Planned to be a frequently-launchable and mostly reusable vehicle, four space shuttles were built by 1985. The first to launch, *Columbia*, did so on April 12, 1981. The shuttle was not all good news for NASA: flights were much more expensive than initially projected. After the 1986 *Challenger* disaster highlighted the risks of space flight, the public again lost interest. Nonetheless, the shuttle has been used to launch milestone projects like the Hubble Space Telescope (HST). The HST was created with a relatively small budget of $2 billion but has continued to operate since 1990 and has delighted both scientists and the public. Some of the images it has returned have become near-legendary, such as the groundbreaking Hubble Deep Field images. The HST is a joint project between NASA and the European Space Agency (ESA), spearheaded by Russia. Its success has paved the way for greater collaboration between the agencies.

In 1995 Russian-American collaboration was again achieved as the Shuttle-Mir missions began. Once more, a Russian craft (this time a full-fledged space station) docked with an American vehicle. This cooperation continues to the present day, with Russia and America the two biggest partners in the International Space Station (ISS), the largest space station ever built. The strength of their cooperation was even more evident when NASA began relying on Russian launch vehicles to service the ISS following the 2003 *Columbia* disaster, which grounded the shuttle fleet for more than two years.

Costing over one hundred billion dollars, the ISS has at times been difficult for NASA to justify. The population at large has historically been hard to impress with details of scientific experiments in space, preferring news of grand achievements. Even now, the ISS cannot accommodate as many scientists as planned. During much of the 1990s, NASA was faced with shrinking annual budgets. In response, NASA's ninth administrator, Daniel S. Goldin, pioneered the "faster, better, cheaper" approach that enabled NASA to cut costs while still delivering a wide variety of aerospace programs (Discovery Program). That method was criticized and re-evaluated following the twin losses of the *Mars Climate Orbiter* and the *Mars Polar Lander* in 1999.

The Space Shuttle program has continued to be plagued with problems. A piece of debris broke off the external fuel tank on *Discovery* upon its July 26, 2005 launch. A similar problem is blamed for setting off the chain of events that led to *Columbia*'s disintegration in 2003. NASA announced on July 27 that the shuttle fleet would be grounded until investigations were completed and the problem of foam debris solved. NASA sent a mission to service the telescope in October 2008, the last repair mission envisioned.

Source: NASA, The Hubble Space Telescope, http://hubble.nasa.gov/missions/intro.php; "Space Shuttle," Wikipedia, http://en.wikipedia.org/wiki/Space_shuttle.



Hubble Space Telescope
NASA
http://hubble.nasa.gov/technology/spacecraft.php

Lesson 5
The World Is Flat

Preparation

Have students brainstorm a list of the five biggest challenges facing the US today. List the challenges on the board and briefly discuss.

Introduction

Explain to students that many people believe the greatest challenge facing the US is the economic challenge of **globalization**. Discuss the meaning of globalization. (It is a term used to describe the changes in societies and the world economy that result from dramatically-increased international trade and cultural exchange. It describes the increase of trade and investing due to the falling of barriers and the interdependence of countries.)

Introduce Thomas Friedman's *The World Is Flat: A Brief History of the Twenty-First Century*. The book focuses on how technological advances have recently affected globalization by leveling the economic playing field for many areas of the world. Have students read Student Handout 5 (The World Is Flat) and discuss.

Activities

Assign students to work in groups to analyze one of Friedman's ten flatteners. Each group should research its flattener by collecting, evaluating, and employing information from multiple sources. Some flatteners work better than others. In particular, Friedman's definition of "insourcing" (flattener 8) is at odds with some other definitions of the term.

Students should continue work on their "Advances in Science and Technology" timeline, including Friedman's ten flatteners.

Assessment

You may want to give students the option of presenting their information in a variety of formats. Oral presentations might be done as simple reports or as a skit or other dramatic recreation of the events. Individuals should be responsible for brief written reports that feature analysis, solid documentation, and accuracy.

Sources: Thomas L. Friedman, *The World Is Flat: A Brief History of the Twenty-First Century* (New York: Farrar, Straus, and Giroux, 2005).

