



TRANSFORMATIONS
SCIENCE, TECHNOLOGY & SOCIETY

What's It Worth?

RISK AND VALUE IN
TECHNOLOGY AND SOCIETY

TEACHER'S
GUIDE



TRANSFORMATIONS: Science, Technology & Society

Program Goals

- ▲ to enhance and enrich science instruction in Middle School classrooms
- ▲ to explore ways that technology takes scientific knowledge and applies it to meeting society's needs and solving society's problems
- ▲ to foster among students a spirit of inquiry, encouraging and developing their problem-solving skills
- ▲ to help create citizens who are critical thinkers, prepared to make informed decisions about complex social/technological issues that will confront them in decades to come

WHAT'S IT WORTH? Risk and Value in Technology and Society

This unit addresses the interrelationship between what society judges as valuable and worth taking a risk for, and technological advances—how does one influence the other? The exploration in the accompanying video includes a visit to Joanne Pascarella, a biomechanical engineer with

Dow-Corning-Wright, and Curtis Jackson, a drilling engineer in charge of a jackup drill rig in the Gulf of Mexico. The topics below are those presented in the Teacher's Guide for "What's It Worth?"

- ▲ Social Values and Technology
- ▲ Technology and Economics

Curriculum Connections: Earth Science, General Science, Physical Science; an economics unit in Social Studies, a literature unit on values

Summary of the Video

When the band has its first paying gig— for \$100.00 at a music festival two hours away—the members react in contrasting ways. It becomes clear that each values something different about playing in the band (togetherness, creative possibilities, potential for money and fame).

Simone pursues the issue of value by visiting Joanne Pascarella, who demonstrates how technology can take common silicon and turn it into something beneficial and valuable— artificial finger joints. But as Simone sees, the process of researching, designing, producing, and testing makes the joints very expensive and therefore not currently available to everyone— "a question," Joanne points out, "that society needs to answer."

