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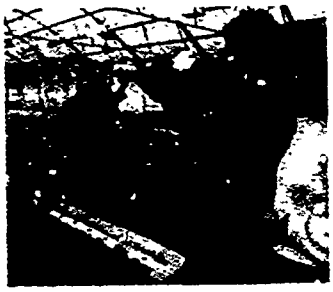
ABSTRACT

This resource guide accompanies "You, Me, and Technology," a 12-program series on science, technology, and society for junior high, high school and vocational students. Designed to be viewed separately or together and in any sequence, each program is matched by a lesson in this guide which contains an overview of the topics, content, objectives, and suggested teaching activities. General instructional activities to introduce the programs are included. Those to follow the programs include integrated activities and activities specific to each of five content areas: science and technology, mathematics, social studies, English/communications, and vocational education. These areas reflect the impact of the interactions of science, technology, and society on human life and on the schools. A set of transparency masters with suggestions for their use in the classroom to supplement the activities is included. A matrix correlates the contents of the video programs with textbooks in science, technology, and social sciences. There are also recommendations for readings and additional resources. (KR)

Teacher's Guide





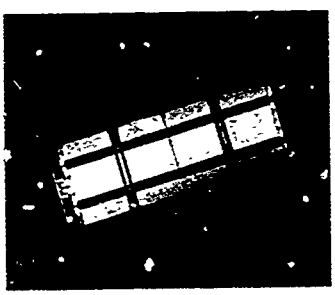


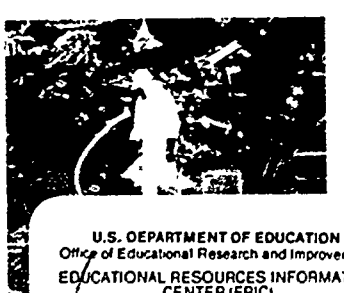

YOU, ME, AND TECHNOLOGY









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Teacher's Guide for

You, Me, and Technology

A series on science, technology, and society for
junior high, high school, and vocational school students

Project Director and Guide Writer

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Contents

Minaruth Galey, the project director of ***You, Me, and Technology***, holds a bachelor's degree in zoology and chemistry, a master's degree in genetics and biochemistry, and a doctorate in science education and educational technology. She has trained teachers since 1970, first as a professor at Temple University and now at the University of Colorado at Denver. She also brings to the project several years of experience working in research laboratories and thirteen years as a public school science teacher. ***You, Me, and Technology*** is the twenty-fourth instructional television series she has directed and/or produced.

To You, the Teacher

When you use any part of ***You, Me, and Technology***, a team of educators is assisting you. Teachers and curriculum and content experts helped in one or more stages of the development and evaluation of the student video programs, this teacher's guide with its transparency masters, the curriculum design, and an inservice video program.

Objectives for *You, Me, and Technology*

1. To develop technological literacy—that is, an awareness of the methods, structure, and general principles of technology.
2. To recognize the impact of technologies on society and the effects of social decisions on technologies.
3. To recognize that as society becomes more technological, only those who are technologically literate will be able to participate fully.
4. To develop an objective attitude toward technologies and to search for the tradeoffs between their costs and their benefits.

The 12 programs in the series are designed to be viewed separately or together and in any sequence. Each program is matched by a lesson in this guide which contains an overview of the topics and content, objectives, and suggested teaching activities. You are encouraged to adopt only those objectives important for your class and, of course, to add your own objectives. A thirteenth program, "Teaching with ***You, Me, and Technology***," is designed to help teachers develop classroom activities. It may be in your school video library.

The instructional activities to introduce the programs are general ones. Those to follow the programs include integrated (multidisciplinary) activities and activities specific to each of five content areas: science and technology, mathematics, social studies, English/communications, and vocational education. These areas reflect the impact of the interactions of science, technology, and society on our lives and on the schools. Some activities require only discussion or chalkboard work. Others require some preparation by the teacher and may be extended beyond one class period. A set of transparency masters with suggestions for their use in the classroom supplements the activities. A matrix correlates the contents of the video programs with textbooks in science, technology, and social sciences. There are also recommendations for readings and additional resources.

Yours is the key role in ***You, Me, and Technology***. The programs present basic concepts about technology and describe some ways technology interacts with society and with individuals. Only you can guide the students into a thoughtful comparison of the costs and benefits of technology in their lives.

We are proud to help you prepare your students to live in this technological society.

Minaruth Galey

Minaruth Galey, Ed.D.
Project Director

Program One Living with Technology (consumerism)

Overview

The Manning family illustrates how four areas of technological development touch people's lives and how people react in different ways.

Clothing—Once a cottage industry, clothing is now mass-produced so that almost everyone who wants can be well-dressed in any desired style. Advertising, unmatched in its use of modern communications media, creates desire for these new products.

Communications—A century and a half ago, news of a major event took months to travel by word of mouth. Now news reaches the world and beyond in an instant. Meanwhile, television, radio, and stereo sets entertain us. A barrage of noise is the price we pay. We need to decide when we're being informed, when we're being manipulated, and what's worth our time.

Transportation—The Mannings can live where they choose because of technology's triumph over distance. The trade-offs for this freedom of movement involve noise, air pollution, and the risk of death. Information technology makes a new kind of cottage industry possible for more and more people.

Food—Getting even so simple a food as milk to the table involves transportation, testing, processing, and packaging technologies. As a society, we're now more concerned about being overfed than about being underfed. We need to make responsible, informed decisions.

Objectives

After viewing the program and completing the activities, the students will show progress toward the goal of recognizing the trade-offs in technology by being able to

- Give an example of one technology or product of technology, other than computers, that they use in each of three areas of their lives—school, home, and recreation.
- Trace briefly the development of technologies from the lives of previous generations to their own lives in any two of these four areas—clothing, communications, transportation, food.
- Identify one personal advantage and one personal disadvantage to using products and/or processes of today's technologies in the areas of clothing manufacture, communications, transportation, and food.
- Describe with one example how technologies have contributed to "throw-away" attitudes.

Before the Program

1. Describe the objectives you have selected for the class.

2. Introduce the words "consumerism" and "technology." Note that technology is defined here as the use of human knowledge (science) and creativity to design processes and products to extend the capabilities of a human being and to modify the environment.

3. Discuss differences between technologies of today and of the recent past as they apply to sports.

Program Summary

The Manning family deals with the benefits, frustrations, and dangers of technological developments in clothing, communication, transportation, and food processing. Viewers meet Ruth Manning, who travels thousands of miles a day in her business as a management consultant; Ralph, an accountant, carries on his business at home with the help of a computer and modem. Their children, Debbie, 16, and Harry, 18, and Ruth's father, Arnold, who lives with them, deal with technology all day at home and at school. Ralph's hobby of fixing old radios leads to a presentation of the revolution in communications from the time of Andrew Jackson, when news took months to spread to the frontier, to the moon landing with instant communication back to earth. These developments involve trade-offs: noise pollution and the difficulty of distinguishing information from propaganda. Modern transportation, which permits the Mannings to live where they wish, is contrasted with older forms. Greater freedom of movement has also brought greater risks and pollution. Struggling with a faulty vending machine, Debby Manning exemplifies consumers who deal with the effects of highly developed food processing and distribution systems. The program ends by asking, "How free are we in a technological society?" It emphasizes that we must examine trade-offs to make good decisions.

After the Program

Transparency masters 1, 2, and 3 are particularly relevant to this program.

1. **Integrated**

   - Ask students to determine the advantages and disadvantages of a given technological advance. Divide the class in half, or into an even number of small discussion groups. Select one technology from the list below, or one of your own choice.

     off-shore oil drilling
     automobile
     nuclear power
     television
     jet propulsion
     computer

     Ask groups to brainstorm and list all the advantages of the technology chosen. They should consider advantages under such headings as betterment of health, cheap energy, increased leisure, faster communication, faster transportation, increased national security. The rest of the students should list the disadvantages of the technology. They should think of these under such

headings as health risk, safety risk, pollution, and unemployment. Pair opposing groups, have them exchange their lists, and then have each challenge the other's items. Challenges and defenses can be structured in the form of a debate.

After the debate, ask students to discuss some of the criteria that led them to judge a characteristic of a technology either an advantage or disadvantage. Ask them to name some technologies currently being debated and explain the issues at stake.

- Ask students to list at least a dozen events involving them that occurred between the time they got up and the time they entered school. Circle each item on the list in which they were making use of a technology or its product. Then have students interview their parents or grandparents to make a similar list of what previous generations did as teenagers between rising and entering school. Students may find accounts of the morning activities of even earlier times in such books as Laura Ingalls Wilder's *Little House* books or *Farmer Boy*, in Louisa May Alcott's *Little Women*, or in other historical novels.

  Then have the class brainstorm about the probable morning routine of future generations in the year 2020. Have them chart the information they have acquired.

Year	Clothing	Communications	Transportation	Food
1900				
1940				
1980				
2020				

2. **Science and Technology**

   - Set up a four-column chart on the chalkboard with the headings "Technology," "Yesterday," "Today," and "Future" to compare changes in personal technologies, such as treatment for a cold, hair care, and indoor games.

   - Develop a tree chart to show the spin-offs of knowledge, social effects, and technologies from any one technology or technological program. For example, if the trunk of the tree represented the space program, one branch would be labeled "Teflon" and another "microchips" to show these two items as by-products of problem solving totally unrelated to their everyday application. Teflon was developed for dry lubrication; the microchip, for lightweight electronics.

3. **Mathematics**

   - Have students review the properties of the binary number system and explain its importance in the present design of computers.

   - Have students discuss the impact of computers and calculators on problem solving today. Predict ways in which further advances in technology will effect the types of mathematical problems that can be solved more easily in the future.

4. **Social Studies**

- Propose removing products of technologies from the present setting and consider how we would manage. For example, without plastic, most of today's school desks, walls, pens, etc., would vanish. Is one technology more important than another? Is a technology's value proportionate to the products it produces?

- Have students interview their parents and grandparents to identify changes within their lifetimes in technologies of clothing, food, and entertainment.

5. **English/Communications**

- List words that have developed from technology, and those words from technology that are derived from Latin.

- Ask the students for examples from books or films of situations in which specific technological ideas, products, or developments are important. Organize them by type or by chronology. Discuss the roles the technologies played.

6. **Vocational Education**

- List jobs that students know were almost totally eliminated by technology. Then list jobs people do today that were created by technology.

- Take a trip to the supermarket to list technologies related to a family's weekly shopping. Note the technology of organizing the supermarket to force people through the entire market to make their purchases, even if they have a list of only three or four items.

Student Resources

Fox, Stephen. *The Mirror Makers: A History of American Advertising and Its Creators.* New York: Morrow, 1984.

Kaiser, Susan B. *The Social Psychology of Clothing and Personal Adornment.* New York: Macmillan, 1985.

Program Two — Decisions, Decisions, Decisions (information processing)

Overview

Technology is our way of using knowledge to expand human potential and modify the environment. It calls for complex decisions.

The first step in the decision-making process is gathering information, or input. This input is fed through a processor (a machine, an electronic amplifier, a human brain).

The processor delivers an output—the decision (a signal, a mechanical activity, human actions). Feedback becomes part of the input the next time such a decision is made.

Machines routinely make simple decisions for us. In industry, they are making more complex ones. Robotics is big business. Computers land jet planes and help diagnose illness. There may be no limit to the artificial intelligence of computers. Computers cannot, however, make value judgments. Personal, social, political, and ethical decisions are often limited by such constraints. People, not machines, must decide whether to build an SST, for example, or how to experiment with DNA.

Machines won't decide our fate unless we let them. By creating machines to enhance our society, we also assume responsibility for making decisions that affect society.

Objectives

After viewing the program and completing the activities, the students will show progress toward the goal of technological literacy by being able to

- Draw a model of basic information processing, indicating input, output, processor, and feedback.
- Describe the operation of machine processors such as the thermostat, using the terms input, output, processor, and feedback.
- List four examples of decision making that use technology.
- Give one example of how machines help human beings make improved decisions.

Before the Program

1. Describe the objectives you have selected for your class.
2. Discuss the way students make decisions on simple matters such as which clothes to wear to school. Then compare those methods with the ones used in complex decisions, such as career selection.

Program Summary

A flowchart diagrams the decision-making process. Examples of information processors include a machine, an electronic amplifier, or a human brain. Outputs, or decisions, might take the form of a signal, a mechanical activity, or human actions. An electronic driving game shows how feedback monitors our decisions. A simple furnace thermostat makes constant decisions. Robotics are machines that process a great deal of information to make very complex decisions. Modern instrument landing systems in airplanes make many decisions for the pilot, but the pilot must still provide input. A cardiologist shows how hospitals use computers for many life and death decisions, but ultimately the doctor and patient must provide personal judgment. Two computer scientists emphasize that a human intelligence must always remain in control of decision making. A flowchart diagrams how people make decisions about social and ethical problems when a variety of constraints apply. The program concludes that when there are social, political, and ethical constraints on decisions, humans, not machines, must make them.

After the Program

Transparency masters 1 and 4 are particularly relevant to this program.

1. Integrated

- Have students draw the model of information processing described in the video, or show them transparency 4. Ask various students to name decisions they make frequently. List these on the board. Choose several of these decisions and ask students to analyze them in terms of the model they have drawn. Make sure that they use the terms *input*, *output*, and *feedback*, and relate these correctly to different parts of their own decision-making process.

  Ask them what is most difficult about the decision-making process. Have them give examples.

  Ask them how technology can assist their decision making. Ask them for examples of technological innovations that help in gathering information, processing information, and providing feedback. Have them describe how these technologies work.

  Ask them to suggest kinds of decisions technology cannot or should not make.

  Have them discuss, giving reasons, whether machines will ever control all aspects of the decision-making process.

- Tell students to imagine that they are members of the city council of Techville. They will soon need to decide the following issue, which you will distribute or read to them.

  > Techville has been suffering a severe economic depression. Unemployment is high, and many stores are closing. The mayor has been working actively to attract new industries to the community. Now the mayor has found a chemical production company interested in building a plant on the edge of town. Local construction companies would be hired to build it, and the plant would hire approximately 1,000 workers when it opens. In addition, the company has promised to provide the local high school with up-to-date laboratory and audiovisual equipment, to build a recreation center with a large swimming pool, and to upgrade streets and highways in the neighborhood. The chemicals that the plant would produce would be highly toxic, however. Fumes generated in the production process would be vented into the air, and the factory would generate toxic waste that would have to be removed. Some of the chemicals are highly explosive. In an accident, a dangerous chemical cloud could be released. If the city council votes to offer the chemical company a tax abatement, it will come. If not, it will go elsewhere.

  Tell students that before they vote, they should follow these procedures.

  > List alternatives. *(They can propose various compromise alternatives, such as voting for the tax abatement only if the company agrees to certain restrictions and conditions, which the students should list.)*
  >
  > Cross off unacceptable alternatives.
  >
  > List the arguments for and against the alternatives that remain. *(Certain restrictions might be too expensive for the company to be willing to accept, for example.)*
  >
  > Choose the alternative that seems best.

Have students write a paragraph in which they discuss the alternatives they considered, state their decisions, and explain their reasoning

2. **Science and Technology**

- Compare brain functions with computing functions. What hardware parts would be needed to compare with 13 billion brain cells? What could the resultant machine do?

- Demonstrate the quantities of one million and one billion. Example: If one page of paper can hold a thousand characters (40 characters times 25 lines), then two reams of that paper can hold a million characters (a thousand times a thousand sheets of paper). Measure the height of two reams of paper (four inches). Then a billion characters (a thousand million) requires a stack of paper four thousand inches or 333 feet high—the height of a 30-story building. Compare this quantity to the number of dollars in the federal budget. How to count so much so fast? With computers, of course.

- Review the scientific principles and information processing involved in the way a thermostat works

3. **Mathematics**

- Review with students the structure of a flowchart. Have them design flowcharts showing a breakdown of their daily activities. They should insert a box where they make a decision. They might chart such activities as brushing their teeth, preparing a bowl of cereal, or solving a subtraction problem.

- In the videotape a polyhedron represented a DNA molecule. Ask students to define *polyhedron* and have them construct simple polyhedrons through paper folding. Ask them whether they can think of other polyhedrons in nature.

4. **Social Studies**

- Review the thermostat as an information processor. Then compare the operation of the thermostat to Climatrol, which is a system used in large public buildings that removes any opportunity for individual human intervention.

- Show how communications technology has enhanced the effectiveness of propaganda devices in commercial advertising. A brief reminder: The devices listed in the *World Book Encyclopedia* are simplicity and repetition, the use of symbols, gaining people's trust, distortion and concealment, lying, censorship, and terrorism.

5. **English/Communications**

- Discuss the importance of students' being able to follow oral and written directions, even when using computers.

- Write a science fiction story with a computer as the main character. Analyze the problem of supplementing logic with emotion to develop character, plot, and theme.

6. Vocational Education

- Identify ways in which data processing has affected the students' trades.
- Develop a list of the kinds of skills people in various trade areas will need to acquire as computers have an impact on different vocations.

Student Resources

Silver, Gerald A. *The Social Impact of Computers.* New York: Harcourt Brace Jovanovich, 1979.

Simons, Geoffrey. *Silicon Shock: The Menace of the Computer Invasion.* Oxford: Basil Blackwell, 1985.

Program Three The Technology Spiral
(four technology revolutions)

Overview

Major changes in the way we live have occurred because of four technological revolutions: the development of tools, the development of agriculture, the industrial revolution, and the current revolution in information processing. These revolutions in technology greatly improved productivity, but also increased the demand for energy and damaged the environment in a variety of ways.

The development of simple tools and the use of fire made it possible to feed more people with a given amount of land. As the domestication of plants and animals permitted even greater concentrations of people, cities began to develop. Specialization of labor was introduced and the invention of reading and writing contributed to the accumulation of knowledge.

Tools that depended on the energy of human muscles necessarily remained simple, but the introduction of the steam engine opened the industrial age. Fewer people were needed on farms and more were needed in the cities, where they performed specified tasks in exchange for fixed wages.

The development of the computer dramatically increased human capabilities and ushered in the "Information Revolution." The age of high technology also has given us the new science of biotechnology, which carries with it both the power to push agricultural productivity to unheard-of levels and the danger that organisms with harmful side effects might be created.

Objectives

After viewing the program and completing the activities, the student will show progress toward the goal of technological literacy by being able to

- Define technology as the use of knowledge (science) to produce products and processes to extend human capabilities and to modify the environment.

- Distinguish between hard and soft technologies, giving examples of each.
- Name the four technological revolutions, mentioning such characteristics as the kinds of tools involved, the effect on productivity, and the energy requirements.
- Show how the technology of each age influences life in that age.
- Explain how the technology of one age affects the development of the next age.
- Demonstrate, giving examples, that technological revolutions are area-specific rather than worldwide.

Before the Program

1. Discuss with students how their lives would be different without television or without some other specific technology.
2. Mention the four technological revolutions (tool, agricultural, industrial, and information) and ask students what books or movies they have seen that relate to one or more of them.
3. Describe the objectives you have selected for the class.

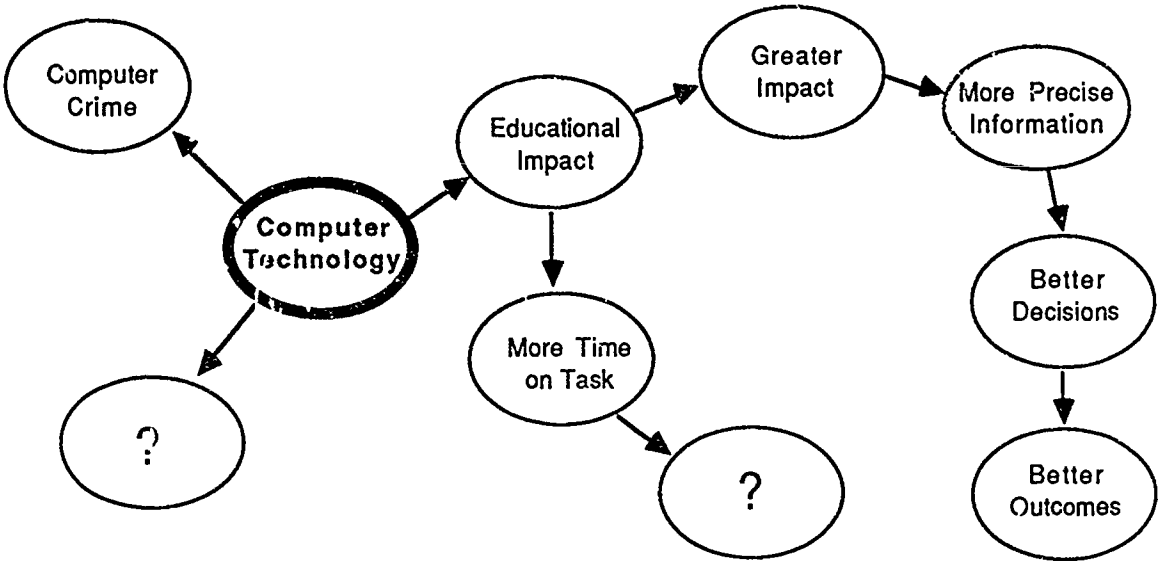
Program Summary

Jennifer likes to listen to music on her stereo unit, but when she is deprived first of the transistor, then of the vacuum tube, and then of a gramophone, she has to get out her fiddle and make music herself. The teenagers in the program dramatize life in a world in which in which there are no petroleum products, no one has yet invented the wheel, in which even agriculture is unknown. They witness the revolution brought about by the development of tools, first of stone and then of iron, and they learn how modern robotics and cybernetics represent the most recent turn in this technological spiral. A scientist points out that new methods of biotechnology promise extraordinary productivity, but they also carry new risks and make heavy demands on energy. The industrial revolution created a new working environment—the assembly line—and caused deforestation and pollution. We are now entering the age of information, in which revolutions in communications technology are swiftly reshaping our experience of the world.

After the Program

Transparency masters 2, 3, 5, 6, and 10 are particularly relevant to this program.

1. **Integrated**
   - Divide students into four groups. Ask each group to consider one of the technological ages. Specify a tool or feature of that age and have students brainstorm to create a "map" or "web" with that tool or feature at the center. Students asked to consider the impact of computers in the information age might create something like the "map" or "web" on the following page.



- Divide students into four groups. Ask each group to produce or describe a newspaper that the students imagine might have appeared during one of the four technological ages. How would the newspaper have been produced? What stories and editorials would have appeared? What products would have been advertised?

- On an outline map of the world, have students color code each area according to its technological development. For example, areas in the agricultural age might be colored green, areas in the industrial age blue, and so on. Why don't the same technological revolutions take place in all countries at the same time? Are there similarities in technological development among the "third-world" countries? What factors influence when and where technological revolutions take place? Can technological development be forecast based on these factors?

2. Science and Technology

- Compare the schools (or learning places) in each of the four technological ages. What kinds of buildings, equipment, and teachers would they have had? What knowledge of science was needed? What processes of science were used?

- What scientific principles needed to be understood for the efficient operation of the technologies of each age? *(In the agricultural age, the efficient planting of seeds required the ability to predict the change of seasons, which required a knowledge of the principles of astronomy.)*

3. Mathematics

- Invite a photographer or photojournalism teacher to your class to explain the mathematics used in photography. The presentation should include a discussion of lens length, shutter speed, f-stop, and the interdependence of these. Calculating the enlargement or reduction of images should also be explained.

- Remind students that it has been predicted that robots may soon be performing much of the work currently done by human labor. Ask students to speculate about the kinds of mathematical and problem-solving skills that will be needed by people who will work with them.

4. **Social Studies**

- Have students record interviews with their grandparents or with other older people about technological changes that have taken place during their lifetimes. Students should have a list of current technologies and ask specifically about the impact of these.

- Divide the class into four groups. Have each group describe the impact that one of the four technological revolutions had on the family. For example, the industrial revolution moved the work site from home to the factory. This increased the division of labor in the family and meant that members of the family were separated for much of the day.

5. **English/Communications**

- Debate the use of computer programs that correct spelling or that point out possible grammatical and stylistic errors. Do such programs lessen the responsibility of the writer? Is work written with the help of such a program of less value?

- Have students read "There Will Come Soft Rains" from Ray Bradbury's *The Martian Chronicles*. What technologies are found in this story? How do these relate to information in the video?

6. **Vocational Education**

- On the chalkboard, list several technologies and their use in specific vocational fields. These might include robotics in automobile manufacturing, biotechnology in agriculture, automated tellers in banking, and word processors in offices. What employment opportunities do these technologies create? What opportunities do they reduce or eliminate? What levels and kinds of skills are needed to take advantage of the opportunities created? Do these technologies create or eliminate any safety hazards?