Lesson 5

Student Handout 5—The World Is Flat

The World Is Flat: A Brief History of the Twenty-First Century by Thomas L. Friedman analyzes the progress of globalization in the early twenty-first century. His central theme is the "flattening" of the world, a metaphor for the global leveling of competition and capability through globalization. The author analyzes how accelerated change is made possible by technological advances like cell phones, the Internet, open source software, and so on. He emphasizes the inevitability of a rapid pace of change and the ways in which emerging abilities of individuals and developing countries (like China and India) are creating many pressures on businesses and individuals in the US. In the book, Friedman identifies ten forces that have "flattened" the world. Below is a listing of the ten flatteners and the ways in which each has helped to flatten the world.

1. 1989. The fall of the Berlin Wall unlocked the economic potential of millions of people who had been stymied by the state-controlled economies characteristic of the communist political system.

2. 1995. The first true Internet browser, Netscape, offered its shares to the public. The excitement of this innovation led to the rapid growth of the Internet. Perhaps most importantly, it led to the massive investment in technology, known as the dot-com stock bubble, that brought massive investment in the fiber-optic cable needed to carry all the digital information.

3. Late 1990s. Work flow software was created to maximize computer use. In particular, software, called transmissions protocols, was developed to allow people to connect software programs together.

4. Late 1990s. The open source movement began with software creators whose source code was made freely available, end-users having various degrees of rights to modify and redistribute the software, as well as the right to use the software for commercial purposes. It has made software and information freely available to people around the world and in the process leveled the playing field.

5. Late 1980s. Outsourcing is the contracting-out of jobs from internal production to an external entity. It also implies transferring jobs to another country or building a facility in an area where labor is cheap. While it originally referred to manufacturing jobs, it increasingly includes more high technology jobs.

6. Late 1980s. Offshoring is the relocation of business processes to a lower cost location, usually in a different country from where the business is headquartered.

7. Early 1990s. Supply-chaining refers to creating a network of facilities and distribution options that buys materials, transforms them into intermediate and finished products, and then distributes the finished products to customers. Friedman sees Wal-Mart as the most efficient company at improving its supply chain.

8. Early 1990s. According to Friedman, insourcing is when a business takes over certain unwanted functions of a corporation (like UPS does for transportation) and sells the corporation this service so that both companies profit.

9. Mid-1990s. Friedman calls in-forming the search engines like Google that allow masses of people to find out an unlimited amount of information about many things.

10. Late 1990s. "Steroids" is the term Friedman uses to describe wireless technologies, like cell phones, personal digital assistants (PDAs), etc., that amplify all the other flatteners.

This unit and the Three Essential Questions

HUMANS & the ENVIRONMENT	We know that new technologies have had a huge impact on the earth's natural and physical environment. In what ways do you think new technologies have the ability to limit or reverse the negative impact of globalization on the environment?
HUMANS & other HUMANS	What are some of the social implications of advanced health-care technology? Should all patients have a legal right to either demand or refuse advanced health-care technology?
HUMANS & IDEAS	What are "intellectual property rights?" Should intellectual property rights be sacrosanct, or should people have the right to access, use, modify, or remix material such as software programs, as long as they give credit to the creator of the source?

This unit and the Seven Key Themes

This unit emphasizes:

Key Theme 2: Economic Networks and Exchange

Key Theme 4: Haves and Have Nots

Key Theme 6: Science, Technology, and the Environment

This unit and the Standards in Historical Thinking

Historical Thinking Standard 1: Chronological Thinking

> The student is able to (B) identify in historical narratives the temporal structure of a historical narrative or story.

Historical Thinking Standard 2: Historical Comprehension

> The student is able to (D) evidence historical perspectives.

Historical Thinking Standard 3: Historical Analysis and Interpretation

> The student is able to (B) compare and contrast differing sets of ideas, values, personalities, behaviors, and institutions.

Historical Thinking Standard 4: Historical Research Capabilities

The student is able to (C) interrogate historical data by uncovering the social, political, and economic context in which it was created; testing the data source for its credibility, authority, authenticity, internal consistency and completeness; and detecting and evaluating bias, distortion, and propaganda by omission, suppression, or invention of facts.