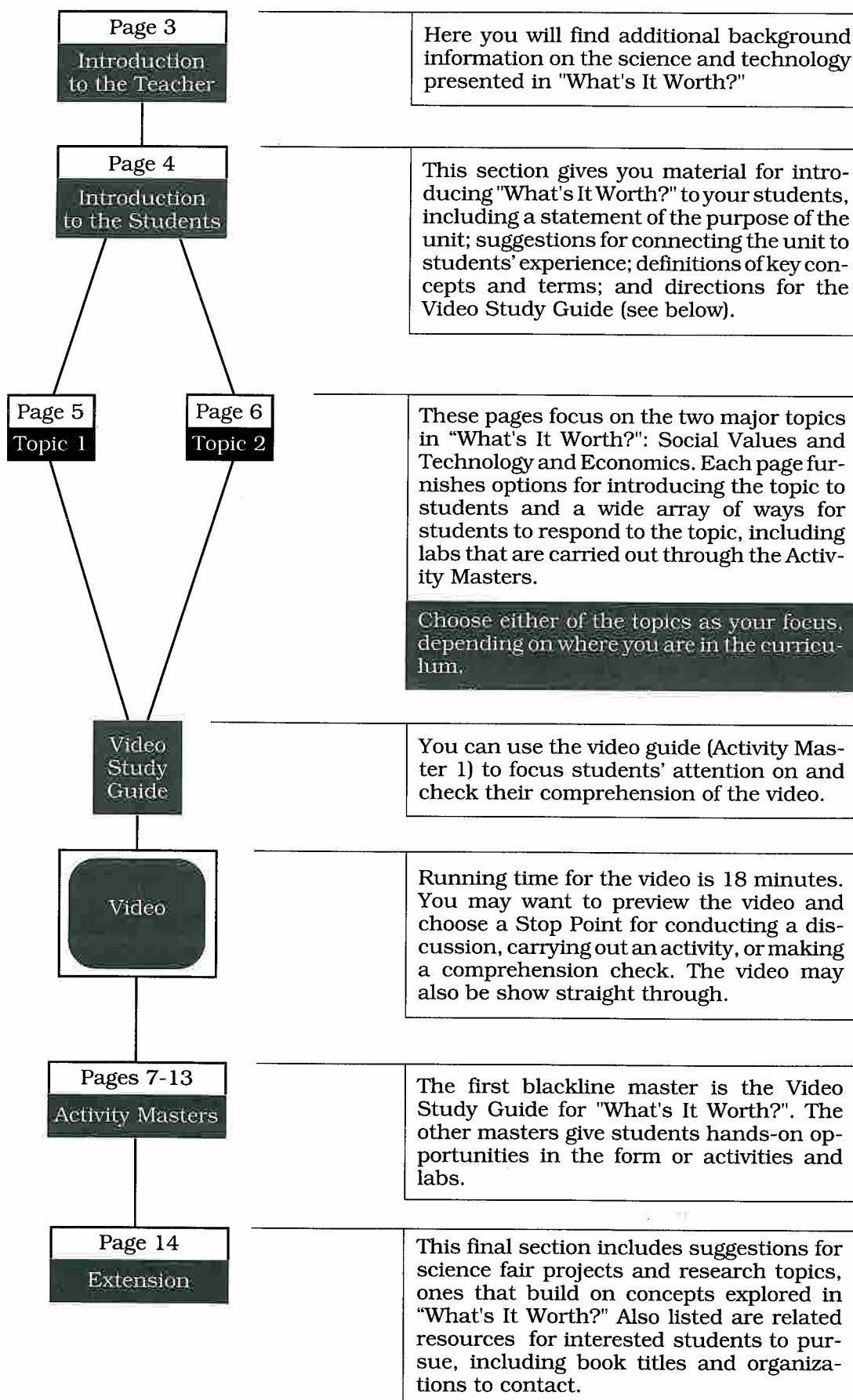
Is the band willing to take the risk of going to the gig in Billy's old gas guzzler? Billy explores the issue of risk when he visits Curtis Jackson on a jackup drill rig. Curtis explains how careful planning and technological backup systems can minimize but not eliminate the risk of a well blowout. Some risk is acceptable, he says, if society values the results.

The band thinks the risks are worth it and the experience will be valuable to all of them... so the gig is on.

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Suggestion for Using Unit H: "What's It Worth?"



WHAT'S IT WORTH?: An Introduction for the Teacher

"What's It Worth?" investigates the influence of value on technology; how the amount of time, energy, and money society is willing to put into something is an indicator of its value to society; how technology can take an essentially valueless item and transform it into something of value; and how risks are evaluated and accounted for in the pursuit of something we value.

Below is a fuller explanation of and additional information about examples presented in the video to illustrate value and risk in technology: a lab that works with silicon and an offshore drilling rig.

What is silicone?

Silicone is a synthetic polymer made from silicon, oxygen, and hydrocarbons. It is very stable, resisting changes due to heat, moisture, and chemicals. This stability and durability—and the fact that it is unlikely to be rejected by the human body—make silicone a prime candidate for implantation in people.

The specific properties of silicone vary, depending on the type and number of hydrocarbons. Simple silicones are thin liquids; more complex silicones can take a rubber form. Silicones can be used as lubricants and are found in adhesives, paints, and waterproofing.

What is the distinction between silicon and silica?

Oxygen and silicon are the two most abundant elements in the earth's crust. These two elements can combine to form the compound silica (SiO_2), the chemical name for the mineral quartz. Not surprisingly, much of the rock at the earth's surface is composed of silica.

One popular application of the element silicon is in the production of integrated circuits. The high-purity silicon used in computer chips is refined from silicon-containing compounds.

What is drilling mud?