- Create a list of future careers that students think will open up as technology advances. They should feel free to suggest such "blue sky" careers as environmental space ecologist or satellite welder. Make a second list of careers that students think will be eliminated.

Student Resources

The Drive for Power. 52-min. color film. 1973. Distributed by Time-Life Video.

Mumford, Lewis. *Technics and Civilization*. New York: Harcourt Brace Jovanovich, 1963.

Program Four Energy for Societies
(alternative energy sources)

Overview

The discovery of fossil fuels literally moved the work of the world off the backs of humans. Plentiful supplies of iron and coal made possible construction of engines that markedly increased the productivity of the industrial nations. Industrial societies consume far more energy than preindustrial societies did. As the productivity of a society increases, so does its need for energy. Societies in the world today are at various technological levels. With these advancing levels of technology come increasing levels of energy consumption. We must find alternatives to fossil fuels and carefully assess the trade-offs between the use of fuels and damage to the environment.

We must become more skilled at recognizing the advantages and disadvantages of various energy sources so that we can minimize the threat to the environment and to human life. Our failure to recognize the trade-offs has already resulted in damage to the environment and the depletion of some energy sources. Supplies of wood, coal, gas, and oil are limited, and so many products are made from oil that it is becoming too valuable to burn.

Nuclear energy can produce great amounts of energy by nuclear fission—splitting atoms. This process has been highly developed by scientists and engineers, but the problems of moving and storing the radioactive wastes produced by nuclear reactors have alarmed many citizens. The technologies of both passive and photoelectric solar energy are based on well-understood scientific principles, but economic factors sometimes limit their use. Wind turbines and various kinds of biomass—trees, crops, even garbage—can be converted into usable energy.

Objectives

After viewing the program and completing the activities, the student will show progress toward the goal of technological literacy by being able to

- Name several alternative energy sources and the advantages and disadvantages of each.
- Describe briefly the greenhouse effect and a major environmental problem associated with it.
- Describe briefly how solar energy and atomic energy are converted into electricity.
- Tell what happens to a society's energy consumption as its standard of living and its productivity increase.
- Determine the part energy plays in his or her own life and develop a personal plan for energy conservation.

Before the Program

1. Ask students if they know how energy is generated and where it comes from. List their answers on the board in a horizontal line.

2. Tell students that they will be asked to list the advantages and disadvantages of each energy source after they have viewed the program.

3. Describe the objectives you have selected for the class

Program Summary

A teenager concerned about the shrinking supply of oil and gas consults experts in various energy fields. She learns that only a 100-year supply of oil is left in the world, but all major alternatives pose problems. Coal is plentiful, but burning it produces a greenhouse effect and acid rain. Nuclear energy is cheap and nonpolluting, but it creates radioactive waste and may promote development of nuclear weapons. Passive solar energy, photovoltaics, and wind power offer promising and clean sources of energy, but they are still very expensive. Biomass, methane gas, and photosynthesis are natural energy sources that could be harnessed, but each has problems. Energy conservation and efficiency combined with cogeneration systems provide only a partial answer.

After the Program

Transparency masters 1, 2, 5, 6, and 8 are particularly relevant to this program.

1. **Integrated**

   - Look at the list of energy sources the students named before the program. Have them name any others they can think of. Then have them make a chart, either on the blackboard or on their own, filling in advantages and disadvantages of each energy source, following the format below.

	Advantages	Disadvantages
Coal		
Gas		
Wood		
Nuclear Power		
[Continue with other energy sources]		

   - Have students make an Energy Use Chart, using the format shown on the following page, to keep track of the energy they use for a full 24 hours. Sources of energy they might list include petroleum, coal, nuclear fission, solar energy, wind power, and energy from biomass. When all students have completed their charts, have one or more of them compile the results. What are the peak times

for energy use? What source of energy is used most? What generalizations can be made about energy use among teenagers? How could teenagers conserve energy?

Time	Energy Device	Use	Source of Energy
12 to 6 a.m.			
6 to 7 a.m.			
7 to 8 a.m.			
8 to 9 a.m.			
[Continue on through the day]			

2. Science and Technology

- To help students understand solar energy, place a thermometer in a glass of water and place the glass is a sunny spot in the classroom. Measure the time it takes the temperature to rise five degrees. Repeat this at various times during the day and make a chart of the results. Have students suggest and test ways of making the temperature rise faster. For example, glasses filled with the same amount of water might be set side by side—one on aluminum foil, one on black paper, and one behind a magnifying glass. Students might also try determining the effect of adding various colors of vegetable dye to the water.

- Have students learn to read the electric meters in their homes and determine how much energy is used in 24 hours. Add a column to the energy use chart for estimates (in kilowatt-hours) of electrical energy used for each time period. Find the total of the estimates and compare that with the actual amount used according to the meter.

3. Mathematics

Try to obtain information from your local power and electric companies. Most such companies have charts on yearly local energy consumption and information about various kinds of energy, different types of fuel used in the area, and relative costs of generating electricity. Make sure students understand all terms used in the activities that follow.

- Have students use information from local utility companies to prepare a circle graph (a pie chart) illustrating the sources of fuel used to generate electricity locally.

- Ask students to research and explain the meaning of *wattage* and compare the wattage of incandescent and fluorescent lights. Have them count the number of light bulbs in their homes. Ask them to calculate how much electricity would be used in their homes if all bulbs burned simultaneously for one hour. Compare the amount of energy used in 24 hours by one fluorescent bulb and an equivalent sized incandescent bulb.

4. **Social Studies**

- Have students discuss acid rain and other instances of one nation's or region's use of an energy source damaging another nation's or region's environment.
- Ask students to list ways in which their daily lives would change if the electricity were to be shut off for a month. Have them compare and discuss the lists.
- Have students give examples of possible government policies relating to the use of energy resources that—while intended to benefit all—might be perceived as unfair or unnecessarily harsh by some segments of the population. Suppose, for example, that the government were to ration gasoline.

5. **English/Communications**

- Have students write to the editor of a newspaper about why we should either increase or decrease our use of a particular energy source. The letters should state the problem, the possible solutions, and an opinion about which solution is best.
- In his book *Walden*, Henry David Thoreau discusses how he attempted to simplify his life by moving to Walden Pond. Have students read and discuss the first chapter ("Economy") as it relates to energy use in today's world. Do new energy sources make our lives simpler or more complex? Are Thoreau's ideas of economy and simplicity applicable to life in the information age?

6. **Vocational Education**

- Ask students to describe products they have seen advertised to improve home energy efficiency. How would decreased fuel prices affect the purchasing of such products as insulation, fuel-efficient heating systems, and weather stripping?
- Tour the plant in which electrical energy is generated for your area or have someone from that plant visit the class. Discuss the forecast for future energy demands and how those demands will effect jobs in energy industries. Find out about jobs in energy industries that require the following levels of training: high school, vocational school, apprenticeship, two-year college, four-year college, and graduate school.

Student Resources

"Energy: Fuels of the Future." *Time*, 11 June 1979.

Energy in Perspective. 21-min. color film. 1976. Distributed by BP North America.

O'Toole, James, and the University of Southern California Center for Futures Research. *Energy and Social Change.* Cambridge: MIT Press, 1976.

Program Five Health and Technologies (costs and benefits to society)

Overview

Individuals are responsible for their own health through nutrition and hygiene. Technology can prevent disease and also cure it by such means as chemotherapy and antibiotics.

Health technology has developed such highly sophisticated methods of saving and prolonging life as the transplantation of organs, the implantation of artificial organs, and life-support systems such as kidney dialysis machines. Balancing cost, risk, and benefits, however, is becoming more complex, and deciding whether to develop certain technologies is becoming more difficult. When such technology is in short supply, which patients should have priority? Under what circumstances is it ethical and humane to remove a patient from life support? What are the legal implications?

Objectives

After viewing the program and completing the activities, the student will show progress toward the goal of technological literacy by being able to

- Describe the difference between health technologies designed to save lives, sustain lives, and make life better.
- Describe how technology—orthotic and prosthetic devices—can provide for special needs of handicapped or disabled persons.
- Explain several options available to allow an individual to take responsibility for his or her own health.
- State some of the reasons that personal health care has become such an important activity in the United States.

Before the Program

1. Point out to students that the United States has become a health-conscious nation. Ask them to provide examples of this health-consciousness and to discuss the reasons for it.
2. List for students the objectives of this program.
3. Tell the students the program is about taking charge of one's health and enhancing one's capabilities. On the chalkboard write *biotechnology*, *orthotics*, *prosthetics*, *genetic engineering*, and *cell fusion*. Tell students that they should listen for the meaning of these terms. Then write in a horizontal line *Disease Control (i.e., diabetes)*, *Diet and Nutrition*, *Orthotic Devices*, and *Prosthetic Devices*. Tell them to watch for examples of each of these.

Program Summary

A visit to a large community health fair frames discussion of modern medicine. Health is "people taking care of themselves and others." Views of a hospital intensive care unit show how patient care has improved, but such units require specially trained personnel to use the equipment, and cost is a problem. These constraints raise difficult questions: Whose life shall we save? How much does it cost? Who should pay? A 19-year-old girl discusses her experiences with dialysis and kidney transplants. A visit to a health fair dramatizes how much of good health is the result of preventive care, involving such lifestyle issues as diet, hygiene, and exercise. Orthotics is another area in which technology supports medicine. A visit to a hospital operating room in which a pacemaker is installed demonstrates the great progress made in the last 20 years in treating patients of heart disease. Amputees are shown helped by developments in prosthetics, including a computer-driven, above-the-knee prosthesis. A visit to Temple University illustrates new refinements of the Jarvik artificial heart. Genetic engineering and biotechnology may some day supplant many current medical practices.

After the Program

Transparency masters 7 and 9 are particularly relevant to this program.

1. **Integrated**

   - Point to the terms you have listed on the board. Under one of the four phrases (*Disease Control (i.e., diabetes), Diet and Nutrition, Orthotic Devices,* and *Prosthetic Devices*), have students name several examples from the program or from their own knowledge and write them in a column. (*Under* Orthotic Devices, *for example, students might suggest kidney dialysis machines, eyeglasses, laser cane, and so forth. The artificial heart would be an example of a* Prosthetic Device.)

   - Ask students to consider the following.

     If and when the artificial heart is perfected, about 34,000 people per year will need the transplant at a cost of about $3 billion.

     Medicaid has paid for $2 billion worth of dialysis since 1976.

     The annual cost of hip-replacement surgery is estimated to reach $1 billion annually.

     Most of the cost of medical science and technology is passed on to taxpayers through such programs as Medicare and Medicaid.

     A former U.S. Surgeon General stated that "perhaps as much as one half of all U.S. mortality (in 1976) was due to unhealthy behavior or lifestyle; 20 percent to environmental factors; 10 percent to human biological factors; and 20 percent to inadequate health care."

     Using these and other facts they find on their own, students should write editorials taking a position on spending for health care in the U.S. today.

   - Orthotic and prosthetic devices have greatly helped disabled people to function almost normally. Architecture and engineering that consider their needs can also help them. Ask each student to submit an idea or design that would help solve a problem faced by handicapped or disabled people. For example, adding audible signals to traffic lights might help blind people.

2. Science and Technology

- Dialysis is the use of a porous membrane to separate materials dissolved in or suspended in a liquid. Have one or more students do research on how this process is applied in the artificial kidney and present their findings to the class.

- The program describes two areas in genetic engineering: the transplantation of genes from one species or individual to another; and the cloning of cells to grow outside the body. Have students use recent periodicals to learn more about the work being done in these two areas. What problems are scientists attempting to solve through each? What are the potential hazards?

3. Mathematics

- Ask students to bring in labels from tablet and liquid medication bottles. Have them notice the way dosage is labeled. *(A label showing "250 mg/5 ml," for example, shows that 5 ml of liquid medication contains a dosage of 250 mg.)* Ask students to figure the quantity of medication that would be necessary if the dose were doubled, halved, or increased by a third. Tell them that dosages for small children are often figured in terms of their weight. Have them solve the following problem, and then give them other similar ones, using these activities to review metric conversions and metric weights and measures.

  A pediatric medication is listed as 100 mg per 10 kilos of weight every 24 hours, and it is available in liquid form in which 10 ml contains 250 mg. How much should be given to an 88-pound child in each of four equal daily doses? *(88 lb. = 40 kg. Dosage for 40 kg is 4 x 100 mg or 400 mg every 24 hours. Divided into four equal doses, each dose should contain 100 mg. 250/100 = 10/X. Solving, X = 4. The child should have 4 ml four times a day.)*

- Invite the school nurse to the classroom to take the students' blood pressure and to explain the ratio used in reporting blood pressure. Identify "normal range" and discuss the process used to determine "average" or "normal." Ask students to explain how, in a given group of people, the average blood pressure could be above or below normal.

  Have the nurse discuss the ways in which mathematics are used in nursing. Ask the nurse or a guidance counselor for a list of the high school and college mathematics courses necessary for a degree in nursing.

4. Social Studies

- Discuss with students the personal and social problems that may arise as medical science and technology extend life expectancy.

- How are organ donations managed in your state? Discuss the social, ethical, and legal implications of such a program.

5. English/Communications

- Discuss with students the use of euphemisms and "doublespeak" in this area of health technology.

- In the novel *Brave New World*, Aldous Huxley describes a laboratory where human babies are grown in bottles. How does this laboratory compare with the technology in the program? Ask students if they have read—or assign them to

read--other science fiction that describes some type of biotechnology. What advances have been made toward the realization of the technology described?

- Have students read *Flowers for Algernon* by Daniel Keyes and write persuasive essays about why Charley's surgery should or should not have been performed.

6. **Vocational Education**

- Tour a local facility such as a hospital, a physician's office, or an ambulance service, or ask a local emergency unit to come to the school.

- Set up a three-column chart on the chalkboard with the headings "Home Health Assistance," "Health Technologies," and "Emergency Health Services." Ask students to list jobs that are emerging in each of these categories. What aptitudes and levels of training are required for these jobs?

Student Resources

Sochurek, Howard. "Medicine's New Vision." *National Geographic*, January 1987.

Dixon, Bernard. "Overdosing on Wonder Drugs." *Science 86*, May 1986, 40-43.

Program Six Feeding the World (agricultural technologies)

Overview

This program is about agricultural technologies and inequalities in the distribution of food around the world. Most Americans can eat for pleasure rather than necessity. Yet even in this country, as in many parts of the world, people are dying of hunger. How can we have giant food surpluses in some countries and starvation in others? Can technology solve this puzzle?

No single breakthrough can feed the world. Agricultural innovation has not been enough; transportation, the amount of workable land, population growth, the availability of water, and political shifts all effect food distribution. Food production has increased greatly over the past 50 years--American farmers can produce five to six times as much food on the same amount of land used in the 1930s. But today the world also has produced many more mouths to feed. Technological advances such as pesticides, machines, fertilizers, weed killers, and irrigation increase production; but overused, or used improperly, they lead to erosion of the soil, depletion of natural nutrients, and pollution of the ground water.

Improved technology will help feed the world, but more important is mobilizing people to use technology wisely, to balance costs and benefits, and to evaluate the many tradeoffs of each potential solution.

Objectives

After viewing the program and completing the activities, the student will show progress toward the goal of technological literacy by being able to

- List technologies that increase food production and describe briefly the trade-offs involved in one of these technologies.
- Recognize how social institutions and technical activities interact in the relationship between the growth of cities and increases in food production.
- Describe, with an example, the interdependence of societies and social responsibility with respect to surplus food in the United States.
- Compare the possible benefits and risks of biotechnology in general, or specifically those of the ice-minus bacteria.

Before the Program

1. Ask students to list and discuss reasons why over 500 million people in the world today suffer from chronic hunger and malnutrition.
2. List examples of technologies related to the production and preservation of food. After the program, you may want to compare the benefits and costs of each.
3. List for students the objectives of this program.

Program Summary

Four teenagers cruising fast-food restaurants learn that it is not easy for us to "get our act together" to feed the world. Dramatic segments, interviews, archival film footage, and scenes from farms, refugee camps, rock concerts, and markets around the world dramatize the dilemma of travelers on Spaceship Earth as their expanding population must be supported by limited and dwindling resources. Social organization is necessary when people all over the world are clamoring for food. Interviews with farmers and scientists show how advances in technologies can bring more food to more people, but each breakthrough involves negative trade-offs. Pesticides, fertilizers, ice-minus bacteria, forest clearing, one-crop farming, and aquaculture all promise higher crop yields, but each brings a variety of costs and benefits.

After the Program

Transparency masters 6, 11, and 12 are particularly relevant to these activities.

1. **Integrated**

   - Ask students to list the steps necessary to put cornflakes on a breakfast table. After you have written five or six steps on the chalkboard, divide the students into groups of no more than five people each. Ask each group to develop a detailed flowchart showing all essential steps, people, technologies, and materials necessary in the production and delivery of cornflakes to the breakfast table.

     Once each group has developed a flowchart, reconvene the class and design a master flowchart on the chalkboard. At a minimum, the following ideas should appear, in this approximate order.

land→ farmer→ seed→ water→ fertilizer→ pesticides→ planting machinery→ harvesting machinery→ gasoline and oil→ tires→ transportation→ storage facilities→ market→ bankers→ buyers→ transportation workers→ processing plant→ machinery→ carton manufacturer→ distributor→ food store→ buyer→ consumer

Have students circle the technology items on the flowchart. (*Everything but the people and land are technologies. If the water is delivered by irrigation, it, too, is considered as a technology product.*) Ask the students how important technology is to that bowl of cornflakes.

Ask students to describe the effect of a breakdown in any part of the flowchart. For example, what would happen if gasoline and oil were unobtainable?

- "You can learn anything if you have the right metaphor," said Ray Bradbury, the science fiction writer. Metaphors, or comparisons, are especially effective in understanding complex issues such as those in feeding the world, and they are used througnout the video program.

  With the song "Skip to My Lou" in the background, the program opens with scenes of overflowing food, farm animals, and happy, well-fed children. "My darlin'" shows that the children are loved; "eat all your food" indicates our problem of getting children to clean their plates. Harsh drumbeats accompanying pictures of hungry children accentuate the starkness of their existence. In only a few seconds, the viewers grasp the essence of the problem to be discussed.

  Have the students identify metaphors used in the program and tell what they mean. (*The difficulty of putting together a meal from a choice of fast-food restaurants is similar to the difficulty of providing sufficient food for the world's population; every possible solution has certain drawbacks. "Who's in the driver's seat? Your generation is up next" compares a teenager's role in the future to that of a driver of a car.*)

2. Science and Technology

- Nutritionists advocate eating "unprocessed or lightly processed foods." Have students list some of these. Where are they to be found? To what extent do even these depend on technologies? (*Raw fruits and vegetables were raised with the help of considerable agricultural technology; fresh fish have been caught with modern fishing techniques; and all foods involve transportation and distribution systems.*)

  Have students list foods consumed on the previous day. Ask them whether they have consumed any food item that is not dependent on technology. (*Only raw, wild fruits or berries, gathered and eaten on the spot, would probably qualify.*)

3. Mathematics

- Locate the person or office in your area who monitors weather data and reports to the National Weather Bureau. Arrange for that person to visit the class and discuss the types of data that are collected. Compare local rainfall amounts, temperature extremes, and average temperatures with other areas of the United States and other countries around the world. Explore the ways that technology

has changed the data collection, storage of information, and reporting process during recent years.

- Find out how many students attended your school during each of the past 10 years and make predictions on the enrollment for the next five years. Compute the percentage of increase or decrease for the time period. Prepare a line graph representing the data.

4. Science, Social Sciences, and Mathematics

- Have students make a graph to demonstrate the approaching land-deficiency crisis. Food needs currently grow at 3% each year, but land available for farming increases at a rate of 3% every 10 years. First create a table like the one below. Show students how the values for years 1 and 2 have been calculated. Then let them calculate the remaining values for years 3-10. (Values for all years are provided for your information.) Then have students graph the data for all 10 years.

Year	Food Needs (3%/yr)	Increase in Farmland (3%/ 10 yrs)	Deficiency
1	1.03 x 100 = 103.0%	1.003 x 100% = 100.3%	103.0–100.3 = 2.7%
2	1.03 x 103 = 106.1%	1.003 x 100.3% = 100.6%	106.1–100.6 = 5.5%
3	(1.03 x 106.1 = 109.3%	1.003 x 100.6% = 100.9%	109.3–100.9 = 8.4%)
4	(1.03 x 109.3 = 112.6%	1.003 x 100.9% = 101.2%	112.6–101.2 = 11.4%)
5	(1.03 x 112.6 = 116.0%	1.003 x 101.2% = 101.5%	115.9–101.5 = 14.4%)
6	(1.03 x 115.9 = 119.4%	1.003 x 101.5% = 101.8%	119.4–101.8 = 17.6%)
7	(1.03 x 119.4 = 123.0%	1.003 x 101.8% = 102.1%	123.0–102.1 = 20.9%)
8	(1.03 x 123.0 = 126.7%	1.003 x 102.1% = 102.4%	126.7–102.4 = 24.3%)
9	(1.03 x 126.7 = 130.5%	1.003 x 102.4% = 102.7%	130.5–102.7 = 27.8%)
10	(1.03 x 130.5 = 134.4%	1.003 x 102.7% = 103.0%	134.4–103.0 = 31.4%)

- One boy in the program discovers that the ice cream he is eating contains *agar*, a product derived from seaweed. Ask students to list ingredients printed on the labels of various snack foods and then to find out what these substances are and what they contribute to the food product. Certain foods, for example, may contain *annato coloring, malt syrup, sodium phosphate, lactic acid, propylene glycol, silica gel,* and *malic acid.* Other foods may contain *carrageen* or *lecithin. (Useful references include a good dictionary, or a book by Ruth Winter,* A Consumer's Dictionary of Food Additives, *rev. ed., Crown: New York, 1978, in many libraries.)*

  Have students research and discuss the work of a food scientist. They might debate whether such work contributes to or detracts from better nutrition for a populace.

5. Social Studies

- Ask students to list foods, on shelves at home or in supermarkets, that are imported into the United States. *(Among these are coffee, bananas, sugar, sardines, olives, tea, spices, and vanilla).* Why does the United States, a country that is generally agriculturally self-sufficient, import food products from other countries? (The use of maps may extend this activity.)

- Ask students to describe several ways in which an urban, industrialized society depends upon the development of food production technologies. *(Distance and length of time between consumers and sources of food require transportation, distribution, storage, processing, and packaging technologies; great agricultural efficiency is required for 3% of the people to feed 97%; the urban lifestyle demands quick, efficient food preparation and "fast food" chains of restaurants create demand for uniformity of product.)*

6. **English/Communications**

- Tell students the following facts about the life of an Indian farm family in the Guatemalan highlands: They cultivate their fields by hand, using mattocks (L-shaped digging tools), hoes, and other hand implements. They keep hens, chickens, and a few guinea pigs (raised for eating) and raise corn, beans, and a few other vegetables on two or three small fields. They have no electricity, and cook on a kerosene stove. Field work is done by the farmer and his children. His wife helps, but she also weaves rugs, cloth, and baskets to take to market. She trades these, and any surplus produce, for kerosene, cooking oil, rice (grown in the lowlands), cookware, and farm implements. She carries everything in a basket on her back. (The country is very rugged and lacks roads; wheeled vehicles are of little use.)

  Have students write a news article on "A Day in the Life of a Guatemalan Farmer." They should try to describe what the family members do, and what they eat, how they prepare it, and where they obtained it. Their account should show some appreciation of life supported by very limited technology.

- New kinds of processed foods are developed daily. Producers depend on advertising to introduce them and make them acceptable. Have students examine and report on a current ad campaign for some food or a fast food restaurant. What appeals are made? What new terms are introduced? Ask them to discuss whether an advertising campaign in an underdeveloped nation would make similar or different claims.

7. **Vocational Education**

- Have students list occupations in the following categories that support agricultural technology: electronics, transportation, distribution, and office work.

- Ask students to list new businesses that have been developed from the demand for convenience foods. *(Convenience stores, gourmet frozen foods, packaging, refrigerator-shipping processes, freezer and refrigerator display cases, microwave ovens, vending machines, food processing.)* Discuss with them some of the skills required in these and other businesses they might suggest.

Student Resources

The Farmer in a Changing America. 27-min. color film. 1973. Distributed by Encyclopedia Britannica Educational Corporation.

George, Susan, ed. *Ill Fares the Land: Essays on Food, Hunger, and Power.* Washington, DC: Institute for Policy Studies, 1984.

Easterbrook, Gregg. "A Feeding Machine." *Science 86,* January-February, 1986, 48-54.

"Genetic Engineering," *Interactions* series. 20-min. color video. 1978. Distributed by Agency for Instructional Technology.