Historical Thinking Standard 5: Historical Issues-Analysis and Decision-Making

The student is able to (C) identify relevant historical antecedents and differentiate from those that are inappropriate and irrelevant to contemporary issues.

Resources

Resources for teachers

Friedman, Thomas L. *The World Is Flat: A Brief History of the Twenty-First Century*. New York: Farrar, Straus, and Giroux, 2005.

Johnson, Steven. *Everything Bad Is Good for You: How Today's Popular Culture Is Actually Making Us Smarter*. New York: Riverhead, 2005.

Koman, Richard. "An Interview with John Markoff," The O'Reilly Network, 20 July 2005, http://www.oreillynet.com/pub/a/network/2005/07/20/johnmarkoff.html.

Lessig, Lawrence. Stanford University Law School, http://www.lessig.org/.

Markoff, John. *What the Dormouse Said: How the 60's Counterculture Shaped the Personal Computer Industry*. New York: Viking, 2005.

McManus, Sean, "A Short History of File Sharing," http://www.sean.co.uk/a/musicjournalism/var/historyoffilesharing.shtm.

MouseSite, The Demo, http://sloan.stanford.edu/MouseSite/1968Demo.html.

PBS Online, "Stephen Hawking's Universe," http://www.pbs.org/wnet/hawking/html/home.html.

Rosen, Jeffrey. "Roberts v. The Future", *New York Times Magazine,* 28 Aug., 2005: 24-50.

Weiss, Gregory L. and Lynne V. Lonnquist. *The Sociology of Health, Healing, and Illness*. Englewood Cliffs, NJ: Prentice Hall, 2000.

Resources for students

Friedman, Thomas L. *The World Is Flat: A Brief History of the Twenty-First Century*. New York: Farrar, Straus, and Giroux, 2005.

Johnson, Steven. *Everything Bad Is Good for You: How Today's Popular Culture Is Actually Making Us Smarter*. New York: Riverhead, 2005.

"Stephen Hawking's Universe", PBS Online, http://www.pbs.org/wnet/hawking/html/home.html.

Correlations to National and State Standards and to Textbooks

National Standards for World History

Era 9: The 20th Century Since 1945: Promises and Paradoxes. 3A: The student will understand major global trends since World War II.

California: History-Social Science Content Standard

Grade Ten, 10.11.1: Students will analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, computers).

Michigan High School Content Expectations: Social Studies

World History and Geography. Contemporary Global Issues. CG3 Patterns of Global Interaction. Define the process of globalization and evaluate the merit of this concept to describe the contemporary world.

New York: Social Studies Resource Guide with Core Curriculum

Unit Eight: Global Connections and Interactions, D. Science and Technology, 1. Information age/computer revolution/Internet; 6. Medical breakthroughs–disease control/life expectancy/genetics.

Virginia: History and Social Science Standards of Learning

WHII.15. The student will demonstrate knowledge of cultural, economic, and social conditions in developed and developing nations of the contemporary world by a) identifying contemporary political issues, with emphasis on migrations of refugees and others, ethnic/religious conflicts, and the impact of technology, including chemical and biological technologies.

Conceptual links to other teaching units

Big Era Nine considers a multitude of changes affecting humankind and its planet since about 1970. All of the lessons in this teaching unit may be linked in one way or another to the subject of the next unit, 9.6—Population Explosion and Environmental Change. In 9.5 students have had the opportunity to investigate five important topics. The computer revolution (Lesson 1) may be a powerful tool in restraining population growth in countries with high growth rates because computers and other electronic devices can help disseminate information about topics like birth control and reproductive health to people in rural areas anywhere in the world. The video game phenomenon, plus other activities that tie us closely to electronic media (Lesson 2), raises the question of ubiquitous (everywhere, all the time) media as an aspect of our physical environment. Might intensive exposure to media damage humans over the long term, or does it enhance certain skills and make them smarter? The connections between health care (Lesson 3) and change in the physical and natural environment are of course numerous and complicated. We also hear the question, “Is the success human beings have had extending their realm from the planet to the reaches of space polluting our atmosphere and potentially the moon and other planets?” (Lesson 4). Finally, what are the environmental and demographic (population related) dimensions of globalization? (Lesson 5)