All buried rock layers are under pressure from the rocks above. Offshore wells often must be drilled several miles under the ocean bottom. Synthetically produced drilling mud is pumped down into a well to lubricate the drill, but more importantly, to

act as a control. The mud balances the pressure created by the water, oil, and/or gas contained within the pores of the rock below. Increased pressure calls for increased density in the material that is added to the mud to increase its weight.

What is a well blowout, and how is this danger minimized?

The biggest risk of a blowout occurs when the drill bit encounters a rock formation where the pressure of the water/oil/gas increases suddenly and without warning. If this pressure is not countered, the well "blows," ejecting contents from the borehole and damaging the rig in the process. Because oil and gas are flammable, a spark at the surface can cause ignition, burning the drilling rig and whatever is nearby. Most importantly, lives may be lost.

Data from nearby wells, seismic data, and instantaneous recordings of data from the drill bit as it penetrates the formation are all used to anticipate "overpressure" zones. The instantaneous data recordings are part of a system called MWD (Measurement-While-Drilling), a recent technological advance in drilling engineering.

WHAT'S IT WORTH?: An Introduction for Students

Introducing the Unit

Present the goals of "What's It Worth?" to your students:

- ▲ to recognize that there is a relationship between what society values and the price it is willing to pay (in money, time, energy, and risks taken)
- ▲ to see how this value/price relationship influences technology
- ▲ to realize that technology can take something of relatively little value and transform it into something society values and is willing to pay for.
- ▲ to explore what gives something value and to think about what things are worth taking risks for

They should not feel, however, that they are responsible for memorizing the technological processes and tools described in the video.

Connecting the Unit to Students' Experiences

Point out that conservation and fighting pollution are major issues today but that thirty or forty years ago they were often ignored. The laws that have been passed to protect our environment and the technological advances made in these areas are the result of a change in our society's values—from a feeling that industrial progress was the most important thing to a sense of responsibility for our planet.

Tell students that **their** values will affect the world when they become the voters of tomorrow.

Key Concepts and Terms

Students will be exploring and extending their understanding of the words listed below (in bold face) by topic area. You might write these words on the board and briefly discuss them to determine which are familiar to your students.

Topic: Social Values and Technology

- ▲ The **value** of an item or belief is its importance or usefulness to a person or set of people. Society in general may value an object, such as gold, or a belief, such as the value of hard work. Personal values vary from individual to individual—one person's trash is another's treasure.
- ▲ After oxygen, **silicon** is the most com-

mon element on Earth. In an impure form, as it is in sand, silicon has little value. However, it can be transformed by technology into valuable products, such as computer microchips.

- ▲ **Silicone** is a silicon compound that has great value as a material for creating artificial implants, such as replacement finger joints.
- ▲ Silicone finger joints can greatly benefit people suffering from **arthritis**, an inflammation and stiffness of the joints. People with arthritic fingers may find it too painful to do something as simple as pick up a glass.

Topic: Technology and Economics

- ▲ Price and value are related but not synonymous. The **price** of an item is the amount of money it costs to buy it. Several factors influence price, such as how expensive it is to produce the item, how easy or hard it is to acquire, and whether or not enough people value the object to pay a certain price for it.
- ▲ Drilling for oil or gas involves an economic **risk**—only one out of every ten exploratory wells drilled produces enough oil or gas to be profitable.
- ▲ There is a personal risk, too: the danger of a well **blowout**, a violent eruption of oil, water, and gas from far under the earth up through the well.
- ▲ Drilling engineers take steps to **minimize**, lessen as much as possible, the risk of a blowout. An important safeguard is MWD, Measurement-While-Drilling.
- ▲ MWD allows engineers to get **instantaneous**, or immediate, information about what is happening as the drill bit goes deeper into the earth—engineers can find out the pressure around and below the bit, the temperature, the kind of rock being drilled, and the speed of the drilling.

VIDEO STUDY GUIDE

To focus or direct students' viewing of the video, distribute Activity Master 1, the Video Study Guide. You might have your students work individually, or small groups could each be responsible for a particular section of the Study Guide. Allow time—stopping the video at various points or after the video is over—for students to discuss their responses.