Program Seven Communications: The Expanding World (communications)

Overview

This program is about communications technology and how it expands our individual worlds by instantaneously bringing us sounds and images from distant places. Until very recently, progress in communication technology depended almost solely on innovations in transportation. But this situation changed drastically with the invention of Morse code and the telegraph. In the last 100 years our methods of communication have changed more rapidly and radically than in the many thousands of preceding years.

The first important communications technology was the invention of writing, which made it possible for us to record, store, and preserve our thoughts. The development of movable type and printing presses gave all readers access to books and other materials previously available only to a small, wealthy elite.

Massive innovations in telecommunication technology have created a global revolution. The telegraph, using scientific principles of electric current to overcome the limitations of long-distance communication, changed human ideas about time and space.

Access to mass media offers a powerful means of influencing public opinion. This power raises important issues concerning the roles and responsibilities of advertisers and politicians. We live in an "age of images" that gives us instant access to every corner of the world through satellites and our television sets, with new impacts on our lives and governments.

Objectives

After viewing the program and completing the activities, the student should understand that technology is neither good nor bad by being able to

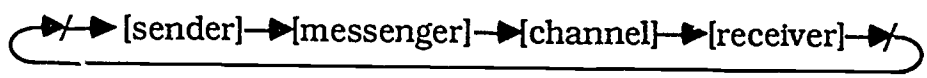
- Show how communications are basic to human activity by listing two communication needs for individuals, for businesses, and for communities.
- Describe how the invention of movable type has
  (1) increased literacy for all classes of the population
  (2) increased knowledge and education levels
  (3) created the possibility of democratic government
- State the significance of the technologies of
  (1) the telegraph
  (2) the telephone
- Describe one area of concern about television technology, such as privacy and the legality of recording programs at home.

Before the Program

1. Have students identify the kinds of communication that would be involved in each of the following activities. They might create a flowchart showing all the steps and people involved in

   - arranging a cruise to the South Pacific
   - selling a 1965 Mustang
   - learning how to operate a new Japanese camera

2. Introduce the following (or any) communication model, defining the terms. Particularly emphasize that the *message* is a set of symbols that have no meaning in themselves. Any meaning is given by the *sender* and the *receiver*. The *channel* is the route or medium of travel of the message. Assign each item on the flowchart developed in the previous activity to one of the following rubrics.



3. List the objectives for the students.

Program Summary

High school students, watched by extraterrestrials, produce a television program on communications technology. Archival film clips and interviews help dramatize the revolution from simple speech, through writing and printing, to modern developments in which sound and image are transmitted over wire and through the air. The history of the phone company, as a natural monopoly and then as the subject of antitrust action, is touched on, and the result of the breakup of the Bell system is debated. Fiber optics, satellite transmission, and telecommunications have brought people closer together, but they create unresolved legal problems.

After the Program

Transparency masters 13 and 14 are particularly relevant to this program.

1. **Integrated**

   - Return to the communications model and have students list many examples of senders *(teachers, authors, politicians)* with their expected receivers *(students, readers, voters)*.

     Introduce the concept of *noise*, both internal and external, as any interference in the receiver's getting the whole message. Have students describe examples of internal noise (*tiredness, poor vocabulary, a stereotyped view of the sender or receiver*) and external noise (*smell of school lunch, room too warm, jet flying over the building*).

     Ask students how technology assists in the reduction of internal and external noise in the communication process? Discuss print, the design of textbooks, television, radio, and other examples.

- After Thomas Edison invented motion pictures in the 1890s, he announced that in 10 years there would be no more textbooks because students would be learning from films. Have students discuss the impact of motion pictures and television programs on society and on their individual lives. Then have them similarly discuss the impact of about five or more communications technologies, such as fiber optics and satellites.

2. Science and Technology

- Have students research and list concerns for potential physical and psychological hazards of recently developed communications devices, such as sound and video equipment. To start the discussion, cite this statistic from a 1970 University of Tennessee study (E.J. Piel and John Truxal, *Technology: Handle with Care*, McGraw-Hill, 1975, p. 155): Twenty-five percent of freshman entering college have a 15 percent hearing loss; at the end of the sophomore year, the hearing loss is 30 percent.

- Ask students to talk to older relatives or friends about the 1906 earthquake in San Francisco, the 1937 Hindenburg disaster, and the 1985 Mexico City earthquake. How soon after the disaster did they learn of it? Which communications technology brought them the results? What scientific breakthroughs occurred between these events? What technologies brought new and faster ways of reporting?

3. Mathematics

- Give students copies of a transportation (airline, train, or bus) schedule. Discuss the impact of time zone differences on elapsed time between departure and arrival of flights. Have students compute elapsed time for different flights.

- The role of mathematics in aerodynamics is significant. Have students trace the history of airplane flight. Investigate the meaning of air resistance, lift, absolute ceiling, and rate of climb. Determine how each of these is calculated.

4. Social Sciences

- Have students report on how communications technology has affected political campaigning, democratic processes, and world relations. *(They might compare the presidential campaigns of Abraham Lincoln and Ronald Reagan. They might find out what happens when projected returns in a national election are broadcast before polls have closed in the West. They might attempt to describe ways in which perceptions of a country currently in the news are shaped by the nature of the images on televised news broadcasts.)*

- Research and discuss the effects of extended use of television on family interaction and on students' everyday lives.

5. English/Communications

- It has become common to use the telephone in many instances in which writing was once common; it is easier to call grandmother than to write her a thank-you note. Have students discuss this phenomenon and speculate about its possible effect on the writing and reading abilities of school-age children. If students are familiar with word processing on computers, have them debate the effect of such technology on the quantity and quality of their writing.

- "I haven't read the book, but I saw the movie." Have students compare printed and filmed presentations of a narrative. What are the strong and weak points of each medium for telling a story? If students have both read and seen a filmed version of the same narrative, ask them to compare the two versions. (*Diary of Anne Frank*, *To Kill a Mockingbird*, and many Shakespeare plays are readily available in print and on film.)

- Detective stories and science fiction reflect a society's current awareness of and fantasies about technology. How are these represented in print or on film? What attitude toward technology is revealed?

5. **English/Communications and Vocational Education**

- Ask students to describe the communication skills that are required in all customer service occupations. Why are these communication skills as important as the service being provided? Think of such examples as parts manager, travel agent, receptionist, and hotel desk clerk.

7. **Vocational Education**

- Have students list some of the jobs that have been created by the rapid innovations in communications technology. *(They could group the jobs into various categories; under "print" they could list copy editors, typesetters, layout artists, and bindery workers. Under "television technologies" they could list such jobs as camera crew, sound mixer, graphics specialists, and lighting technicians. Reference to one of the flowcharts developed before the program may be helpful here.)*

Student Resources

"Breaking Up Bell: The Supreme Court Says It's O.K." *Fortune*, 4 June 1983.

Bradbury, Ray. "There Will Come Soft Rains." *The Stories of Ray Bradbury*. New York: Random House, 1980. This story has been widely anthologized.

Marx, Gary T., and Sanford Sherizen. "Monitoring on the Job." *Technology Review*, November/December 1986.

Program Eight A Changing Romance: Americans and Wheels (transportation)

Overview

Americans love mobility and freedom, and the automobile makes these possible. The idea that every farmer and working man should have a car was an idea unique to Henry Ford, requiring the development of the assembly-line system of production. The auto-

mobile industry is an outstanding example of a modern industry based on high-level marketing and manufacturing technology.

Mass production and marketing of automobiles depended on mass consumerism, which became a driving force in industrial societies. The assembly-line production of the automobile reduced the worker to a machine. New management techniques increased the depersonalization of work.

Transportation, particularly the automobile, has shaped modern city life. We can work in a teeming city by day and abandon it for a quiet suburban or rural home at night. We pay a high price, however, in pollution, traffic jams, insurance payments, accidents, and even deaths (45,000 annually). For our own protection, government regulations require safety devices and emission controls. Yet these controls are trade-offs many are willing to make for the sake of high mobility.

No transportation system can be viewed in isolation. Cities depend on skyscrapers and the people to fill them for their very existence; skyscrapers would not exist without elevators, rarely thought of as a mode of transportation. Air traffic is crucial to all major cities, but new or expanding airports require changes in access roads to accommodate heavier flows of traffic. As roads improve, more people drive to work, fewer use the available mass transit systems, fares go up, even more people choose to drive, and the process repeats itself.

The modern city is a fragile, complex organism, and the many transportation systems that make it possible are intricately related.

Objectives

After viewing the program and completing the activities, the student will demonstrate understanding of the interrelationships of technology, society, and individuals by being able to

- Describe ways in which the development of transportation systems has affected the growth of a region.
- Explain, by giving an example, why and how the development of a new technology in one transportation system affects other transportation systems.
- Describe two consequences of the use of automobiles on urbanization, social mores, and the lifestyle of individuals.

Before the Program

1. Poll students to find out how they came to class. Ask how the students' preferred method of transportation has affected (a) the physical plan of the school *(parking lots, bus loading areas)*, (b) school scheduling, (c) students' lives *(after-school jobs, extracurricular activities)*.

2. Ask students to name areas in their community characterized by frequent traffic congestion. Ask them why they think these problems occur, and list their suggestions for alleviating the situation. Save their suggestions until after the program. Then ask them to discuss and evaluate them in light of what they have learned.

3. Describe the objectives for the students.

Program Summary

Four teenagers learn that "even with modern technology, it isn't always easy to get where you want to go." A flight from Europe to the United States may take less than seven hours, but it may take three hours to drive home from the airport. Stuck in a traffic jam, each of the young people dreams of ways to eliminate congestion and the problems caused by the car, but they learn that any change in one part of the system brings consequences elsewhere. Highway construction may speed traffic flow, but it can destroy neighborhoods, increase the number of cars on the road, threaten public transportation, and create "bedroom communities." A dream about the supercar of the future leads into a review of the history of the automobile industry, illustrated with archival footage, and its linkage with the growth of a consumer-oriented economy, mass production, and the assembly line. The car has been transformed into a symbol of glamor and romance, but it is nonetheless responsible for 45,000 deaths a year and involves enormous costs to society. By the time they reach home, the young people learn that all forms of transportation—even the elevator—are interdependent.

After the Program

Transparency masters 5, 10, 15, and 16 are particularly relevant to this program.

1. Integrated

- Ask students to draw a map of their neighborhood that includes their home, school, and the home of a friend. Have them put in streets and landmarks and mark their home with an X, but put no mark on the other two places. Ask them to write directions to accompany the map for a visiting relative to go from their homes to the school, and then on to the friend's home. Have someone trace on the map the route described.

  Ask how the directions might differ when different types of transportation are used.

- Have students list the personal transportation needs (getting to and from school, work, social activities) that would be met by having a car of their own. Have the class choose, from current newspaper ads, one used car that appears to be a good buy.

  Then divide the class into four groups, one to call banks and loan companies for local interest rates and terms for car loans; a second to call insurance representatives to find out local rates for teenage drivers who own their own cars; a third to review automobile industry and consumer magazines (*Consumer Reports* and *NADA Official Used Car Guide*, both available in libraries) to discover average mileage and maintenance costs of the chosen car; and a fourth group to list wages paid high school students at local fast food restaurants, supermarkets, and other places where students are commonly employed. (The American Automobile Association publishes a pamphlet called "Your Driving Costs" each year. It tells how to calculate driving expenses and gives a breakdown of average costs of driving a small, medium-sized, and full-size car. It is available free of charge—send a self-addressed, stamped, business-sized envelope—from AAA Public Affairs, 8111 Gatehouse Road, Falls Church, VA 22047.)

  Reconvene the class and pool the findings. Have students create a chart in which car payments, insurance premiums, cost of gas, and average repair costs are listed. (Compute all of these in weekly or monthly terms.) Then have students figure how many hours they would need to work each week or month to pay for all expenses related to the car. Ask them to discuss whether the number of hours

they would need to work would affect the time available to them for homework, family activities, or social life.

Have students reexamine their list of advantages of owning a car. Ask them what alternatives are available for each of the transportation needs they listed, and how much each would cost. (Remember school buses, and consider fares on buses and taxis.) Have students debate whether or not ownership of a car is really an advantage for a high school student. They may also wish to discuss the effects of available car transportation on health and fitness, and bring in current accident and fatality rates.

2. Science and Technology

- Technology is often used to provide solutions to problems originally caused by technology itself. Have groups of students try to solve a problem such as traffic jams or automobile safety by proposing a newer technology that would not add to the problems. Have them describe it and defend it.

- Display a local map, if available, and ask students to describe the transportation options available to someone working at a specific downtown business who lives in a rural/suburban area, near the downtown, or in another town 20 to 30 miles away. Suppose each of these people works in a factory or industry on the edge of town. Ask students how successfully their community meets the needs of people who do not drive or own a car.

3. Mathematics

- Have students contact any long-distance telephone company that services your area. Have them get information to design a map illustrating the price breakdown for long distance calls from your community. Compare the costs of long distance calls made within your local service area, within your state, and out-of-state.

  Have students design a communications system linking each room and office in your school in a network that uses the least amount of wire.

- Ask students to estimate the amount of time they spend watching television each day. Practice using the hand-held calculator to compute various statistics: class average; individual time for one week; one month; and one year.

4. Social Studies

- Have students debate the trade-offs in providing money for highways or mass transit. Debate who will benefit the most and who will be hurt the most, now and in the future.

- The technology exists to make vehicle travel much safer than it now is. Have students report on and debate whether such safeguards should be mandated by law. They should research the cost of traffic accidents in human lives, medical costs, lost work time, and repair bills, and they should try to estimate how society is affected by this cost. They should also consider constitutional rights and traditions of liberty, and consider whether society can force citizens to protect themselves from injury, or whether it can force people to protect others who may not be able to protect themselves– by mandating child restraints, for instance.

5. **English/Communications**

- Have students collect ads for automobiles. Ask them to characterize the language and the type of appeal they make.
- Do the second Integrated Activity. Then have students write an essay or have a debate defending or attacking car ownership for high school students.

6. **Vocational Education**

- Ask students where new business and industry have located in their area in the last ten years. Do these new locations have anything to do with the availability of transportation? What kind of secondary effects do different transportation systems have on the location of housing, stores, schools, churches, and recreation?
- Ask students to think of three companies for which they might work. If they did not have a car, how would they get to work?

Student Resources

Hailey, Arthur. *Wheels*. New York: Bantam, 1973.

Halberstam, David. *The Reckoning: The Challenge to America's Greatness*. New York: Morrow, 1986.

Henry Ford's America. 56-min. color film. 1977. Distributed by Karol Media for National Film Board of Canada.

"Talking to Mr. Gridlock" (Interview with New York City's Traffic Commissioner, Samuel Schwartz). *Instructor*, May 1985.

"The Auto," *Interactions* series. 20-min. color video. 1978. Distributed by Agency for Instructional Technology.

Program Nine — China, Japan, and the West (transfer of technologies)

Overview

The key to Western and Eastern cultural differences and their technological progress may be traced to varying attitudes towards nature and time. In the West, the dominant Christian religion taught that humans had been given stewardship over nature. that it was their moral duty to find, extract, and put to use all resources of the world. Time came to be seen and valued as one of the most precious of resources, since wasting it meant failing in a primary moral obligation. The discoveries and explorations initiated by Columbus's voyages, the Renaissance, the Reformation, and the growth in scientific knowledge all promoted rapid development of technologies. Fundamental to these

social and technological developments was the scientific view of the world. This view promoted the idea of a natural law discoverable by observation and analysis, which could be the basis of progress and technical development.

Five very important inventions that underlay much of the transformation of the medieval Western world were gunpowder, movable type, the compass, the stern rudder, and the clock. All but the last of these originated in the East, in China. Yet the Chinese made little or no effort to develop or use these.

In China, it was held that humans were but a part of nature and that their task was to live in harmony and balance with it. Much of Western technology, even that which originated in China, was viewed as upsetting the delicate natural balance. Further, the Chinese feared that by accepting Western technology, they would be embracing Western values. Although it is one of the oldest continuing civilizations in the world, China today is still developing in technology.

Japan, on the other hand, after maintaining an isolationist policy and resisting Western influence until the last century, made an astonishing about-face in the span of little more than a lifetime to become a leading technological society. Although their philosophies and values were similar to those of the Chinese, the Japanese chose to adopt Western technology rather than risk being swallowed up by the West. They managed, in a very short time, to become a leading technological power while retaining their own unique community-oriented values.

Objectives

After viewing the program and completing the activities, a student will show progress toward the goal of technological literacy by being able to

- Provide a general description of the comparative technology of China and the West in the fifteenth century and in the nineteenth century.
- Describe "technology transfer" with examples of technologies transferred from China to the West in the fifteenth century.
- Explain briefly how cultural developments promoted the rapid development of technology in the West.
- Compare the differences in the responses of Chinese and Japanese societies to Western technologies of the nineteenth and twentieth centuries.

Before the Program

1. Could a modern city run without clocks and the concept of being on time? Discuss what could happen.
2. List for the students the objectives to be met.

Program Summary

A sequence of images of clocks and clockworks, interspersed with early European drawings and paintings, initiates a discussion of the concept of time in Western society. Pictures of monastic life and the strict daily schedule of the monks are presented, as well as images of city life and hard-working tradesmen. Time, a valuable commodity, had to be measured carefully; mechanical clocks, increasingly elaborate, were developed, and

punctuality became a virtue. Their invention permitted the growth of other technologies requiring scientific precision, and a great variety of instruments were developed. The stern rudder and compass, movable type, and gunpowder (shown through older artwork and modern footage) were Chinese inventions adopted and developed in the West. Scenes of China and pictures of ancient Chinese calendars and astronomical devices illustrate the traditional Chinese attitudes toward time and nature. For many years China was suspicious of Western technology, and only recently has undertaken an ambitious effort to adopt Western technology. Japan, presented through scenes from contemporary life, art, and drama, was once equally isolated, but it has become a world leader in technology. Japan's success in the Russo-Japanese War, its recovery from the ruins of World War II, and its wholesale adoption of Western business practices are illustrated and described.

After the Program

Transparency masters 17 and 18 are particularly relevant to this program.

1. **Integrated**

   - Ask students to discuss the relationship between culture and the development and use of technology. Define culture as the meanings people attach to self and others, to things, to institutions and ideas, and to other groups of people.

     Ask the student to discuss how the following technologies are reflections of the corresponding culture.

     The automobile and American culture

     The bicycle and Chinese culture

     The fast food industry and American culture

     The fishing industry and Japanese culture

     Turn the discussion to a definition of the term "technology transfer." Ask for three historical and three modern examples of technology transfer. Discuss the following.

     Why does technology flow easily today between the United States and Japan? An example is the fast food industry

     Why was it difficult for technology to flow between the United States and China until just recently? Why is it easier today?

     What benefits are derived from technology transfer between two nations? What harmful effects might there be due to technology transfer between two nations?

   - Social critics and historians often refer to the "Protestant work ethic" which they associate with the attitude toward work and earning money that characterized the earliest American settlers, especially the Puritans in New England. Have students research the meaning of this concept. Ask them whether they think it still is a dominant force in Western society. If it is not, what has brought about a change?

     Have students research and report on the work values and ethics of the Chinese, Japanese, and American societies. Which work ethic seems best suited to compete in the world today?

2. Science and Technology

- Have students discuss the analogy between a mechanical clock and the universe. Why would this concept be particularly attractive to a European of the sixteenth century?

- Units of minutes and hours are adequate to measure most daily events. Some sports require measurements in seconds, or even fractions of seconds. Ask students what kinds of investigations would require measurement in units smaller than seconds. What are such units called? What instruments can measure them? What about units larger than a year? What is a light-year? What does it measure? How do concepts of distance (space) and time become intertwined in astronomy?

3. Mathematics

- Introduce students to clock arithmetic. Point out that in the United States, we work with a 12-hour clock. What effect does this convention have on adding and subtracting hours? Suppose, for instance, that it is now 11:00. What time will it be in 4 hours? Does $11 \oplus 4 = 3$? *(Yes, in clock arithmetic, it does. The symbol $\oplus$ denotes clock addition.)* Draw a clockface on the chalkboard. Draw one hand set one hand permanently on 12. Emphasize that there is no number higher than 12, and $12 \oplus 1 = 1$ in this system. Help students develop an addition table based on this clock, showing what happens as the moveable hand is set on each successive number. The chart should be in this form.

$\oplus$	1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	.	.	.	.	.	.
2	3	4	5	6	.	.	.	.	.	.	.	.
3	4	5	6	7	.	.	.	.	.	.	.	.
4	5	6	7	.	.	.	.	.	.	.	.	.

Discuss at least five patterns found in the table. Develop a flowchart for the steps in finding the time a given number of hours from now and whether it will be A.M. or P.M. What are the advantages of the 24-hour clock used by the military forces? You can expand this activity by developing subtraction, multiplication, and division tables for clock arithmetic to reveal interesting patterns for students.

Discuss the location and purpose of the International Date Line. How does the date line affect travelers by ship and by airplane in going from the United States to Japan and China?

- Obtain schedules for airlines that connect your location with cities in China and Japan. Calculate the time required to travel to these locations. Also, compare the "time" and "date" difference between your location and cities in China and Japan.

4. Social Studies, English/Communications

- "Made in Japan." Tell students that 30 or 40 years ago the phrase *Made in Japan* marked a product that was often cheap in price and appearance, easily broken, nonrepairable, and rarely suitable as a gift.

  Ask students to explain what the phrase *Made in Japan* means about a product today. Have them list Japanese products in their homes. Ask why their families

bought these instead of comparable American-made products? Ask how Japanese imports have affected our economy.

- Ask students to read and report on newspaper or magazine articles dealing with some of the problems involving a possible clash between technology and culture. Some of these might deal with life-support systems for patients in irreversible comas, voluntary or mandatory testing for diseases like AIDS, the length and rigor of testing required before new drugs or treatments are adopted, animal testing of cosmetics, nuclear or biological weapons, chemical additives to foods, or trade-offs between technology and the environment in evaluating different energy sources (coal, oil, or nuclear power).

  How does the pluralism of U.S. culture make deciding such issues particularly difficult?

  Have students choose and research one such issue. Then ask them to adopt the point of view of a concerned participant. (A student could be, for example, a doctor pioneering a new treatment, a relative of a patient, a scientist hoping to patent a new biotechnology development, a coal-miner, or a home owner near a proposed power plant.) Have them write an essay in the form of a letter or brief to the appropriate federal regulatory agency or court arguing for or against action on one of these issues. Their essays should consider the technological as well as emotional aspects of the problem.

5. **Vocational Education**

- Have students read and report on articles about Japanese and American management styles in large corporations. Have them list several ways the typical Japanese worker's experience is different from the American worker's. Ask them which environment they would prefer to work in.
- Several Japanese companies have opened plants in the United States. If there is one nearby, invite a representative of the company (either management or a worker) to describe to the class how well the Japanese management style has been accepted by American workers.

Student Resources

Ohmae, Kenichi. *Beyond National Borders*. Homewood, IL: Dow Jones—Irwin, 1987.

"Formal Structures Inhibit Change." *Management Today*, December 1983.

Kesey. Ken. "Run into Great Wall," in *Demon Box*. New York: Viking, 1986.

Program Ten — Population Patterns (rising birthrate, falling death rate)

Overview

Generally people agree that it is good to reduce the death rate, to extend life, and to have children. However, the startling increase in the rate of growth of the world population

has produced pressures on our material and energy resources. These pressures are so great that attitudes and mores in almost every society are being reevaluated in light of the alternatives now available to human beings because of technology.

Objectives

After viewing the program and completing the activities, the student will show progress toward the goal of technological literacy by being able to

- Discuss the growth of population before and after industrialization and the relation between the two events.
- Describe how technologies of medicine, nutrition, and hygiene have increased the rate of population growth.
- Compare different social, geographic, and cultural factors affecting the response of Europe, the United States, and developing nations to great increases in population.

Before the Program

1. Show students the transparency "Faster Than He Can Sow It," and have them discuss the meaning of this editorial cartoon.

   Ask students how population growth creates a problem for the United States and for the entire world. After a few ideas are offered, point out the need for more information, which the videotape will provide for them.

2. List for the students the objectives you want them to achieve from the program.

3. If you plan to use the Learning Log (first activity under "Integrated") after the program, introduce the format of the Learning Log now and give two examples of entries under each column.

Program Summary

When deer were protected from their natural enemies, their numbers grew until lack of food caused many to starve to death. When the birthrate rises while the death rate simultaneously falls, population increases. World population has been growing as a result of four technological revolutions. The tool-making and agricultural revolutions kept man in balance with nature or permitted only a slight increase. The industrial revolution created an economy that depended on growth, and brought about improvements in hygiene that increased life expectancy. In today's "age of information," however, it may be wise to limit growth. The relation between technology and population varies in different parts of the world. In Europe, the combination of birth control and emigration produced a shrinking birthrate at the same time that the death rate was falling. Currently in the U.S. the birthrate is falling, but the population is growing because of immigration. When health measures produced a fall in the death rate in China, the birthrate increased so dramatically that the government instituted a campaign to limit families to one child. In much of the Third World, public health measures have produced a falling death rate, but cultural and technological factors have not yet encouraged a falling birthrate. As a result, the world population is increasing exponentially.

After the Program

Transparency masters 19 and 20 are particularly relevant to these activities.

1. Integrated

- **The Learning Log.** Research into learning has shown that if people respond actively to information as they receive it, they will learn faster and use the information more effectively. A learning log is one way of helping students respond to information as they receive it. It is an effective learning activity as students (and teachers) are forced to attend to their thoughts about, and reactions to, the material presented in the videotape. Suggest that students adopt this simple format. Make sure that students have all drawn the log and understand how to make entries when the video starts.

Learning Log

Videotape: Student Name:

Information presented	Reaction
People removed deer's enemies	Sounds good
Deer numbers grew, 1,000s starved	Lots to learn

[Continue in the same format listing other points of interest in the video]

As they view, students may make inferences and predictions, generalizations or summaries. Some may react to the language. Others may ask questions or voice their doubts or objections. Questions that students ask in their learning logs can serve as springboards for follow-up discussion or provide a basis for individual research.

After they have viewed the program, have students and teachers jointly discuss the entries in their learning logs. All should feel free to offer their insights, questions, and their reactions to the video as a whole.

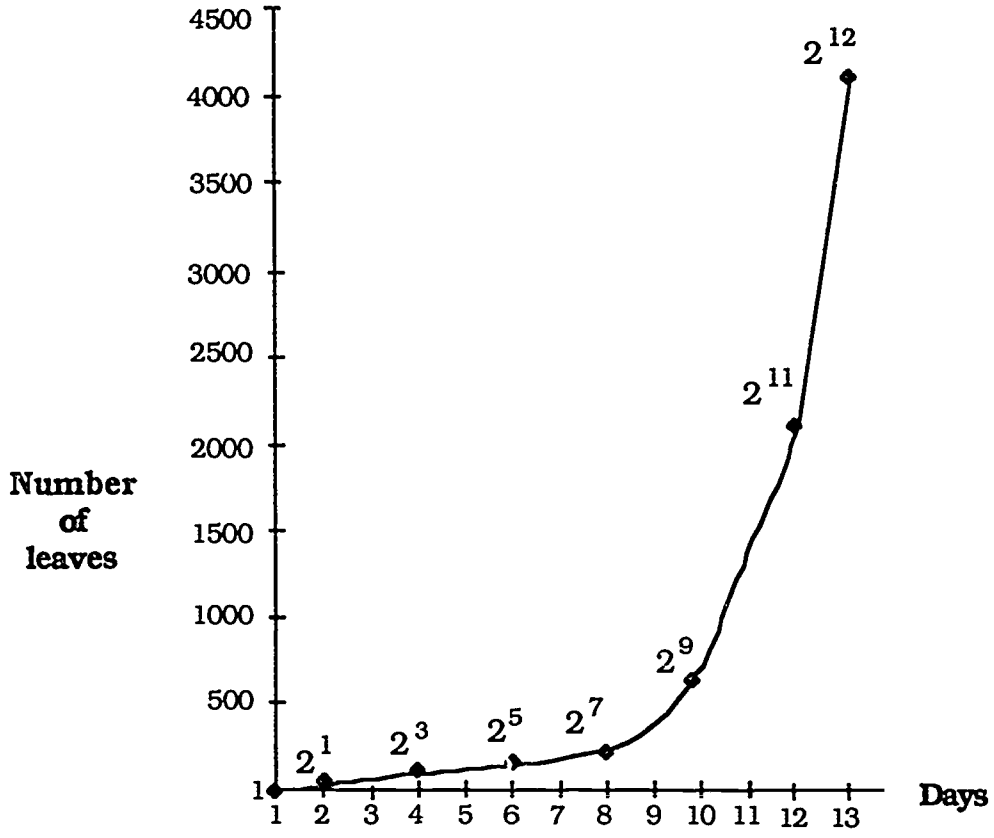
Then tell students that all (teacher included) are going to put something down on paper that expresses their feelings about the video and its presentation of population growth. Tell them that they are free to draw a picture or a cartoon, write a poem, a short story, a sketch, or simply put down whatever thoughts or feelings occur to them in response to what they have seen. *(There is no right or wrong way to go about this activity, except that students cannot write "I like it" or "I don't like it" and then stop. They must go on to articulate the reasons or feelings that lead them to make such an assertion. When students experience subject matter in this way, they will grow as writers, readers, and thinkers, and be helped to understand complex problems.)*

Student and teacher responses should then be shared.

- **Exponential Growth and the J Curve.** Present students with the following problem: Farmer Frank has a pond. In the pond is a lily with a single leaf. Each day the number of leaves on the lily doubles, so that on the second day there are two leaves, on the third day, four leaves, on the fourth day eight leaves, and so forth.

On the 30th day, the pond is full of lilies. On what day was the pond half full? *(29th)*

Have students draw a simple line graph and plot the daily effects of lily leaf doubling. The result should form a J-shaped curve (see example below). Tell students that this graph illustrates the concept of *exponential growth*, a concept that applies to population as well as lily leaves.



Help students apply the concept of exponential growth to world population. Introduce the following concepts.

growth rate—The ratio of births over deaths in the world. The current growth rate is about 1.7. In other words, for every death, there are 1.7 births.

Rule of 72—A mathematical formula to determine the number of years it takes for a population to double: 72 divided by the growth rate equals the doubling time in years.

Tell students that the world's population is currently about 5 billion. Ask them to use the rule of 72 to find out when it will reach 10 billion, assuming the growth rate remains steady. *(72/1.7 = 42.35. Add 42 years to the present year to find out when the population will double.)*

Ask students to think about and discuss the following questions.

If the world's population doubles in the next 42 years, and 93% of the growth takes place in developing countries, what problems could be created?

If population doubles at the current rate, and most of the growth takes place in the Third World, how would the United States be affected?

As we have seen, population increases are related to advances in technology. How can technology be used to resolve some of the problems that come with population growth?

2. Science, Technology, and Mathematics

- Start with a piece of string one inch long. Cut another piece of string two inches longer than the first. Continue cutting pieces of string, each one two inches longer than the previous one, until you have 10 pieces. Lay them next to each other. Plotting the string lengths on a line graph will produce a straight line.

  Start again with a piece of string one inch long. Cut another piece of string twice as long as the first. Continue cutting pieces of string, each one twice as long as the piece before, until you have 10 pieces. Lay them next to each other. Plotting these string lengths on a line graph will produce an exponential, or J-shaped, curve.

- Plant identical garden seeds, such as radishes or turnips, spaced uniformly in each of five identical containers, so that each succeeding container has twice as many seeds as the previous one. (In other words, the only variable between the containers is that of population density.) As the seeds sprout and grow, make observations on the effect of the different population densities on growth rate, color of leaves, need for water, height and lushness of growth, susceptibility to disease, length of life, and death rate.

3. Mathematics

- This program uses large numbers such as *millions* and *billions* to discuss the world population. Explore different ways of writing large numbers, using decimals, exponential notation, and rounding techniques. How do these affect the accuracy of the data and ease of using it?

4. Social Studies

- Have students discuss or debate the appropriate role of the government, schools, churches, and individuals in addressing the issue of population .

- Have students list ways in which technology encourages population growth. *(Agricultural genetic engineering produces new plant strains that yield more food and support more people. Medical technologies, ranging from prenatal care to treat-ments for trauma and catastrophic illness, result in more live births and longer lives.)* Then have them list ways in which population growth creates demands for new technology. *(Grouping people in growing cities requires new waste disposal techniques—sewers rather than outhouses, for example. Dense populations require means of communication, transportation, distribution of food and other necessities, space- and energy-efficient buildings, all of which technology must supply.)*

5. English/Communications

- Have students read Malthus's *Essay on the Principle of Population.* After they have read it and discussed Malthus's argument, have them debate whether or not he was right.

6. Vocational Education

- Encourage students to explore their attitudes toward having children in the future. Ask them to list the factors a would-be parent should consider before deciding to have a child. Can they agree on a minimal number of conditions that should be met before a person can be a responsible parent? Ask students to investigate such topics as

  choosing a spouse
  responsible family planning
  planning a budget
  child-care costs
  choosing between a career or a family
  balancing a career and a family

  Have students report on their findings, make informational charts or displays, or have a panel discussion.

- Ask the students to name jobs that are becoming obsolete in the United States. Then ask them which of these obsolescent jobs may still be needed in developing nations, and why. Toward the end of the discussion ask, "What relationship is there between the job demands of those countries and their continuous population growth?" *(In developing countries with a large and growing population, labor is plentiful and there is a need to keep everyone employed. Labor-intensive work is most appropriate. In developed countries, labor is scarce and expensive and there is a continuous trend to supplant human labor with machines and computers.)*

Student Resources

The Choice Is Ours. 23-min. color film. 1976. Distributed by the Extension Media Center, University of California at Berkeley.

Myrdal, Gunnar. *The Challenge of World Poverty: A World Anti-Poverty Program in Outline.* New York: Vintage, 1971.

Pirages, Dennis C., ed. *The Sustainable Society: Implications for Limited Growth.* New York: Praeger, 1977.

Program Eleven Exploring Space
(benefits of space exploration)

Overview

Since the time of the earliest humans on earth, people have looked up at the sky and wondered, "What is out there?" For several hundred years, we have been able to scan space and receive any information our telescopes were able to pick up. Now, however,

we can explore space actively with the help of rockets and the vehicles and instruments they propel. Before World War II, rocket research was scientific, cooperative, and modest in scope. During the war, the technology of rocket propulsion resulted in the "bazooka," which fired rocket-propelled explosives at enemy tanks, and the V-2 rocket, which sent explosives across the English Channel. Following the war, the U.S. and the Soviet Union entered a space race. Space shuttles and the exploration of space by instruments have become almost common. We need to decide whether or not we should continue to send humans into space, or whether we can rely on instruments to discover all we want to know.

Objectives

After viewing the program and completing the activities the student will be able to

- Describe how scientific inquiry and military goals have led to the exploration of space.
- Discuss the problems involved in maintaining a livable environment in space.
- Debate the arguments for and against manned and unmanned space exploration.

Before the Program

1. Tell students that President John Kennedy committed the resources of the United States to putting a man on the moon. There were great successes in the U.S. Space Program during the 1960s and 1970s, but it is now moving more slowly. Ask students to name a few space successes and failures.

   Tell students that by the end of the program, they should be developing some views about the advisability of committing the country to a space program.

2. List the objectives you want them to achieve.

3. Define *technology* for students as the adoption of scientific principles for the design, manufacture, and use of machines to solve problems. Even though we could walk, people have invented the technologies of wagons and airplanes to take us from one place to another. Ask students to speculate about what led people to find ways of flying. Ask them what technology takes us into space. (*Airplanes, which must have atmosphere to fly, cannot take us into space. Students should mention rockets, which are necessary to launch any vehicle—satellite or space shuttle—into space.)*

Program Summary

The desire of human beings to explore the world combined with technology to press through frontiers and stretch limits on all sides. Space explorers, like the sea explorers of the 14th century, exhibited courage, curiosity, and technical skill. Their discoveries changed our perceptions of the earth we live on. Space exploration depends upon the rocket, first developed by Robert Goddard in the United States, and adopted enthusiastically by Germany, which used it as a weapon in World War II. The technology of space exploration needs vast amounts of money and political commitment. President Kennedy announced that America would move forward with a space program in 1961. The Apollo XI flight put a man on the moon for the first time. Technology developed for exploration may have broad and useful applications. Space flight requires solving the

problems of providing air and food and dealing with weightlessness. Communications, weather, and photographic satellites have valuable commercial uses. Unmanned probes have sent back valuable information about Mars, Jupiter, and Saturn and its rings. Space itself offers possibilities for commercial development. We must decide whether the benefits of space exploration are worth the risks, and when it is necessary to risk human life to continue our discoveries.

After the Program

Transparency masters 21 and 22 are particularly relevant to this lesson.

1. **Integrated**

- Begin by asking students to describe the earth seen through the eyes of astronauts who have traveled into outer space. List the key points of the descriptions on the chalkboard. Next ask students to describe the earth seen through the eyes of early day ocean explorers, and list the descriptions on the board. *(Students should mention the distances between parts of the earth perceived by each group, the shape of the earth, and the features that each group would notice.)*

  Have students discuss the following questions.

  In what ways did early sea explorers' perceptions of the world differ from astronauts' perceptions?

  How would perceptions of the earth held by early day explorers differ from those held by Cro-Magnon people? How would astronauts' perception of the earth differ from those of a hypothetical space traveler who had journeyed far beyond the solar system?

  Of all the perceptions of earth described above, which, if any, is the "right" perception? *(All descriptions are correct if they reflect the perspective of these different points of view.)*

  What is meant by the statement, "Technology has helped humankind to explore and discover more and more. Exploration and discovery allow humankind to change perceptions of the world and often times to alter the course of history"? Ask students to give examples from their knowledge of history. *(Students should be able to mention the sea voyages of the fifteenth and sixteenth centuries, and some may know that the invention of the compass and stern rudder contributed to these. They should also mention the invention of the airplane, making aerial views and measurements possible, and the development of the rocket that led to the possibility of space exploration.)*

- Tell students that a sense of adventure and a willingness to venture into unknown territory figure prominently in history. Great discoveries have been made because someone was willing to step off into the unknown. No new information comes to us when we remain in familiar, well-travelled paths. Read students Robert Frost's poem, "The Road Not Taken," in which the poet expresses the sense of moving into unexplored territory. Emphasize the final lines.

  Two roads diverged in a wood, and I—
  I took the one less traveled by,
  And that has made all the difference.

  Now ask students to answer the following questions concerning the "Exploring Space" videotape they have just seen.

What happened as a result of America's decision to venture into space exploration?

What did we learn from that experience?

How can it influence our future decisions?

Ask students what other frontiers (defined as any undeveloped area or field) there are besides space for us to explore. What roads are now lightly travelled that might be more heavily travelled in the future? *(Students might suggest areas of transportation, medicine, genetic engineering, food, environment, information, and learning theory.)*

2. Science and Technology

- Use NASA's annual report, *Spinoff*, to compile a listing of familiar products that are a direct result of technology developments originally meant for the space program.

- Present students with the application of the *principle of action and reaction* as it is used in rocket and jet propulsion. Use the well-known example of the behavior of a balloon when the gas is allowed to escape. Have students experiment with different gases (CO_2, air, He) as propellants and design gas escape nozzles to provide either longer flight duration or higher speeds. Have them draw a vector diagram to explain the motion.

  Discuss how the gases used to provide rocket propulsion and jet propulsion are produced.

3. Mathematics

- Present students with the following problem in probability. If we wish to keep the probability of failure of a system in a space vehicle at no more than 0.001 (which is .999 successful) and the system has four subsystems, what must the success probability be for each subsystem?

  Tell students that to determine the success probability of the total system, the success probabilities of the subsystems are multiplied together. Having given them the rule, let the class do these calculations. (The answers are provided here for you.)

  For 2 subsystems of .999 success probability $(.999)^2 = .998001$

  For 3 subsystems of .999 success probability $(.999)^3 = .997003$

  For 4 subsystems of .999 success probability $(.999)^4 = .996006$

  That figure is too low a success probability, so recalculate on the basis of success at .9999.

  2 subsystems @ $(.9999)^2 = .99980001$

  3 subsystems @ $(.9999)^3 = .99970003$

  4 subsystems @ $(.9999)^4 = .99960006$

  How must the success probabilities of subsystems compare to that of the whole system?

4. Social Studies

- Ask students to consider the effect of surveillance and communications satellites on our knowledge of other places. When the media make events in one country known all over the world as soon as they happen, what constraints are put on governments? What kinds of secrecy are still possible in a country?

- Have students discuss or debate President Kennedy's speech in which he announced that the nation had committed itself to the goal of furthering space exploration and landing a man on the moon. Is this commitment, made in the 1960s, still valid for the 1980s and 1990s? Should this commitment be reevaluated in terms of costs and benefits?

5. English/Communications

- Have students create editorial or political cartoons expressing their opinions of the risks and values of the space program.

- In 1941 a 19-year-old Canadian pilot named John Gillespie Magee, Jr., was killed when his plane was shot down as he was defending England in the Second World War. The following sonnet was discovered among his papers. It has been widely anthologized, used as a sign-off by a California television station, and quoted by President Reagan—once at the memorial service for the astronauts who died in the Challenger disaster and again in his State of the Union address of 1988. Christa McAuliffe, who died in the Challenger, had a copy.

High Flight

Oh, I have slipped the surly bonds of earth,
And danced the skies on laughter-silvered wings;
Sunward I've climbed and joined the tumbling mirth
Of sun-split clouds—and done a hundred things
You have not dreamed of—wheeled and soared and swung
High in the sunlit silence. Hov'ring there,
I've chased the shouting wind along and flung
My eager craft through footless halls of air.
Up, up the long, delirious, burning blue
I've topped the wind-swept heights with easy grace,
Where never lark, or even eagle, flew;
And while with silent, lifting mind I've trod
The high, untrespassed sanctity of space,
Put out my hand, and touched the face of God.

Ask students to read the poem carefully. Then have them discuss or write on the following questions. What attitude toward flying does the sonnet convey? What is the meaning of the first line? What does it suggest about the poet's attitude toward the earth? What kind of language does he use to characterize the sky and space? What kind of experience is flying for him? What change or development in his attitude to this experience is conveyed in the last three lines? Do you feel that this poem was appropriate for use at a memorial service for the dead astronauts?

6. Vocational

- What jobs are needed in support of the astronauts? *(Consider such people as custodians, food technologists, respiratory technicians, exercise physiologists, computer scientists, mechanics of all systems, accountants, press liaison per-*

sonnel, and those involved in the manufacture of insulated suits.) Using the Department of Labor's *Occupational Outlook Handbook*, compare several of these jobs in terms of required education, job requirements, salary, and so forth.

Student Resource

Gold, Michael. "Voyager to the Seventh Planet." *Science 86*, May 1986, 32-41.

Program Twelve Risk and Safety
(risk in a technological society)

Overview

We can define risk as the unpredictable consequences of natural events, our own actions, or the actions of others. It is inherent in every moment of life. While helping to reduce such natural hazards as famine and epidemics, technology has brought about a new class of benefits and risks. Such developments as dams, factories, and automobiles bring about leisure and control over nature, but they also create dangers for our health and safety. To provide ourselves with the greatest benefits at the lowest risk, we are learning to design safety into the construction and operation of our technologies.

Objectives

After viewing the program and completing the activities, the students will show progress toward the goal of technological literacy by being able to

- Describe, with examples, the statistical nature of risk and the distinctions between perceived and statistical risk, long- and short-term risk. *(You will not die tomorrow because you smoke two cigarettes today, but your life expectancy is lowered if you regularly smoke two packs a day over a number of years.)*
- Distinguish between voluntary risk *(skiing)*; voluntary acceptance of risk *(driving to work)*, and involuntary risk *(breathing polluted air or living near a nuclear plant)*.
- Give examples of risks and benefits associated with such major technologies as large-scale water management, pharmaceuticals, and automobiles.
- Give several examples of safety engineering *(flame-proof cloth, bumpers and seat belts in cars, tamper-proof packaging for medicine)* and the political and economic issues involved in setting safety standards.
- Describe: (1) why there is no such thing as a risk-free society; and (2) what the costs of safety may be.

Before the Program

1. Ask students how they would rate their lives on a scale from very risky to fairly safe. Ask whether it would be possible to plan their lives so carefully that there would be no risk.

2. If you plan to use "Risk-Takers" (first activity under "Integrated") begin it now, proceeding to the point where a bar graph of the class's self-rating is produced. Complete this activity after students have viewed the program.

3. List the objectives you want the students to achieve as a result of watching the program.

Program Summary

Living with technology is much like riding a motorcycle. The right equipment combined with the knowledge and experience of the rider greatly reduces the risk of danger. Risk is part of life, either voluntary risk, such as skateboarding or air travel, or involuntary risks such as drinking tap water that may be contaminated. The risk of danger we perceive in riding a roller coaster may be quite different from the statistical risk calculated by an insurance actuary. Smoking involves a long-term risk, but driving has the highest short-term risk, especially for 16-24 year olds. Is it the manufacturer's responsibility to prevent the misuse of his product? Simulated crashes with dummies show that seat belts, airbags, and other technology could prevent much death and injury, but we are not always willing to pay for these. We pay the cost of a high accident rate, however, through higher insurance premiums. The 1984 catastrophe in Bhopal, India, when fatal toxic fumes escaped from a chemical plant, showed that staying home is not always safe either. When we build large industrial complexes or nuclear energy plants we may be postponing the risk until later. Humans may not be able to survive the technology they have created unless they learn how to predict and control its negative consequences.

After the Program

Transparency masters 23 and 24 are particularly relevant to this program.

1. **Integrated**

   - *Risk-Takers.* Tell students that voluntary risk-taking is a personality trait. Some people find risk-taking an exhilarating experience and continually put themselves into positions where risk is high. Others prefer to follow established paths, keeping risk-taking to a minimum. Draw the following scale on the chalkboard or an overhead transparency, and ask students to rate themselves.

1	2	3	4	5	6
low risk-taker				high risk-taker	

   Draw a simple bar graph showing the distribution of ratings in the class.

   Have students think about a typical day at school, at home, at their job, and at their leisure activities. Have them identify the risks that affect them and then try to categorize these as voluntary risk, voluntary acceptance of risk, or involuntary risk.

Return to the graph and ask the students whether they rated only their voluntary risk-taking? If they include their involuntary risk-taking (not a personality trait), would they not move to the right on the graph?

- Read the following problem aloud or give each student a copy.

> It is the year 2032. Professor Felix Wadnod, an esteemed scientist, has developed a means of prolonging the prime of life for all human beings for at least 150 years. Instead of feeling the joy and the excitement that accompanies discovery, however, Wadnod is worried that he may have gone too far. He is concerned about the risks and wonders whether, instead of announcing his invention, he would do humankind a favor by destroying it, along with all the research and designs.

Ask students, "What do you think Professor Wadnod should do?"

Tally student "votes" on Wadnod's course of action. Have them form three groups consisting of those who think that Wadnod should announce his breakthrough, those who think he should destroy it, and those who are undecided. Ask them to discuss their reasoning and to develop an argument for presentation. Then have each group present its arguments. *(Those arguing for the destruction of his findings should raise such issues, among others, as overpopulation, employment opportunities, and retirement policy.)* Allow for challenges and counter-arguments. After each view has been presented, conclude the activity by asking students to discuss the following questions.

> Are any technologies in use today that should have been destroyed before they were released? If so, how should the decision have been made? Who should have decided?
>
> What was most difficult about deciding what Wadnod should do? Why is it so difficult to make decisions about technology?
>
> Which technologies are currently considered controversial? How do you think these issues and similar problems will be resolved, now and in the future?

2. Science and Technology

- Ask students why a law was passed requiring an environmental impact study for all major federally funded construction projects.
- Investigate protective (risk-reducing) devices. Have students design, build, and test a container that would protect a raw egg from breakage when it is dropped from a considerable height (5-10 meters).

3. Mathematics

- Invite a representative from an automobile insurance company to visit the class. Ask the representative to discuss the difference in premiums for coverage of male drivers compared to female drivers; statistics used by the insurance company to determine insurance rates; and factors that may lower or raise the premiums for insurance coverage. What is the role of odds in this industry?

4. Social Studies and English/Communications

- Have some students interview the school administration to find out what risks or hazards in the school environment have had to be dealt with in the last five to

10 years. What regulating agencies have responsibilities for school safety? Have other students compile a list of governmental regulating agencies that act for their safety in areas of their lives other than school.

5. Vocational

- Ask each student to make a list of the technological risks in a chosen career. Summarize class responses on the following chart.

Career	Voluntary Risk	Voluntary Acceptance of Risk	Involuntary Risk

Continue the discussion by asking the class who should be responsible for trying to decrease the risks in the jobs listed.

- Ask students to name occupations they perceive as high-risk. Once the list is generated, ask the class why they feel some people choose these high-risk occupations. *(Their responses could include money excitement, notoriety, and opportunity.)*

Student Resources

Perrow, Charles. *Normal Accidents: Living with High-Risk Technologies.* New York: Basic Books, 1984.