WHAT'S IT WORTH?: Social Values and Technology

Introducing the Topic: Options

- ▲ Do a whole-class or small-group brainstorming. Have students start by creating a list of things that they feel **everyone** values. Then have them create a list of things they value personally. Follow-up discussion could focus on how the two lists compare and on noting which items are expensive to buy and which are beyond price, such as peace and friendship.
- ▲ Get students to think about how technology can add value and cost by dividing the class into small teams. Begin with a common object: a tree that grows locally, perhaps an oak or a maple. Challenge groups to come up with as many different uses for that tree as they can. Afterward, compare their lists: Which team came up with the most uses? Which team had the most original use? Which uses would probably cost the most to make and buy?
- ▲ Materials needed: **2-liter plastic bottle; water; sharp, pointed object; masking tape.** Introduce students to the workings of an oil rig with this demonstration. Before class, punch a series of holes in the bottle, using a sharp object such as a compass point. The holes should be about 4 cm apart, staggered along a vertical. Cover each hole with a piece of masking tape. For the demonstration, fill the bottle with water, and place it in a pan or near the sink. As you yank off the pieces of tape, have students hypothesize about the behavior of the water coming out of the different holes.

Water coming from the bottom hole shoots out farther because it is under more pressure.

STUDENT INVOLVEMENT: OPTIONS

- ▲ Indicates an activity that would take less than a class period.
- ▲ Indicates an activity that could take most of a class period.
- ▲ Indicates an activity that would go beyond the class period.

Discuss the Video.

Video Guide notes can be used to help students answer these and other straightforward questions:

- ▲ Each band member has a different reason for wanting to be in the band. What does each value?

Billy—money; Simone—togetherness, beauty of art; AJ—money, chance to be creative; Laurie—fame, chance to be a star.

- ▲ What product is Joanne Pascarella working on? How is it of value to society?

Artificial finger joints; can give use of hands back to arthritis sufferers.

- ▲ What reason does Curtis Jackson give for the risks taken to get oil?

When you weigh the risk against the gain, his company thinks it's worth it.

Group Discussion: If you value peace...

Have students react to this statement—**If you value peace, then you support nuclear weapons as deterrents.** Students should give reasons for why nuclear weapons do or do not encourage world peace. Those who are against the weapons should come up with alternative proposals for maintaining world peace.

Homework: Something of Value.

Direct students to bring in a newspaper or magazine ad—one that deals with a product (created by modern technology) that society values. They should also write a paragraph explaining the product's value and something of the technology that goes into it, as well as telling why they personally do or do not value the product.

Activity: The Value of Taking Sides (Activity Master 2, 2 pp.).

You may wish to have students check with you before they choose an issue and before they choose a follow-up option, so you can coordinate their efforts. If time is short, assign the first follow-up option—having students share and compare charts.

Activity: Adding Value or Adding Cost? (Activity Master 3).

This activity sheet will have to be done outside of class. You may want to suggest that students check their own kitchens rather than supermarkets. Make sure students understand that they must compare equal amounts.

Answers: the most processed and overpackaged food will be the most expensive, unprocessed foods the least; examples include pasteurizing, adding ingredients and preservatives, and packaging; examples include ease of use, convenience, variety, safety.

WHATS IT WORTH?: Technology and Economics

Introducing the Topic: Options

- ▲ Do a quick web-building exercise for **technology** and **economics**. After students have brainstormed some associations, have them name some inexpensive machines (e.g., toasters, telephones, pencil sharpeners) and some very expensive machinery (e.g., cars, CAT scanners, space satellites). Help them begin to see a connection between complexity and cost.
- ▲ Use sound-systems technology to start students thinking about the connection between technology and economics. Begin with the whole-class brainstorming of the three ways people listen to self-selected recordings (record players, tape decks, CD players). Divide students into small groups to rank/evaluate each mode, considering factors such as price, popularity, availability of recordings, and the quality of sound reproduction. Set aside time to compare findings and to discuss differences of opinion.
- ▲ Materials needed: **rock, piece of steel, piece of wood, orange**. Bring the materials to class, and ask your students to think of different ways in which value could be added to each. This could be a whole-class or small-group activity. Discuss the results—does everyone value equally all the ideas and uses suggested? Would students pay more money for the objects once they have been changed?