_____. "Risky Systems: The Habit of Courting Disaster." *Nation,* 11 November 1986.

"Three Mile Island: It's Worse Than You Think." *Science Digest,* June 1985.

Using the Transparency Masters

These transparency masters are provided to assist you in reinforcing the concepts in the programs. Use them to create your own overhead transparencies with the equipment available in your school. If you place the transparencies in a cardboard frame, it is easy to write your notes on that frame. However, you may find storage of the transparencies more convenient without frames.

These printed masters usually have a three-part format:

- Statement of the concept in the upper left corner.

  Graphic illustration in the center to help you and the students discuss what the concept means.

- Brief question across the bottom to open a discussion about the effects of this aspect of technology on society and individuals.

Each transparency master is related to one concept in the field of science, technology, and society. Often the concept is about technology. But the questions always have to do with the interactions of society and individuals with technology. You can apply your talent and experience to tailor the discussion to your objectives and to the particular abilities of your students.

Suggestions for Discussion with the Transparencies

Transparency 1: Every technology has trade-offs.

The students need to recognize that costs are not always measured in money. The cost of a project might include the personnel, raw materials, energy, and facilities required as well as risks to the environment. Benefits might include reduced costs or the ability to do a task faster, better, or more efficiently. Every technology has costs and benefits. If costs cannot be reduced, we may choose not to develop or use a technology. In the case of the supersonic transport (SST), the costs could not be sufficiently reduced, and the U.S. government chose not to develop that plane. However, there have been cases where we chose to develop life-saving technologies despite costs, because we value that benefit highly. Today, people disagree about the trade-offs involved in nuclear power plants.

Transparency 2: Technology develops new business and industry.

When a new technology is available, new machines and materials have to be manufactured. Perhaps new factories are needed. Workers may need new kinds of skills to produce the new machinery and/or the new materials. Will people who use the technology need to learn new skills? Sometimes the new technology is a modification of an old one, requiring only small changes in current skills. However, computers required radical changes in manufacturing plants and skills and in the knowledge and skills required to use them. What did that fact mean to the manufacturers of typewriters? Of adding machines? What happened to blacksmiths when the automobile replaced the horse and wagon? What other careers have been reduced or eliminated by new technologies?

Transparency 3: Definition of technology.

When students list the kinds of technology they meet from the time they are awakened until they arrive at school, they commonly list devices. After they have listed nine or ten, list some of the processes of design and evaluation required for developing a technology. Processes of design include identifying purpose, listing desired specifications, sketching desired products or outcomes, and considering direct costs in money, resources, and personnel. Evaluation processes might include checking the fit of a product to the human hand, measuring how easily monitoring devices can be seen, and determining reliability of performance. The greatest invention of nineteenth-century technology was a method of inventing technology. Methods of recognizing needs have also been well-developed. For each technology on the list, describe the manner in which it extends human capabilities and/or modifies the environment.

Transparency 4: Feedback is a characteristic of technology.

The graphic in the center represents any kind of processing of the input, by any kind of human or machine processor needed to obtain the output. Feedback is some effect of the output that returns to the input sources to modify that input. Feedback is the basis of quality control in many manufacturing processes. Feedback might report whether the product is getting smaller or bigger than specified, or whether the manufacturing system is running too rapidly or too slowly for good performance. Adjustments can then be made promptly to ensure products or processes of required quality.

In making a decision about buying an automobile, what kinds of input information should you obtain? What kinds of processing would be needed? What would feedback be if you decided to buy—or not to buy—the car?

Transparency 5: Technology carries a degree of risk.

Have students list the social effects of changes that automobiles have undergone from early models to modern ones. What was the main purpose of the auto engineers as they changed automobile design? As engineers tried to improve the automobile, could they have predicted the social changes? What social changes might be in store as automobiles continue to change? Will it always be necessary, or even desirable, for each individual to have his or her own automobile?

In the discussion it should be brought out that technology carries a degree of risk, because we can never predict all of the consequences of a new technology. Many times people do not even try to predict the consequences. Engineers working to improve the automobile gave little or no thought to traffic congestion. Only when consumer interest groups protested increased injuries did engineers begin to address systematically the problems of safety. That does not mean that auto engineers did not care about people and safety; only that lack of attention to safety was not recognized as a problem. Now local, state, and national governments have laws to ensure safety in the function and operation of automobiles.

What changes might have been predicted at the invention of the plow? The steam engine? The business of the Office of Technology Assessment of the the U.S. Congress is to predict the effects of technologies. What technologies might that office be assessing today?

Transparency 6: Changes in productivity systems mean different energy needs.

Begin by discussing the major sources of energy in tool-making, agricultural, industrial, and post-industrial societies and how the amounts of energy used in each of these societies compare.

In the age of simple tools, human muscles and fire were adequate. In the early stages of the agricultural age, human muscles were still the only sources of energy, so that most families had to raise their own food crops. As domestication of animals provided an additional source of energy, an increased number of families could be supported by one farm.

The industrial age began when the great amount of energy available from steam was harnessed to take the burden of labor off the backs—literally—of human beings and animals. Improved sources of fuel to produce steam provided the great amounts of energy needed.

Now as we are moving into the information age, we have three energy choices. We can reduce, maintain, or increase our use of energy. The first two choices would mean changes in our lifestyles—reductions in personal conveniences—but may better preserve our natural environment. It is more likely that we will continue to increase our use of energy; and this could be our best choice if we can find satisfactory and appropriate energy sources. Our recognition of energy choices reflects our knowledge of technology and its constant energy demands.

Transparency 7: Technologies control and cure disease, and sustain and prolong life.

Begin by pointing out that science has learned the causes of many illnesses. We have developed a wide variety of health technologies to cure and control disease and to sustain and prolong life, but the individual still has the greatest control over his or her own wellness through nutrition, exercise, and good health habits.

How did our increased concern for these wellness activities come about? What are some of the spin-off businesses from this concern with wellness? As we grow healthier, we increase the cost of some kinds of health care and lengthen our lives. As health care needs change and as health care becomes more sophisticated, we must ask whether everyone has access to the technologies that lengthen lives. Can we actually give everyone full medical treatment? Health insurance in England, for example, does not pay for organ transplants for people over 55. Are there ways to reduce costs? Certain new medications appear to be as effective as heart bypass surgery and cost very little in comparison.

Transparency 8: Energy conversion to electricity.

This overhead compares cost in the conversion of heat to electricity and the conversion of solar energy (light) to electricity. Point out that the most efficient way to move energy even short distances is by converting it to electricity at the source and converting it to the desired form at the destination.

For photovoltaic conversion, the sunlight itself is free, but great amounts of sunlight are needed. The cost of solar panels, although once quite high, is now modest, but there are also costs for batteries in which energy not used during the day can be stored for use at night. Thus, installation costs for photovoltaic conversion are high, but operation and fuel costs are relatively low. Since solar cells convert only a small portion of sunlight to electricity, buildings using them often require additional sources of energy. Toxic waste from the manufacture of solar cells is a very difficult environmental problem.

Heat for conversion to electricity may come from a furnace or from a reactor. A nuclear reactor produces much more heat, but requires costly buildings and safety devices to protect workers and the environment from radiation damage. Safely disposing of toxic wastes from reactors is an expensive, unsolved problem. When a coal furnace is used, mechanisms to protect the environment from pollutants such as sulfur and nitrous oxides are needed, but these are much less expensive than the ones required for a reactor. In both cases, the heat energy converts water to steam that turns a turbine that converts mechanical energy into electrical energy.

Transparency 9: Technology is an agent of social change.

Point out that almost all technologies have served as agents of social change but that health technologies are used in this overhead as a convenient example. Primarily because of the development of health technologies, life expectancy has increased from approximately 47 years in 1900 to 73 years in 1980. Have these increases been constant or are they changing? What are some of the health technologies producing these increases? Long life has been highly valued by members of our society. Is it still a desirable goal? What must individuals do to prepare for long life? As the proportion of elderly in our society gets larger, how does society provide health care? Housing? Recreational facilities?

Transparency 10: Assembly lines increase productivity, but at a price.

The development of assembly-line technology brought about great increases in human productivity. Compare an individual cobbler who produced a complete pair of shoes to an assembly line worker who assists in producing many pairs of shoes. What skills might each require? How would their working conditions vary? Students should understand that the cobbler was able to work in or near his home and that he could work at his own pace, knowing that the more shoes he made the more money he would earn. The assembly-line worker does only one or two steps in the total process at a factory where the machines control the pace. Typically, such a worker receives hourly wages. How might a machine or robot replace the worker on an assembly line?

Transparency 11: Technologies increase food production.

Many technologies support the work of agriculture. The center pivot, an example of very advanced irrigation technology, consists of a strong, stationary center post from which a giant arm (1/4 mile long) rotates very slowly 24 hours every day, spraying water on the crops. It uses less water with greater effect than the irrigation ditch, which runs the water all through the field and loses water by evaporation to the air and by absorption into the soil.

The center pivot is so efficient that it is much used in the western states, causing a drop in the water table, an environmental cost that is causing great concern.

Crop dusting is an established practice for delivering both fertilizers and pesticides to the crops in the field. The old biplanes are still used because they are slower and safer at altitudes low enough to spray the fields properly. Two major problems offset some of the benefits of using pesticides. Customarily planes spray three to five times more pesticide than necessary. The pesticide contaminates the soil and moves down to pollute the ground water. Second, the pests, both weeds and insects, tend to develop an immunity to the chemical. Alternating various pesticides tends to prevent the development of immunities.

Transparency 12: Technology changes the number of workers.

The introduction of a new technology tends to cause a change in the number of workers in a business or industry; agricultural technologies are a powerful example of this effect. In the days of settling this country, more than 90 percent of the people were farmers. Even merchants and tradesmen had large truck and herb gardens. After Cyrus McCormick invented and manufactured large, efficient planting and harvesting equipment, decreasing numbers of people were required to operate farms efficiently. Currently, less than 10 percent of the population is employed in agriculture.

Farmers responded to new technologies by building giant farms, now correctly called agribusinesses, which employ about the same number of people as a small farm once did. But at least 80 percent of the people left the farm to go to the city, where they often found work in agricultural machinery factories and food processing plants. This large available workforce permitted cities to grow in size and to develop a variety of manufacturing and production factories. Then transportation technologies were needed to distribute food and clothing and to get the workers to and from work daily.

Transparency 13: Communication expands the individual's world.

In the early days of this country, a teenager's world was much smaller than it is today. Two centuries ago young people usually lived on farms, where they worked every day and talked only to family members. They learned about the world when they went to town and could talk to other people. What kinds of news would they get from those conversations? The one-page weekly and monthly newspapers did not get to the farms and ranches. Events—and news of them—moved slowly. National presidential elections were held in November, but it was January before the members of the Electoral College could vote, and it was March before the president could be sworn into office.

Today's teenagers can hear the president speak to them in their homes. They can watch international events like the Olympic Games. How do our newspapers today compare with those of the early days in quantity and quality of the news?

Transparency 14: Copyrights protect artists.

Society must provide special protection for the rights of artists, writers, and actors who are among the most creative citizens. Because the products—content, idea, form, style—of these people are intangible, it is very difficult to prove theft. C r-right laws were designed to assure that these workers receive the recognition financial benefits of their talents and skills. *Royalties* are payments to writ , composers, and actors for each copy or showing of their work. *Patents* protect ventions; *copyrights* protect the matter and form of a literary, musical, or artistic work.

Copyrights worked well for a long time, but then cassette and video recorders became available. "Pirating" is the term to describe the unauthorized copying of recorded music, videocassettes, or TV programming. Pirating is a crime because it robs people of their deserved recognition and royalties. Pirating is an illegal use of communications technology.

Transparency 15: Transportation technologies increase mobility.

All transportation technologies increase our mobility—that is their purpose. Most suburbs were developed and are maintained because of the automobile. Recently, in large cities such as Washington, D.C., mass transit has been brought to the suburbs.

Suburban living had many attractions. Cheap land made it possible to have a large home and yard and to avoid city crowding. Conditions were safer; there were fewer crimes and less traffic. List as many other benefits as possible.

The costs of suburban living are both personal and environmental. Most suburban residents work in the city where their cars fill streets and parking lots. Fumes from automobiles have markedly increased the air pollution in every city. People living in the suburbs often fail to take advantage of the city's resources, such as museums, theaters, major libraries, and celebrity concerts. Parents in the suburbs often leave home before their children are up and return after they are in bed. They may spend their weekends taking care of the big yard.

If there is time, develop the idea that the situation is continuing to change, with business and industry now moving into the suburbs.

Transparency 16: Technology requires immediate problem solving.

For a general discussion of decision making, transparency master 4 may be helpful.

When people first started driving their own cars, they assumed that the shortest road was the wisest choice. Now, however, a motorist going home from work in the city is concerned about the shortest *time* to get home to the suburbs.

In making decisions, the motorists begin with the need to get home quickly. From experience and the radio news, they gather relevant information (input) about the number of traffic lights, road construction, and traffic conditions. What other information and information sources might help here? Balancing one piece of information against another, the driver then makes the decisions and begins to drive home. What kind of feedback might he use for the next return drive home? He might decide, for example, that the delays caused by repairs on one route are too long, and travel a different way until repairs are completed.

Transparency 17: Cultural factors determine if and how technology is developed.

First, make sure students understand the graph. The x-axis shows the complexity of the technologies; a lower point on the x-axis represents a simpler technology. The y-axis represents time from the fifteenth to the twentieth century and beyond. The line for Japan indicates in a rough way that there was little or no development of technologies until the twentieth century, when development began and increased at a rapid pace. What happened in Japanese culture at that time? Why was there so little development until then? Help the students understand that if your beliefs require harmony with nature, you tend to see any change as interfering with that harmony. Losing a global war made the Japanese fear that they might lose their whole culture. They chose technological change in order to preserve their culture.

The line representing technological development in the West shows that Western technologies were simpler than Japanese technologies in the fifteenth century. With such inventions as the magnetic compass, stern rudder, and gunpowder obtained from China, Western culture could support the development of technologies at a fairly steady rate, surpassing the level of complexity of the Japanese and going far beyond. The concepts of God's gift of dominion over the world and of the existence of natural law provided a psychological motivation and basis for technological development.

What part do economic motives play in the technological developments in the East and West? What predictions would the class make about future technological developments?

Transparency 18: Japanese technology affects the West.

Be sure that the students can read the graph to see that the Japanese sold few cars before 1950, but their sales then grew rapidly to surpass U.S. sales about 1980. U.S. auto sales began to drop rapidly in the 1970s, but recently they are leveling off.

The dotted lines at the end of each line graph indicate the possibilities for Japanese and for American auto sales: Will they stay about the same? Increase or decrease? Your discussion with the students should include not only the predictions, but also the cultural and economic factors on which the predictions are based. For example, the U.S. government may place quotas on Japanese car imports to this country. U.S. auto manufacturers may develop new technologies to produce automobiles faster and cheaper. Americans, in a burst of patriotism, may stop buying foreign cars.

Transparency 19: Technologies extend lives.

Students today hear much about the role of miracle drugs and machines in saving lives, but they should also realize that nutrition, hygiene, and immunization are even more important. These older technologies are responsible for the first major increase in people's life spans. With so much good food available today, it is hard to realize that until the 1800s, people were mainly concerned with getting enough food of any kind. No one knew much about nutrients. Have a few students describe a healthful, nutritious breakfast containing protein, carbohydrates, and vitamins. Tell students that hospitals were once places of death, where very few patients survived. Doctors and workers knew nothing about contagion, contamination, or a sterile environment. They simply went from patient to patient carrying germs and infections, rarely washing their hands. Hygiene and sanitation reduced illnesses, and made hospitals safe enough for people to recover in. Based on the science of bacteriology, immunization and vaccination reflect a much higher level of technology. The ultimate success of vaccination has been to wipe out smallpox. No one in the entire world has the disease or has had it for about seven years. Scientists must now decide whether to kill off the remaining smallpox organisms, which live only in a lab. Have your students consider events in technology and society which may lengthen our life span, keep it the same, or shorten it.

Transparency 20: 'Faster Than He Can Sow It'

Have the students explain the meaning of this editorial cartoon. They should address the symbolism of the stork and why the farmer has a large seedbag. What does the owl mean by "seeds of discontent"? How does the cartoon relate to the video program on population patterns? How can people work to solve the population problem as individuals? How can societies work to solve this problem?

Transparency 21: Space travel has benefits and risks.

Wealth, conquest, and knowledge are three reasons for exploring. Ask students what people in the United States have gained under each of these headings. Under "wealth," be sure to emphasize all the electronic devices and the rapid development of supercomputers. Ask whether we have conquered space or conquered earth's gravity to explore space. Under the heading "knowledge," ask what have we learned about rockets. What have we learned about living in space? Should communica-

tions satellites be listed under "wealth" or under "knowledge"? Raise the issue of risks, and ask, "Which risks have we learned to reduce? To avoid?" John Kennedy's commitment of American resources has brought great rewards for very large sums of money. Is it appropriate for us to continue that commitment into the 1990s?

Transparency 22: Space exploration can involve astronauts or space probes.

To compare the advantages and disadvantages of both sides, have students discuss such requirements for humans to live in space as water, air at a definite pressure, heat, and carefully prepared food. Then turn the discussion to the similarities between space probes and the shuttle or space station. Both require power to take-off and return, communications with earth, and survival in the harsh conditions of space without loss of control. Since the operational costs are somewhat similar for the machinery, the students need to focus on the costs of taking people. Even without knowing the exact sums, the students can clearly see that millions of dollars are needed. Then ask, "When are people required for space exploration?" Voyager and Pioneer have sent back a wealth of information even though no person was on board. People are most needed to convey a sense of the excitement and accomplishment to those on earth who are paying for the space program. The creation of enthusiasm is essential if the program is to continue. People might be needed for certain kinds of repairs or rescues. Making firsthand observations of a new place or event to detect unpredicted elements is also a major reason for sending people.

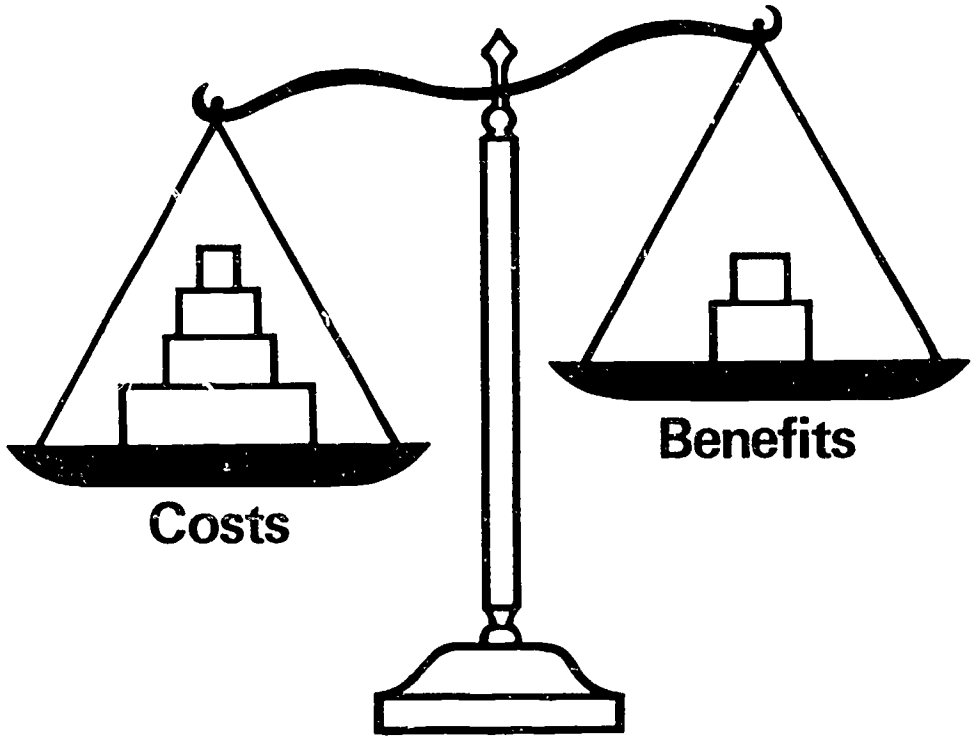
Transparency 23: There is no risk-free society.

Review the three kinds of risk: voluntary risk, voluntary acceptance of risk, and involuntary risk. What kinds of risks are indicated by the three graphics? Even if you can refuse any voluntary risks, can you avoid risks? For each of the three graphics (risks), what can society do to reduce or avoid that risk? What can the students do as individuals to reduce and avoid the risk? Have the students list instances in which they contributed an involuntary risk to their family, friends, and strangers.

Transparency 24: Risks can be voluntary or involuntary.

Discuss briefly which man has a voluntary risk and which has the involuntary risk of smoking. What did non-smokers do to avoid this risk before the no-smoking laws? Why do the students think the no-smoking laws were passed? What changes of attitude would be necessary in bringing about the change? Should people be permitted to accept the voluntary risk of smoking? When people smoke, how does it affect the costs of insurance, the costs of medicare for non-smokers? Is there a right to smoke? A constitutional right to smoke?

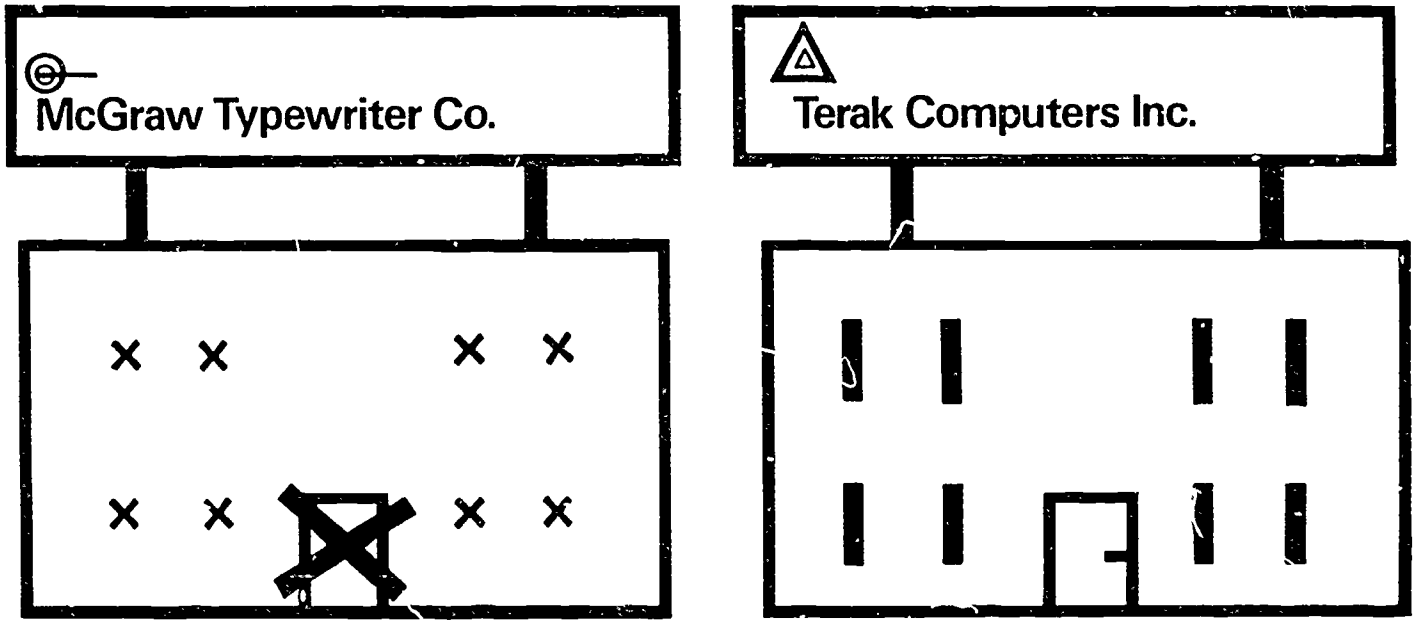
Every technology has trade-offs.



If costs outweigh benefits, what are the options?

Technology develops new business and industry.

Transparency 2



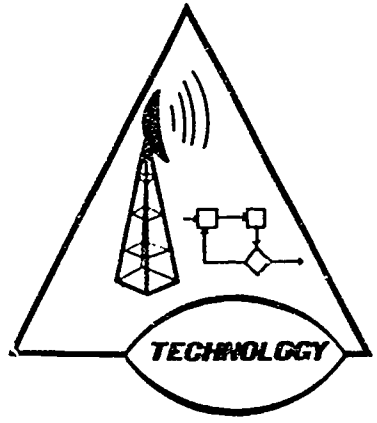
67

New jobs from new technologies?

68

Definition of technology.

Transparency 3



The use of human knowledge (science) and creativity to design products and processes to:

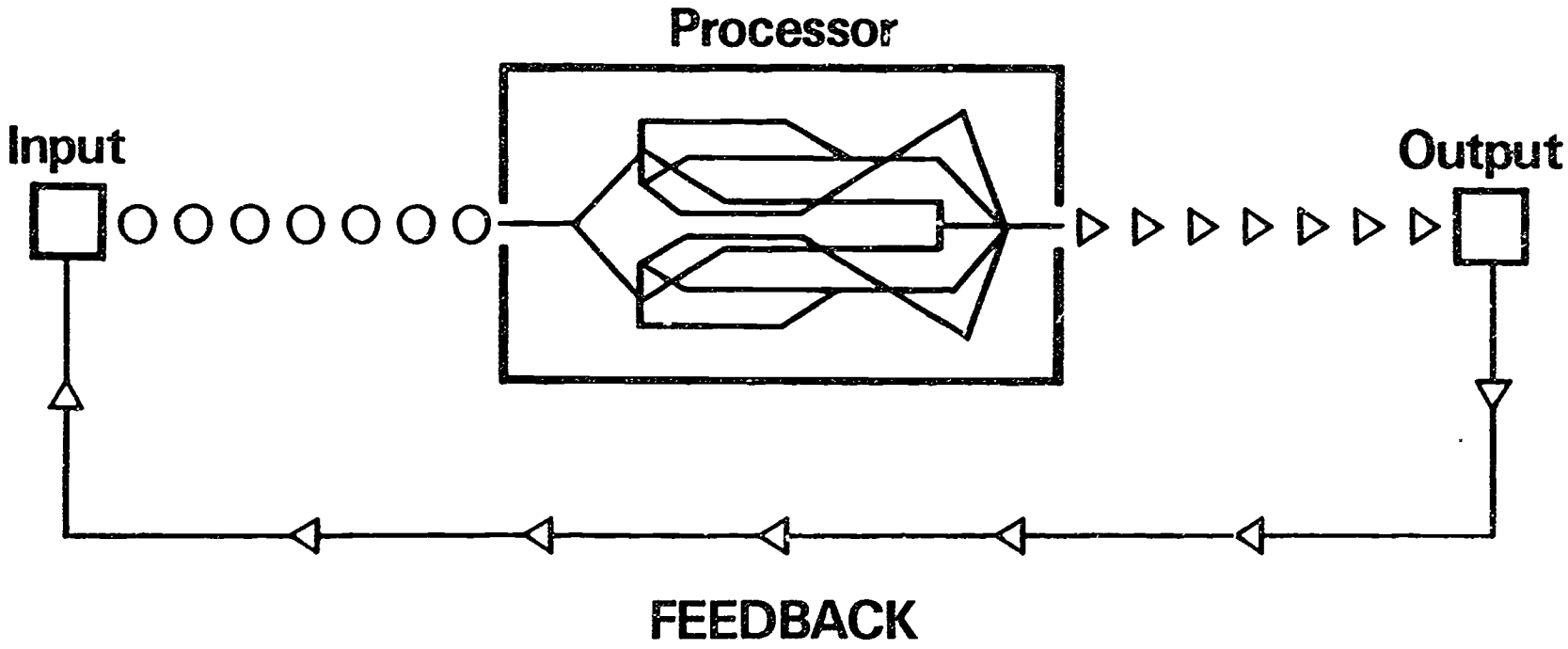
- extend the capabilities of human beings

and

- to modify the environment.

Feedback is a characteristic of technology.

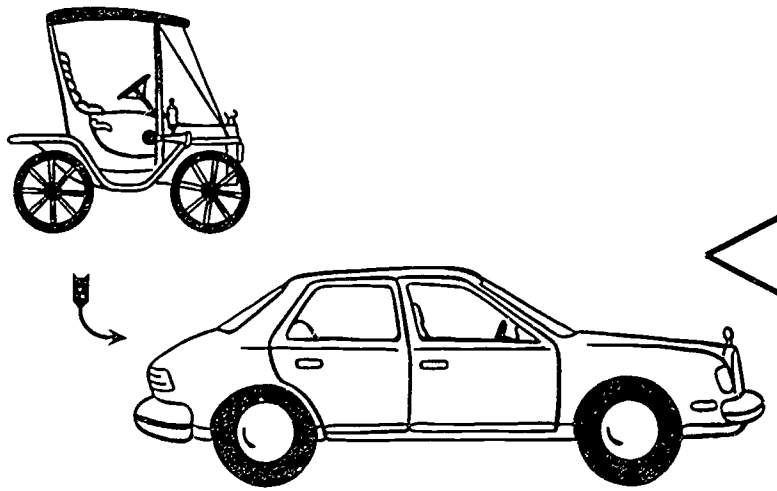
Transparency 4



How is feedback related to quality control?

Technology carries a degree of risk.

Transparency 5



Increased Injuries

Traffic Congestion

Drive-in Movies, Banks, etc.

Better Mobility

? _____

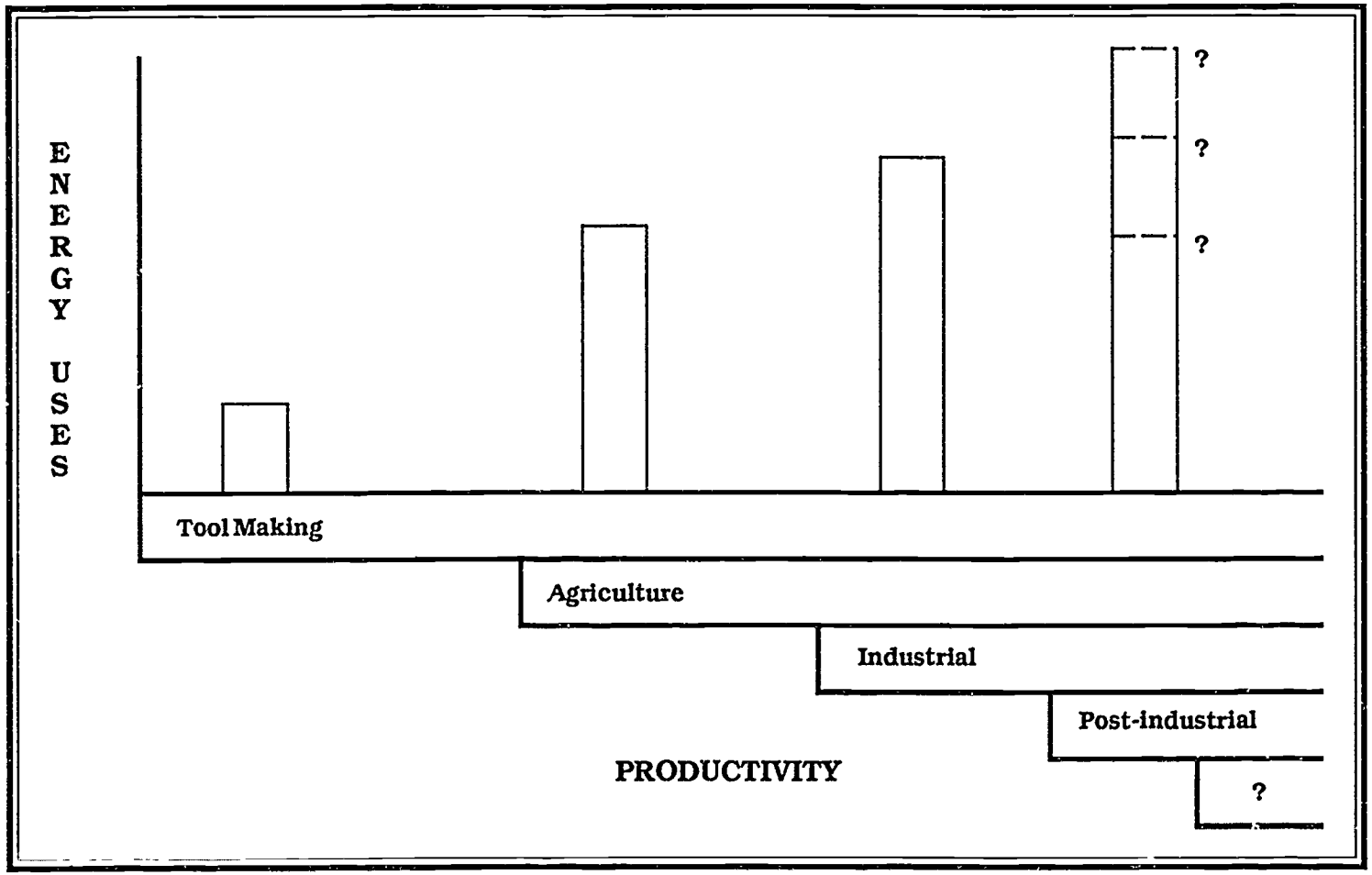
? _____

? _____

Additional social impacts of automobiles?

Changes in productivity systems mean different energy needs.

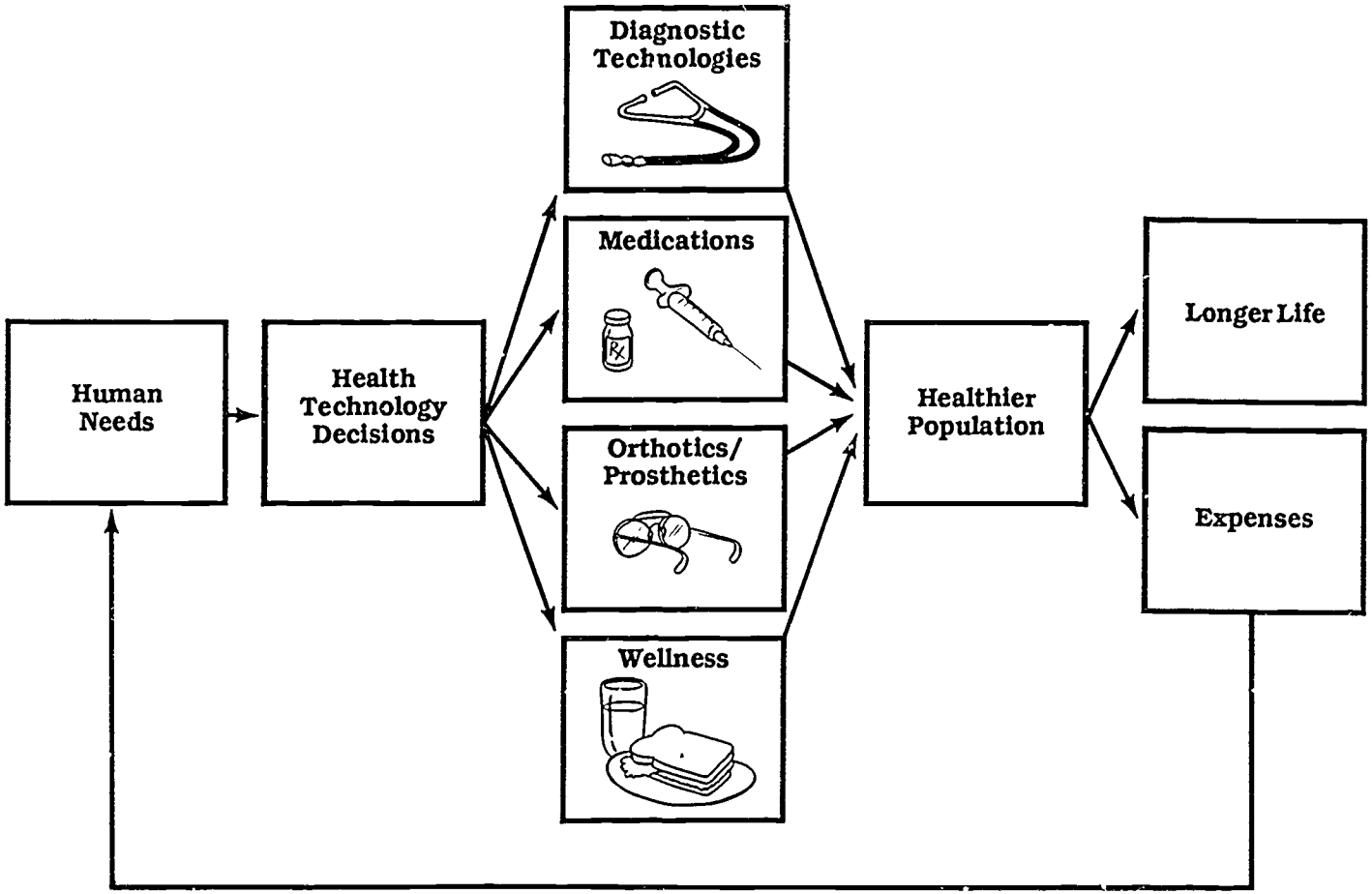
Transparency 6



How will we make our energy choices?

Technologies control and cure disease, and sustain and prolong life.

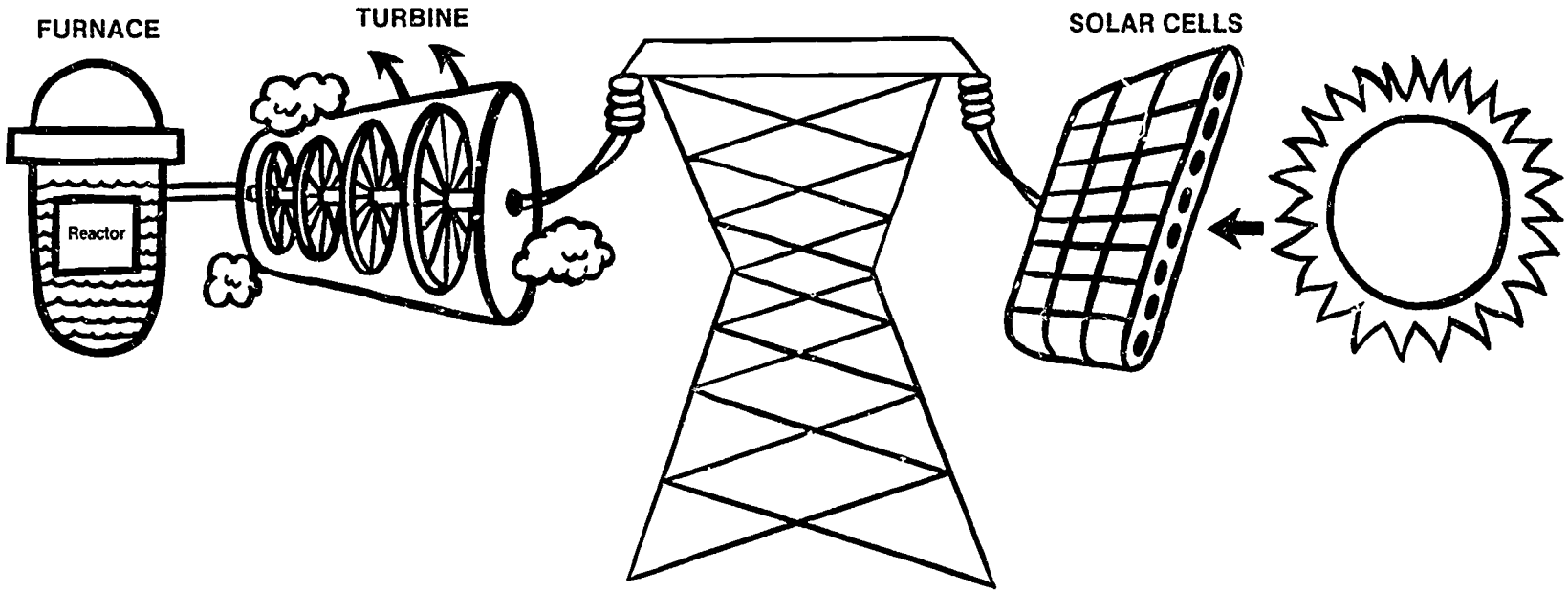
Transparency 7



What are the effects on human needs?

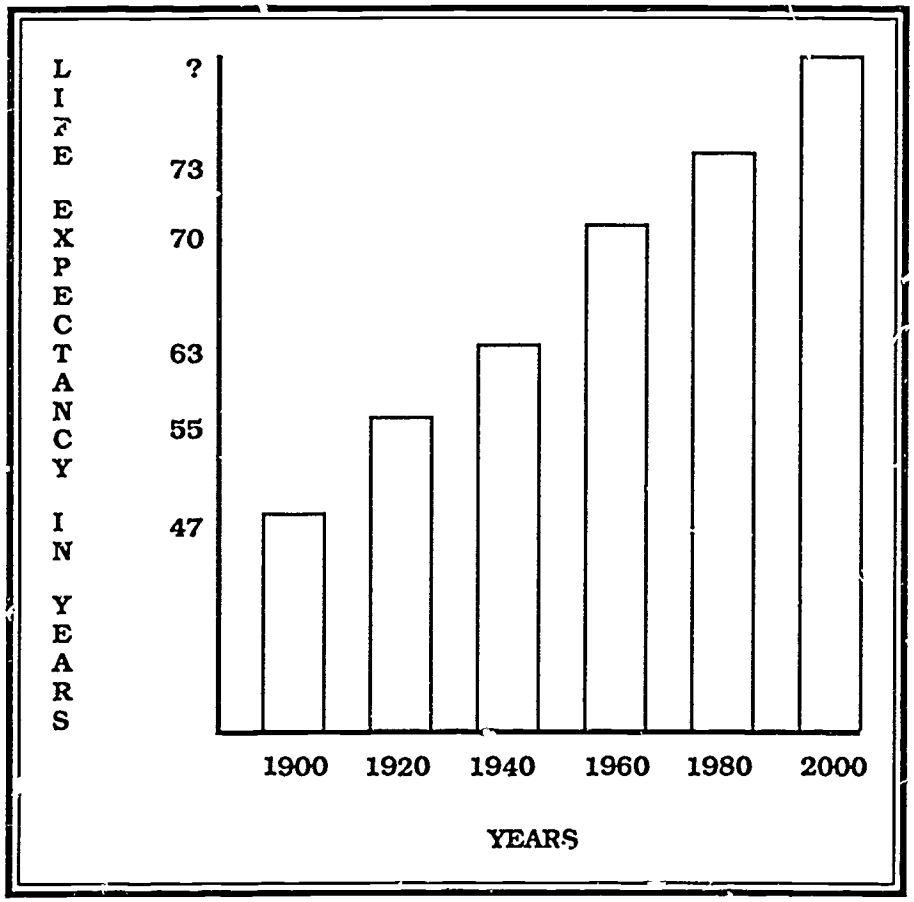
Energy conversion to electricity

Transparency 8



Technology is an agent of social change.

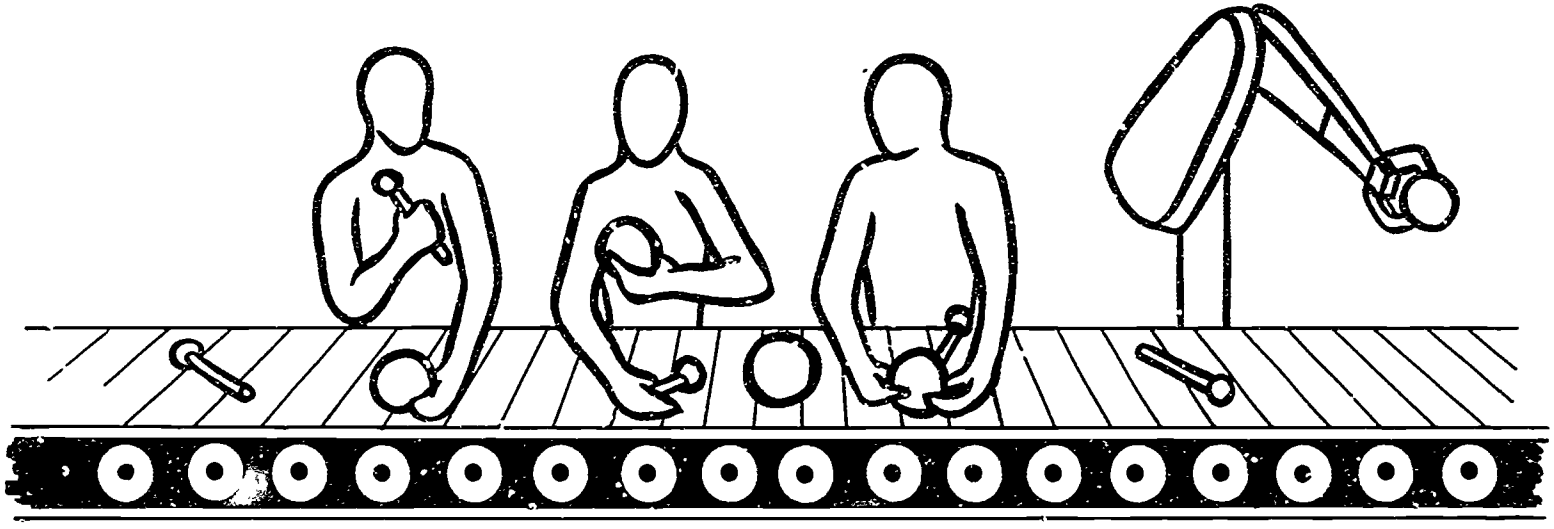
Transparency 9



When is longer life a better life?

Assembly lines increase productivity, but at a price.

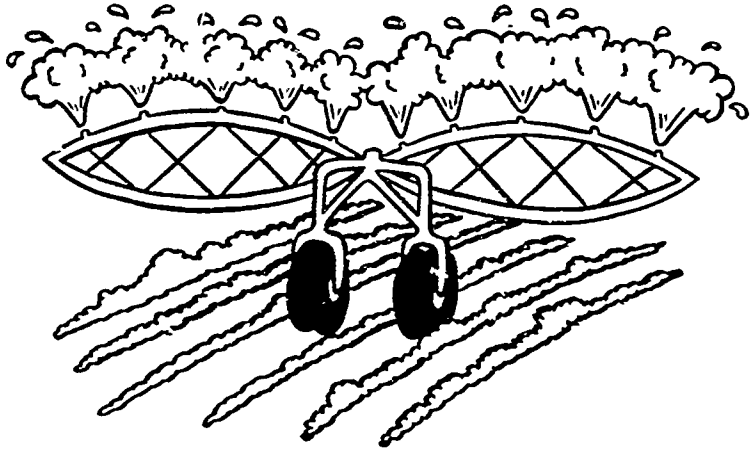
Transparency 10

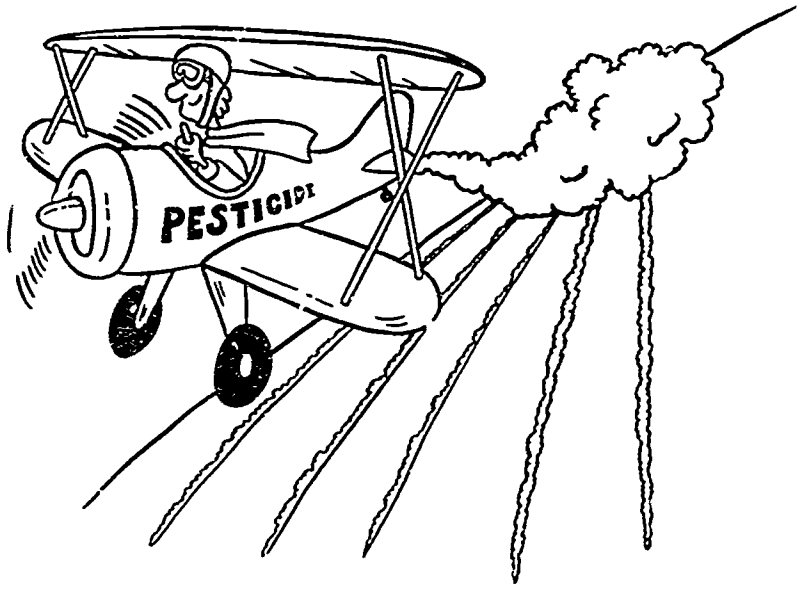


When can machines replace workers?

Technologies increase food production.