STUDENT INVOLVEMENT: OPTIONS

- ▲ Indicates an activity that would take less than a class period.
- ▲ Indicates an activity that could take most of a class period.
- ▲ Indicates an activity that would go beyond the class period.

Discuss the Video.

Video Guide notes can be used to help students answer these and other straightforward questions:

- ▲ What product is Joanne Pascarella working on? Why is this product expensive?
Artificial finger joints; takes money to research, develop, and test—equipment is expensive.
- ▲ What is Curtis Jackson's job? What is the most serious risk in this job?
In charge of jackup drill rig; well blowout.

- ▲ What steps do Curtis and his crew take to minimize the risk?

Drilling mud to control pressure, plan, use a blowout preventer, consult MWD tool to get instantaneous readings.

- ▲ What economic risk is involved in drilling? What reason does Curtis give for risk-taking?

Only 1 out of 10 wells drilled produces oil, and a lot of money is spent drilling a well; if the gain outweighs the risk, it's worth it.

Group Discussion: Is it worth the risk?

Write **coal, oil, and nuclear energy** on the board, and have students brainstorm the risks involved with each. Ask them to weigh these risks by listing any safe guards they know of and the importance of each fuel source to our society. Then have them discuss whether, in each case, they feel the risk is worth it. If not, what would they recommend as replacement?

Activity: A Valuable Economic Enterprise (Activity Master 4, 2 pp.).

Give students a chance to look over both sheets and to think up a few ideas before conducting a class vote to pick the three best ideas for a class enterprise. For students researching a product, suggest **Consumer Reports** as a resource; for those investigating a class trip, mention the idea of group rates and charters. You may wish to open this project up to several classes.

Homework: Technology of Travel.

Give students the following assignment: Pick a U.S. city several thousand miles away. What different modes of transportation could you use to get to this city? What would you estimate each one to cost? What would you estimate the travel time of each to be? Which mode do you think is most economic? Which mode would you prefer to take—why?

Students should submit the assignment in the form of a chart followed by a set of conclusions.

VIDEO STUDY GUIDE

This guide is designed to help you get the most out of the video for "What's It Worth?" Look over the questions below before you watch the video. Use the space under the questions to take notes. What does the video tell you in answer to each question?

1. Each band member has a different reason for wanting to be in the band. What does each value?

A.J.

Simone

Laurie

Billy

2. What product is Joanne Pascarella working on? How is it of value to society?
3. Why is this product expensive?

name: _____ class: _____ date: _____

4. What is Curtis Jackson's job? What is the most serious risk he faces in this job?

4. What is Curtis Jackson's job? What is the most serious risk he faces in this job?
5. What steps do Curtis and his crew take to minimize the risk? Why does he feel the risk is worth taking?
6. What is the economic risk involved in Curtis's job?
7. What parts of the video did you like best? Why?

name: _____ **class:** _____ **date:** _____

THE VALUE OF TAKING SIDES

Simply put, science pursues knowledge, and technology finds ways to use that knowledge to improve our lives. But things are never quite so simple. Often, society must make hard decisions about what knowledge to pursue and which uses do the most good while causing the least harm.

Below are three scientific/technological issues that our society has to deal with; sample responses for and against the issue are included. Choose one of the issues to focus on. Which position do you support—pro or con? Use the chart on the next page to list other reasons you can think of to support your side.