Transparency 11

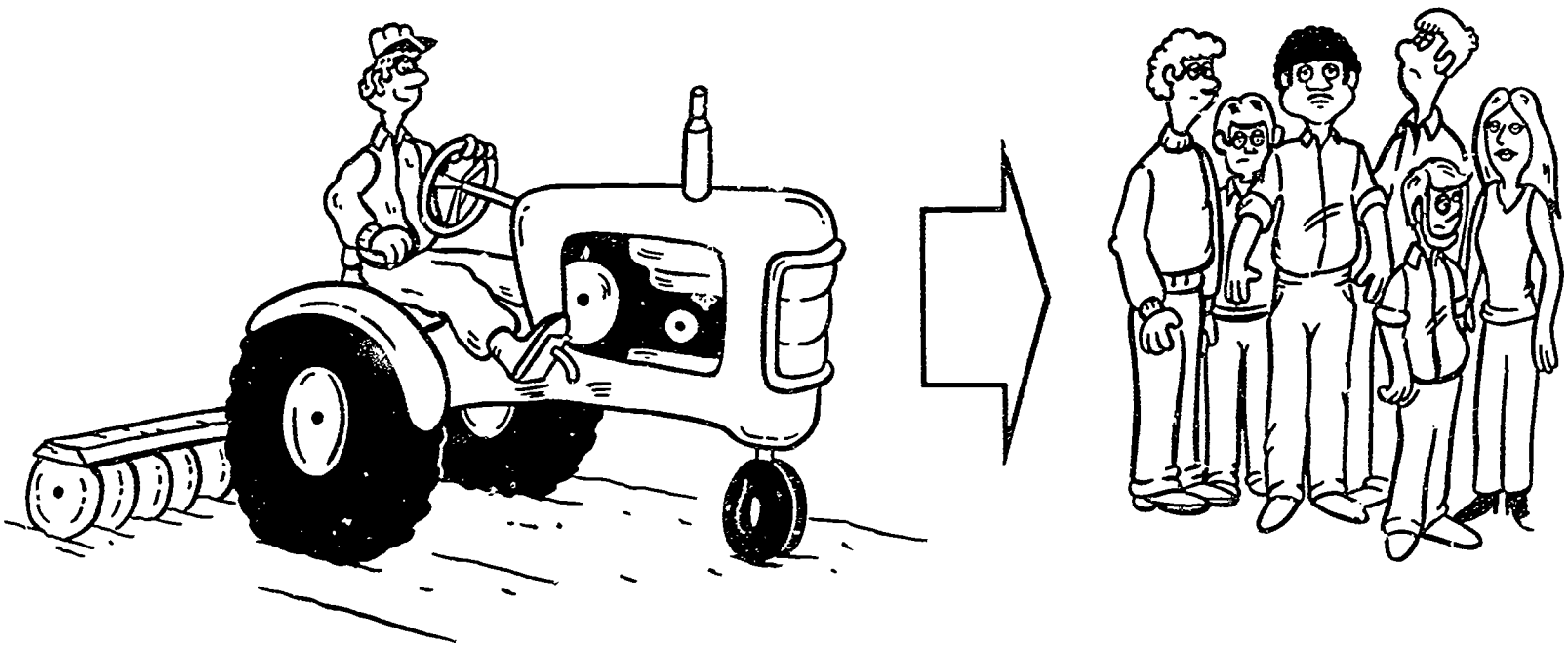




What are the environmental effects?

Technology changes the number of workers.

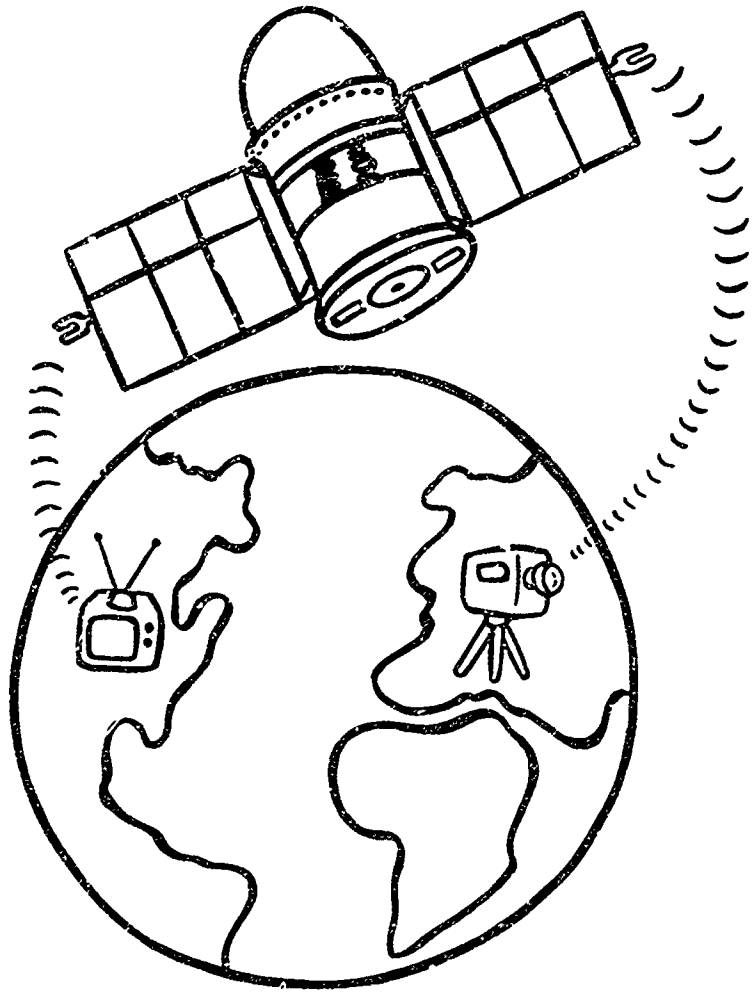
Transparency 12



Where do displaced people go?

Communication expands the individual's world.

Transparency 13

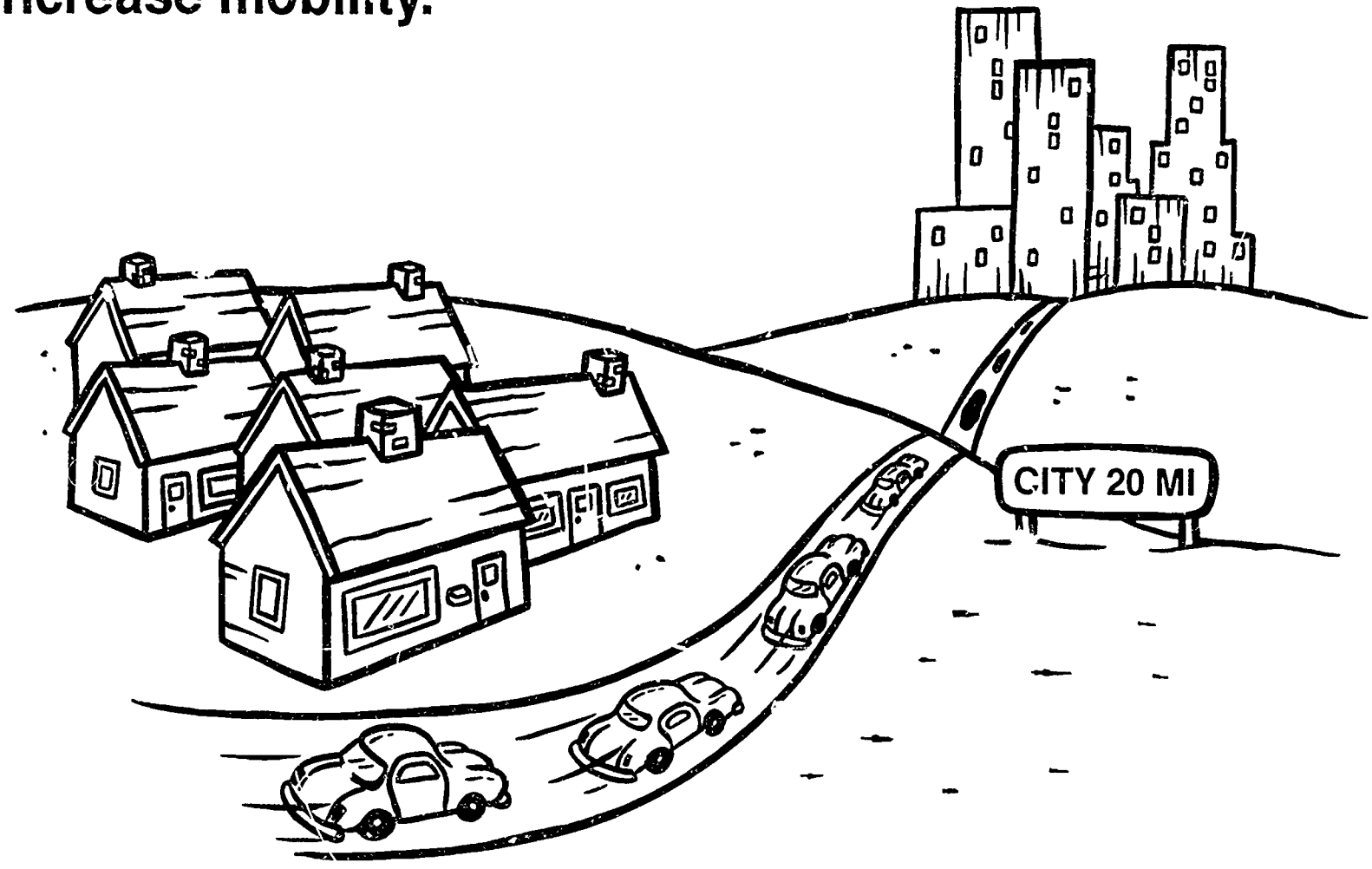


How do sources and frequencies of communication compare?

Copyrights protect artists.

Is a crime being committed?

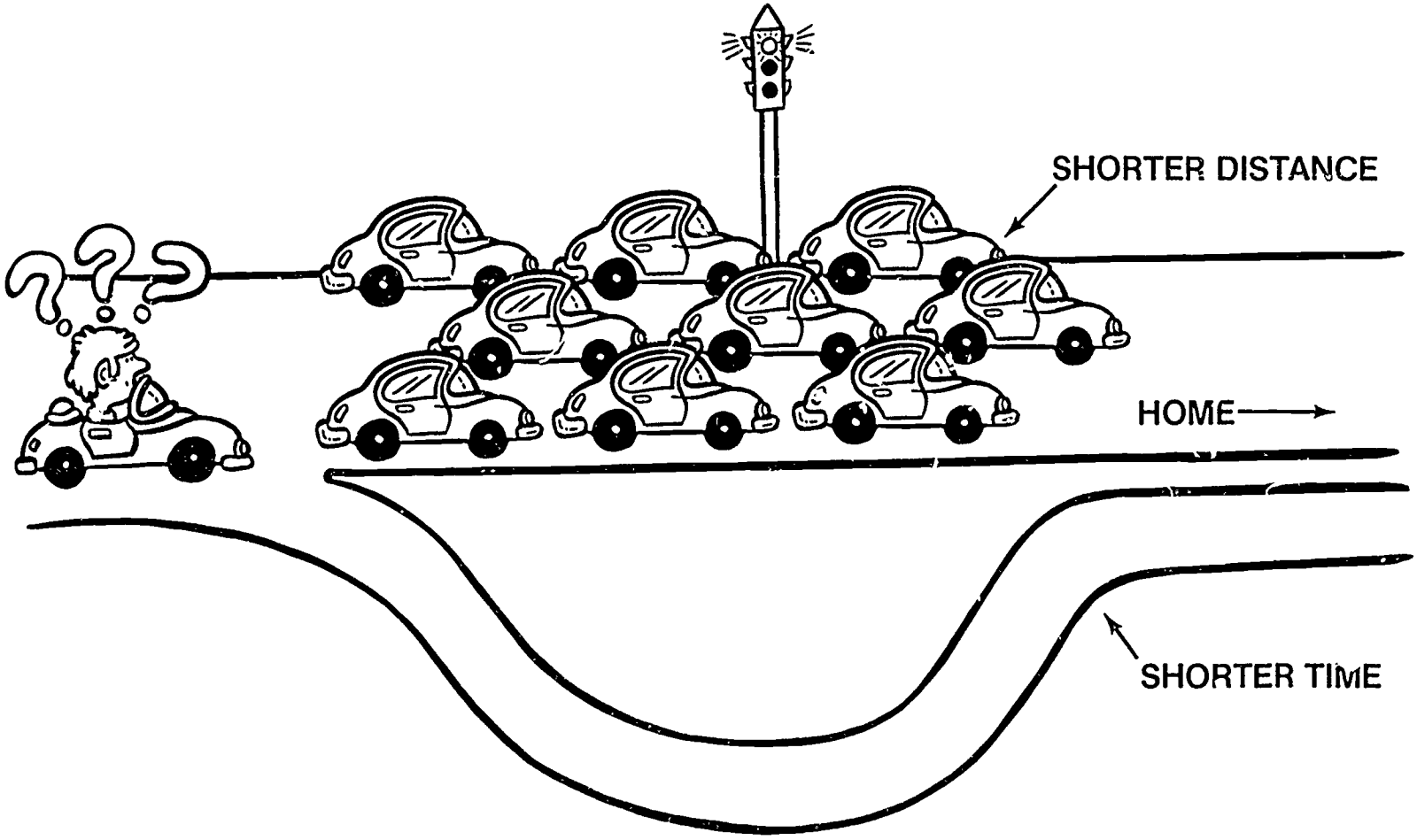
Transportation technologies increase mobility.



How does this affect lifestyle?

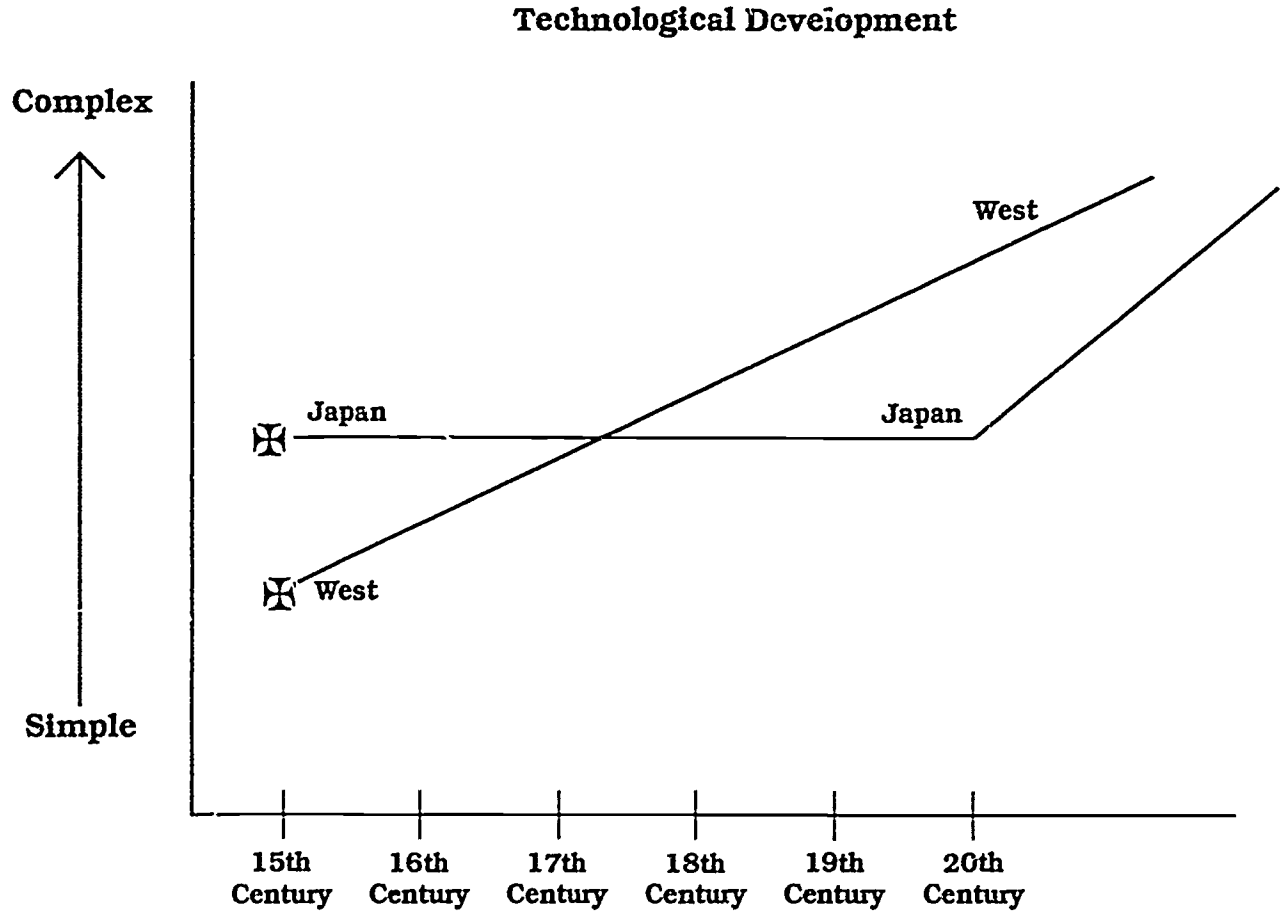
Technology requires immediate problem solving.

Transparency 16



Cultural factors detemine if and how technology is developed.

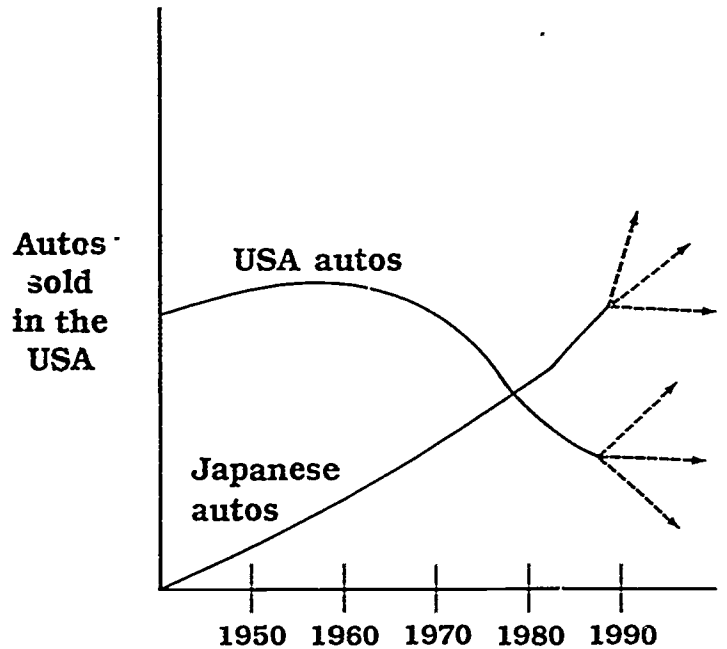
Transparency 17



What motivates East and West to develop technology today?

Japanese technology affects the West.

Transparency 18

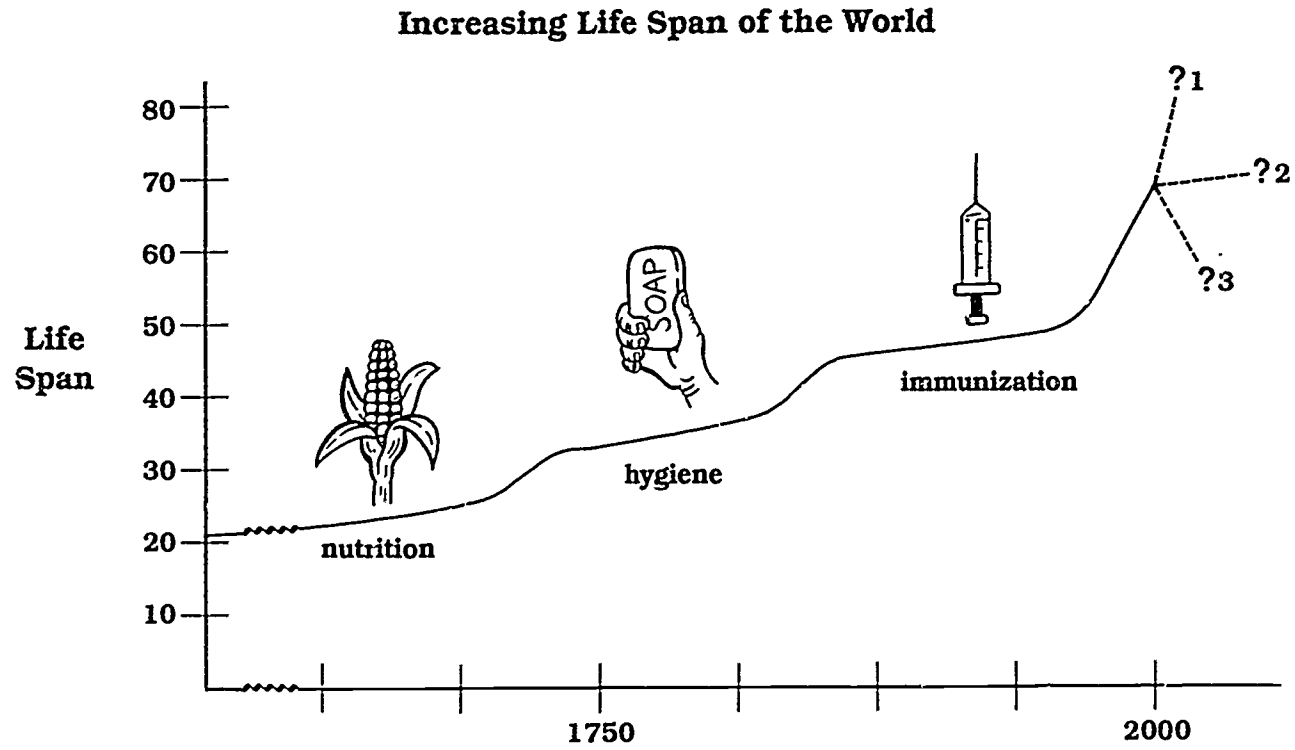


Sales of Japanese and American autos in the United States

How can USA catch up in auto sales?

Technologies extend lives.

Transparency 19

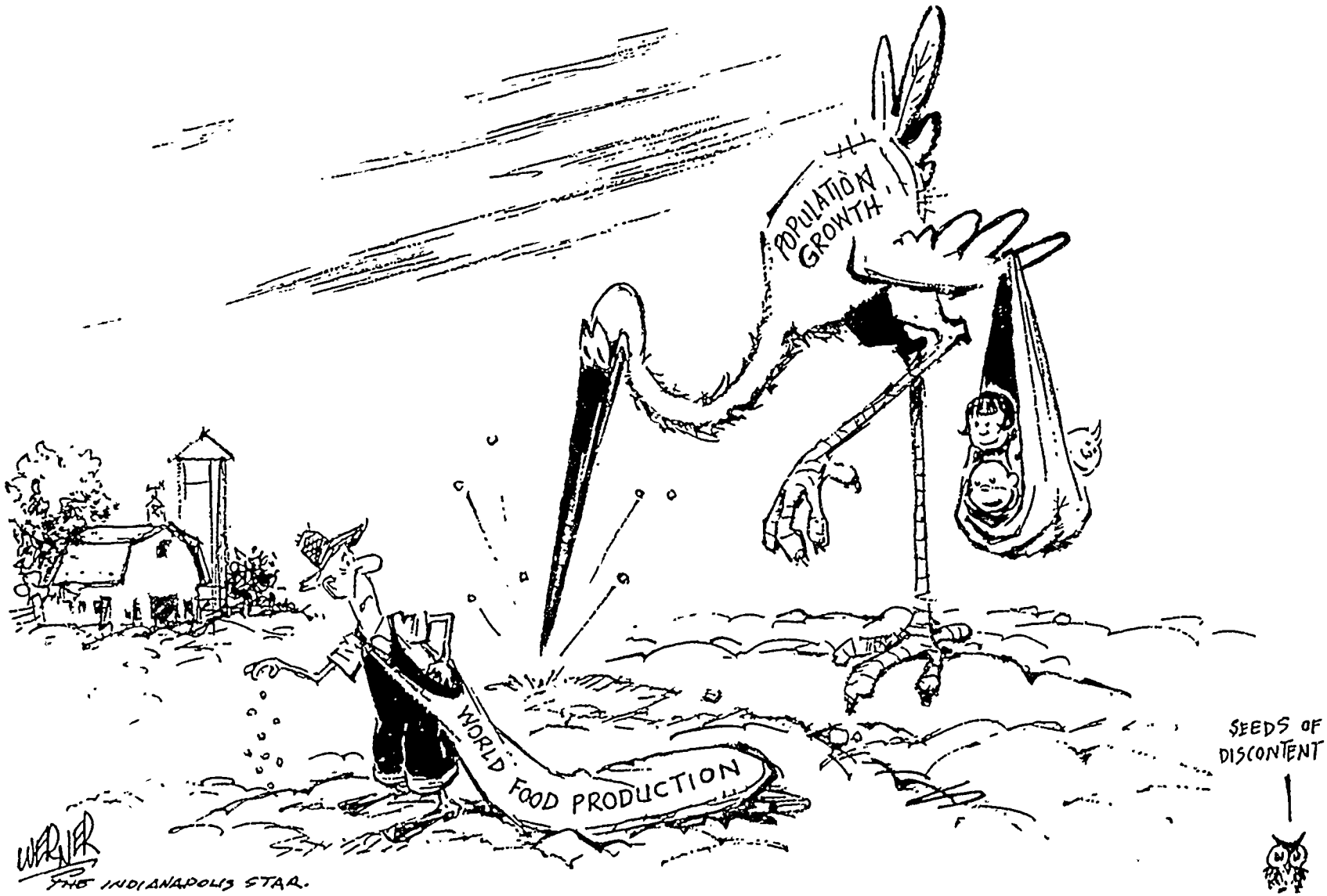


What factors might result in the Growth Predictions 1, 2, and 3?

101

102

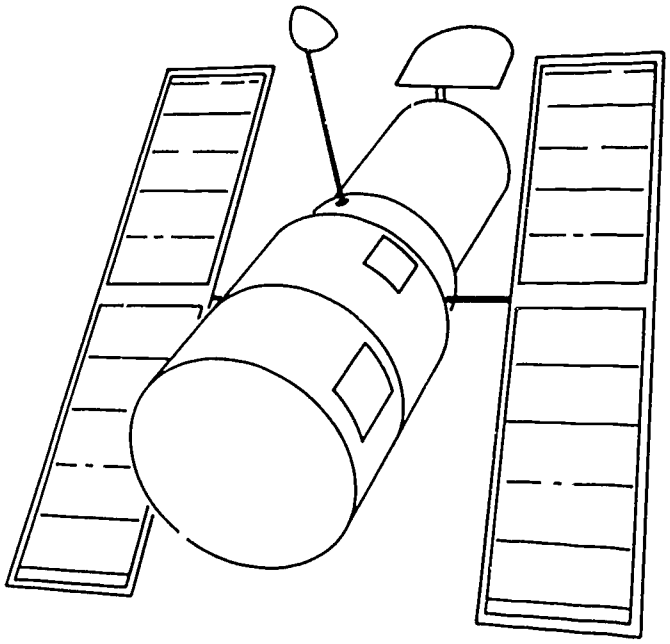
Faster than He can Sow it



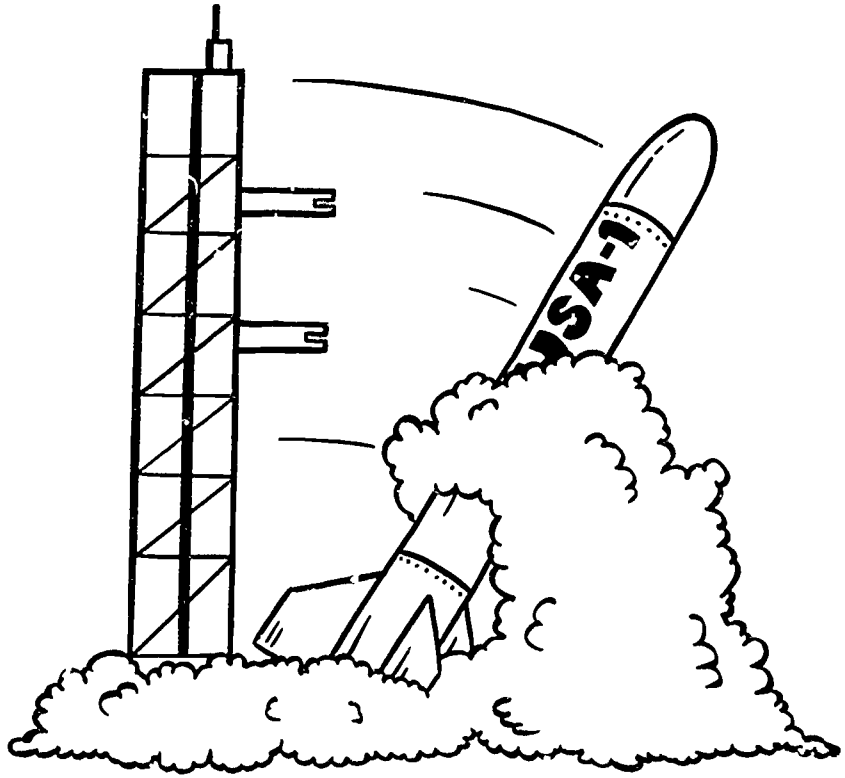
ROTHCO

Space travel has benefits and risks.

Transparency 21

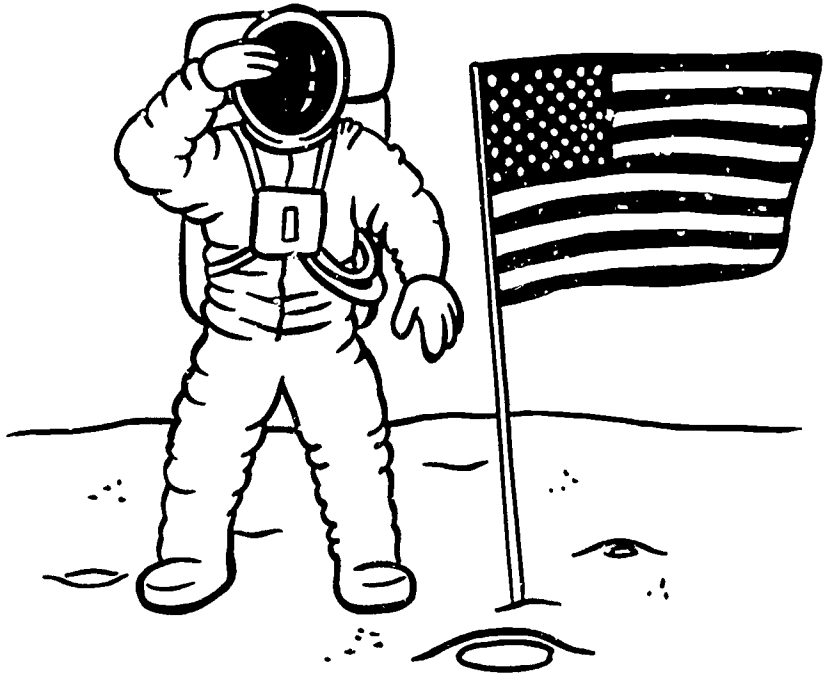


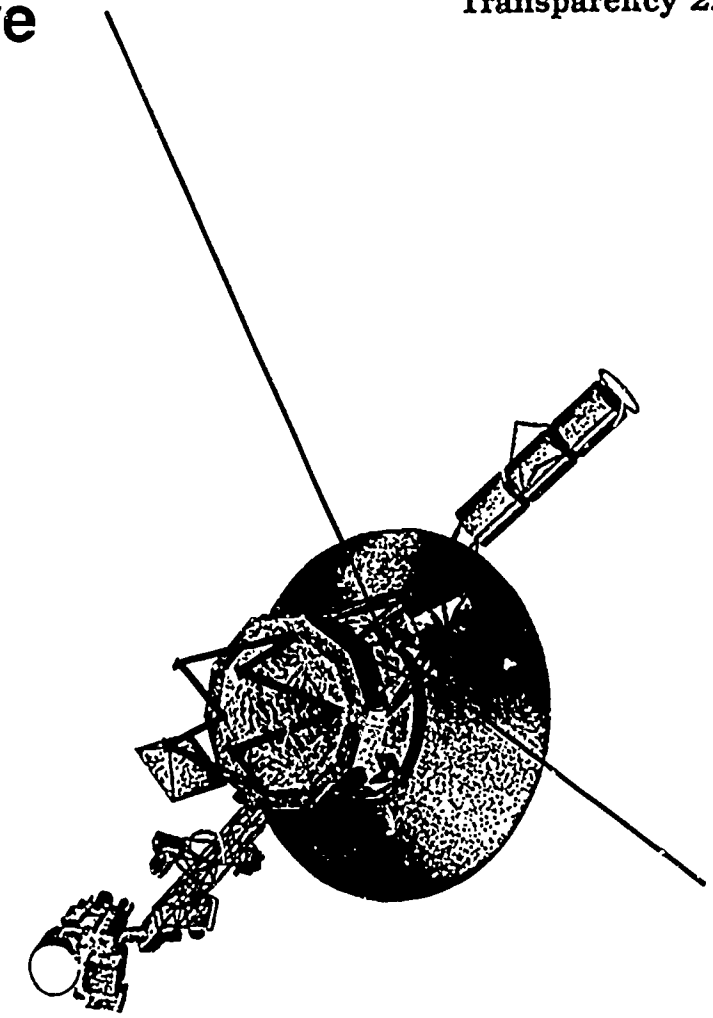
SPACE TELESCOPE



How can we reduce risks and keep benefits?

Space exploration can involve astronauts or space probes.

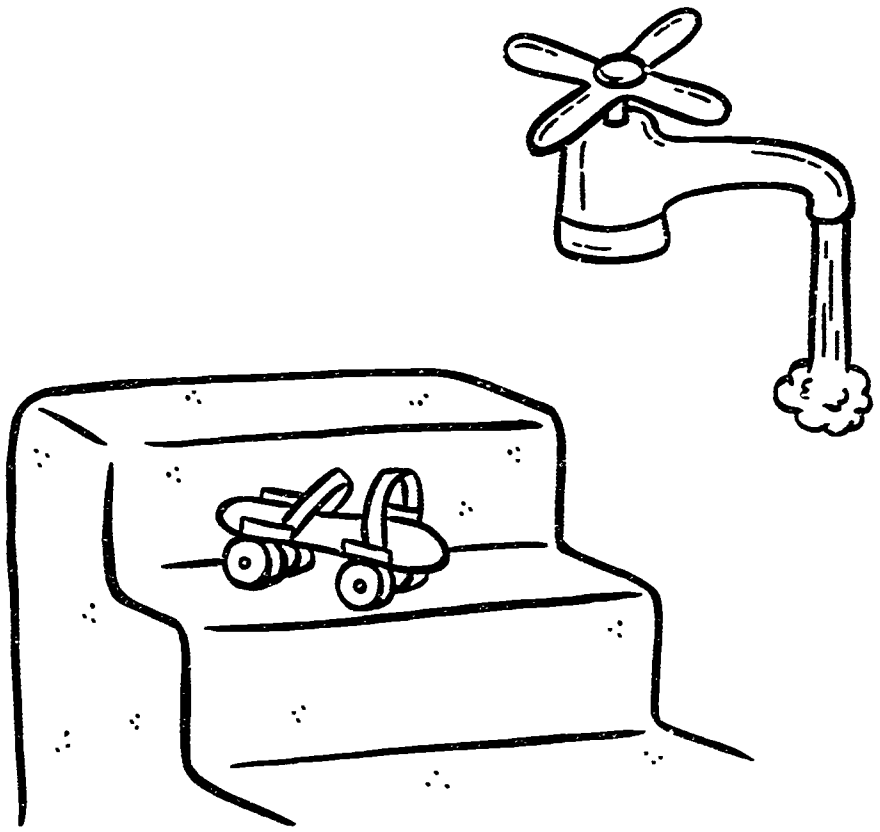


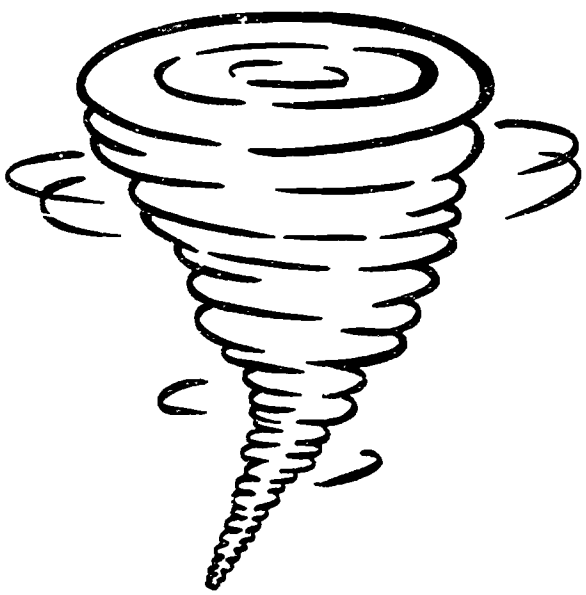


When are people required for space exploration?

There is no risk-free society.

Transparency 23





Can we always reduce risk?

Risks can be voluntary or involuntary.

Can you avoid involuntary risks?

Additional Resources

Readings

Cousins, Norman. *Human Options.* New York: W.W. Norton & Co., 1981.

Hartoonian, H. Michael. "Developing Decision-Making Ability Through the Use of Economic Content" in *Economics Education: Links to the Social Studies*, S.S. Symmes (ed.), Washington, DC: National Council for the Social Studies, 1981.

Morison, Elting, E. *Men, Machines and Modern Times.* Cambridge, MA: The MIT Press, 1966.

Salk, Jonas. *Survival of the Wisest.* New York: Harper & Row, 1973.

Todd, Lewis Paul, and Merle Curti. *Triumph of the American Nation.* Orlando, FL: Harcourt Brace Jovanovich, 1986.

- This standard U.S. history text contains an excellent account of the relationship between U.S. history and technology.

Vonnegut, Kurt. *Player Piano.* New York: Dell Publications, 1974.

Films

Burke, James. *Connection.* Boston: Little, Brown & Co., 1978. Text/film.

Chaplin, Charlie. *Modern Times.* 1936. Ten-reel film.

Judson, Horace F. *The Search for Solutions.* New York: Holt, Rinehart, and Winston, 1980. Text/film.

Organizations with Additional Instructional Resources

Send your request for materials on school letterhead.

AFL-CIO, Educational Department, 815 Sixteenth Street, N.W., Washington, DC 20006

- Request a catalog to identify films on technology and the growth of labor unions There is a rental fee of $5.00 or $10.00, plus return postage on each film.

Computers and Business Equipment Manufacturers Association, 311 First Street, N.W., Washington, DC 20001.

- Request information on computer careers and political issues related to computers.

Joint Council on Economic Education, 432 Park Avenue South, New York, NY 10016.

- Request materials showing the economic impact of technology.

The National Dairy Council, Educational Materials, 6300 N. River Road, Rosemont, IL 60018.

- Request materials on technologies related to nutrition and health.

Background

"Attitudes and Beliefs," "Economics," and "Societal Needs," teacher's programs in *Interactions* series. 30-min. color video programs. 1987. Distributed by Agency for Instructional Technology.

Bell, Daniel. *The Coming of the Post-Industrial Society.* New York: Basic Books, 1973.

Boorstin, Daniel J. *The Discoverers.* New York: Vintage Books, 1983.

Burke, James. *Connections.* Boston, Toronto: Little, Brown and Company, 1978.

Morison, Elting E. *Men, Machines and Modern Times.* Cambridge, MA: MIT Press, 1966.

World Resources Institute and International Institute for Environment and Development. *World Resources 1986.* New York: Basic Books, 1986.

The following periodicals are recommended.

Bulletin of Science, Technology, and Society

Discover

Technology Review

Social Studies, Journal of the National Council of Social Studies

Watch daily newspapers for articles and editorials pertaining to science, technology, and society.

Instructional Support

Publications and other materials from the following sources

- National Science Teachers Association, especially

  Bybee, Rodger, ed. *Science, Technology, and Society: 1985 Yearbook.* Washington, DC: NSTA, 1985 (Cat. number BP 1) for background, curriculum, and instructional strategies, and

  Penick, John E. and Richard Meinhard-Pellens, ed. *Focus on Excellence.* vol. 1, no. 5, *Science—Technology—Society.* Washington, DC: NSTA, 1984 (Cat. number BP 36/5) for case studies, projects, and courses in schools.

- Office of Technology Assessment
  Congressional and Public Affairs Office
  U. S. Congress
  Washington, D.C. 20510-8025

- Social Issues Resources Series, Inc.
  POB 2507
  Boca Raton, FL 33427

- NASA
  Public Affairs Office
  Marshall Space Flight Center
  Huntsville, AL 35812

- Worldwatch Institute
  1776 Massachusetts Ave., N.W.
  Washington, D.C. 20036

- Zero Population Growth
  1601 Connecticut Avenue, NW
  Washington, D.C. 20009

- Local utility companies

Textbook Correlation Bibliography

The following books are all listed in the textbook correlation matrix beginning on page 85. Within each subject area they are listed by publisher. After each citation is the abbreviation (in boldface) by which the book is listed on the grid.

1. Technology

Bennett and McKnight

Bohn, Ralph C. et al. Energy, Power, and Transportation. 1st ed. Peoria, IL: Bennett and McKnight, 1986. **(B&M 1)**

Lindbeck, John R. and Irvin T. Lathrop. General Industry and Technology. Peoria, IL: Bennett and McKnight, 1986. **(B&M 2)**

Davis

Bame, E. Allen and Paul Cummings. Exploring Technology. Worcester, MA: Davis, 1980. **(Davis 1)**

Heiner, Carl W. and Wayne R. Hendrix. People Create Technology. Worcester, MA: Davis 1980. **(Davis 2)**

Todd, Ronald D. et al. Understanding and Using Technology. Worcester, MA: Davis, 1985. **(Davis 3)**

Delmar

Goetsch, David L. and John A. Nelson. Technology and You. Albany NY: Delmar, 1987. **(Delmar 1)**

Hacker, Michael and Robert A. Barden. Technology in Your World. Albany, NY: Delmar, 1987 **(Delmar 2)**

2. Physics and Physical Science

Addison-Wesley

Johnson, Gordon P. et al. Physical Science. Reading, MA: Addison-Wesley, 1984. **(Addison-Wesley)**

Allyn and Bacon

Toffel, Alexander. Physics.: Its Method and Meanings. Newton, MS: Allyn and Bacon, 1986. **(Allyn and Bacon)**

Holt, Rinehart and Winston

Ramsey, William L. et al. Physical Science. New York: Holt, Rinehart and Winston, 1987. **(HRW 1)**

Williams, John E. and Frederick E. Trinklein. Physics. New York: Holt, Rinehart and Winston, 1984. **(HRW 2)**

Charles E. Merrill

Murphy, James T. Paul W. Zitzewitz, and James Max Hollon. Physics: Principles and Problems. Columbus, OH: Charles E. Merrill, 1986. **(Merrill)**

Prentice-Hall

Appenbrink, David W. et al. Physical Science. Englewood Cliffs, NJ: Prentice-Hall, 1986. **(Prentice-Hall)**

3. Biology

Harcourt Brace Jovanovich

Goodman, Harvey D. et al. Biology. New York: Harcourt Brace Jovanovich, 1984. **(HBJ)**

Holt, Rinehart and Winston

Otto, James H. and Albert Towle. Biology. New York: Holt, Rinehart and Winston, 1985. **(HRW)**

Houghton Mifflin

Haynes, Nancy Lehmann, ed. Biological Science: an Ecological Approach. 5th ed. rev. by Richard R. Tolman et al. Biological Sciences Curriculum Study. Green version. Boston: Houghton Mifflin, 1982. **(HM)**

Silver Burdett

Alexander, Peter, et. al. Biology. Morristown, NJ: Silver Burdett Co., 1986. **(SB)**

4. U.S. History

Ginn and Co.

Boorstin, Daniel J., and Brooks M. Kelley. A History of the United States. Lexington, MA: Ginn and Co., 1986. **(Ginn)**

Harcourt Brace Jovanovich

Todd, Lewis Paul, and Merle Curti. Triumph of the American Nation. Orlando, FL: Harcourt Brace Jovanovich, 1986. **(HBJ)**

Holt, Rinehart and Winston

Risjord, Norman K. History of the American People. New York: Holt, Rinehart and Winston, 1986. **(HRW)**

Scott, Foresman and Co.

Berkin, Carol, and Leonard Wood. Land of Promise: A History of the United States. 2nd ed. Glenview, IL: Scott, Foresman and Co., 1987 **(SF)**

5. World History

Ginn and Company

Roselle, Daniel Our Common Heritage: A World History. Lexington, MA: Ginn and Company, 1984 **(Ginn)**

Harcourt Brace Jovanovich

Mazour, Peoples, Rabb. People and Nations: A World History. Harcourt Brace Jovanovich, 1987. **(HBJ)**

Prentice-Hall

Beers, Burton R. World History: Patterns of Civilization. 3rd ed. Englewood Cliffs, NJ: Prentice-Hall, 1986. **(Prentice-Hall)**

Scott, Foresman and Co.

Wallbank, T. Walter, et al. History and Life; The World and Its People. 3rd ed. Glenview, IL: Scott, Foresman and Co., 1987 **(SF)**

6. Civics and Government

Allyn and Bacon

McClenaghan, William A. Magruder's American Government. Newton, MA: Allyn and Bacon, 1987. **(Allyn and Bacon)**

Harcourt Brace Jovanovich

Hardgrave. American Government: The Republic in Action. Orlando, FL: Harcourt Brace Jovanovich, 1986. **(HBJ 1)**

Hartley, Vincent. American Civics. Constitution edition. Harcourt Brace Jovanovich, 1987. **(HBJ 2)**

Macmillan

Remy, Richard C. et al. Government in the United States. New York, NY: Scribner Educational Publishers. Macmillan, 1988. **(Macmillan)**

Merrill

Turner, Switzer, Redden. American Government: Principles and Practices. Charles Merrill, 1983. **(Merrill)**

Scott, Foresman and Co

Lewinsky, Marcel, et al.. Consent of the Governed: A Study of American Government. Glenview, IL: Scott, Foresman and Co., 1988. **(SF 1)**

Patrick, John, and Remy. Civics for Americans. 2nd ed. Glenview, IL: Scott, Foresman and Co., 1986. **(SF 2)**

7. Economics

Dushkin, 1987

Turley Mings. The Study of Economics: Principles, Concepts, and Applications.. Sluice Dock, Guilford, CT: Dushkin, 1987. **(Duskin)**

Harper and Row

Miller, Roger LeRoy. Economics: Today and Tomorrow. Enterprise ed. New York, NY: Harper and Row, 1984. **(Harper and Row)**

Heath

Gordon & Dawson. Introductory Economics. D. C. Heath, 1987. **(Heath)**

Merrill

Clayton and Brown, Economics: Principles and Practices. Charles E. Merrill Co., 1988. **(Merrill)**

Random House

Smith, Allen William. Understanding Economics. New York, NY: Random House, 1985. **(RH)**

Scott, Foresman and Co

Wolken, Lawrence C. and Janet Glocker. Invitation to Economics. Glenview, IL: Scott, Foresman and Co., 1985. **(SF)**

You, Me, and Technology Textbook Correlation

Program	1	2	3	4	5	6	7	8	9	10	11	12
1. Technology												
B & M 1		Ch. 8	Ch. 1-4	Ch. 1-4, 22, 23			Ch. 7-8	Ch. 9-18				
B & M 2		Ch. 2-6					Ch. 39-45, 88-94	Ch. 100-104				
Davis 1	pp. 13-20, 138-139	Ch. 8	pp. 15-16	Ch. 3,15,16			Ch. 7	Ch. 6			pp. 214-216	
Davis 2	pp. 18-20	Ch. 6, pp. 211-216	pp. 216-221	pp. 72-78		pp. 118-120	pp. 169-180	Ch. 6				
Davis 3		Ch. 14, 17	Ch. 2, pp. 308-311	Ch. 5			Ch. 10	Ch. 9	Ch. 12		Ch. 12	
Delmar 1	pp. 395-398	pp. 55-64	pp. 8-12, 395-398	Ch. 5, pp. 399-401	pp. 353-379	pp. 323-346	Ch. 10, pp. 65-67, 255-270	Ch. 7		Ch. 10	p. 187	
Delmar 3	pp. 124-125, 197-198, 318	Ch. 12, pp. 128, 144-161	pp. 11-20	pp. 35-43, 123, 364-365	pp. 317-321	pp. 305-313	Ch. 7, p. 368	Ch. 10		pp. 364-365	pp. 375-376	p. 124
2. Physics and Physical Science												
Addison-Wesley				pp. 154-164, 185-187, 253-268, 476-494, 498-554		pp. 257-260, 263-268	pp. 253-269, 438-450	pp. 131-150, 185-187				
Allyn and Bacon		p. 477		pp. 172-191, 209-225, 457-470	p. 227		pp. 448-475	pp. 48-115			pp. 140-153	
HRW 1				pp. 41-106, 225-253, 457-470	pp. 451-456		pp. 152-222	pp. 18-44, 225-253				
HRW 2				pp. 115-128, 380-384, 410-426, 600-620			pp. 252-264, 280-301	pp. 40-55, 70-83, 200-221			pp. 56-69, 93-99	
Merrill				pp. 178-190, 352-356, 535-545	p. 546		pp. 384-399	pp. 74-92, 164-171, 435-436			pp. 132-145	
Prentice-Hall		pp. 308-313, 426-429, 468-471, 474		pp. 264-281, 336, 354-357, 436-445	pp. 434-435, 466-467	pp. 461-465	pp. 420-424	pp. 220-246, 248-261			pp. 424-426	

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3. Biology												
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