Then look at the follow-up ideas. Use the back of the sheet to make notes on how you would like to carry out the follow-up idea you have chosen.

T H E I S S U E S

▲ The exploration of the planet Mars

PRO "It's important to explore other planets, especially the one closest to us. Don't you want to find out what another world is like?"

CON "Space exploration is really expensive. We have more important things right here on Earth that need our money!"

▲ Using robots in factories to do dangerous or repetitive jobs

PRO "A robot can't be killed in a factory accident."

CON "I don't want a robot doing my job. I need the money. The robot doesn't need the money!"

▲ The human testing of a new drug that may help fight a deadly disease

PRO "I volunteer for the test—I have the disease, and I want a chance to fight it."

CON "I won't volunteer for the test—the new drug may kill me before the disease does!"

name: _____ class: _____ date: _____

THE VALUE OF TAKING SIDES (Continued)

The issue you've chosen:	
Reasons in support of your side:	

Follow-up Ideas:

Check one and make notes on what you will do. Use the back of this sheet for notes.

- ☐ Share and compare your lists with the class.
- ☐ Find a person or group who has taken the other side of your issue. Stage a debate.
- ☐ Get together with someone else who shares your position on the issue. Create a poster or ad campaign designed to persuade others to agree with you.
- ☐ Write an essay that explains how you feel about the issue. Make your arguments as convincing as you can.
- ☐ Your own idea: _____

name: _____ class: _____ date: _____

ADDING VALUE OR ADDING COST?

In the video, you saw how the silicon in sand can be processed into valuable artificial finger joints. Simple materials can be processed to meet a number of important needs, but processing costs money. Investigate how processing affects food value and cost.

Go to a supermarket; use the chart below to record various foods in their unprocessed, pure form and in a processed form, such as 28 ounces of tomatoes and one 28-ounce can of crushed tomatoes. (Remember to compare equal measures.)

Unprocessed food	Price per	Processed food	Price per

Pick one of the foods from your chart. List things that might have been part of the processing.

Food is processed in various ways because of consumer need. Why do you think people value processed foods?

name: _____ class: _____ date: _____

A VALUABLE ECONOMIC ENTERPRISE

With classmates, plan to buy something for your class or school—a video recorder, for example. Or, you could plan and finance a class trip to a place you would like to visit. List some ideas you have for what to buy or do.

IDEAS FOR OUR ENTERPRISE

Get together with classmates. Vote on the various suggestions, picking the three most popular ones to develop. Then divide into three investigative groups that carry out the tasks below. Use the space provided to keep notes on what your group comes up with.

SUBJECT

The enterprise being investigated by your group: _____

This enterprise is worthwhile for your class because _____

RESEARCH

(Are there different brands and models to consider? Are there different ways to get to your destination? Find out and compare!)

name: _____ class: _____ date: _____

A VALUABLE ECONOMIC ENTERPRISE, (Continued)

PRICING

How much is the enterprise going to cost?

Make an itemized list of all possible expenses.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

FINANCING

How will you raise funds for your enterprise?

Begin by identifying below ways to earn money.

Here are some to consider:

▲ car wash

▲ bake sale

▲ baby-sitting service

▲ pet care center

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

IN CONCLUSION . . .

Present your enterprise to the class, and have everyone vote on which of the three ideas seems best to do.

Good luck with your enterprise!

name: _____ class: _____ date: _____

WHAT'S IT WORTH: Extension

Interested students may wish to pursue ideas and concepts raised by this unit. You could direct them to the suggestions and resources listed on this page.

Possible Research Topics

- ▲ Compare and contrast generic drugs versus prescription drugs. Include factors of cost, content, and effectiveness.
- ▲ Write a report about arthritis, including how it can affect people and what treatments are currently available (one of which involves gold).
- ▲ Survey students in the class who have baseball cards. Which ones are the most valuable? Why? What are the factors that make a card valuable?
- ▲ Work together with a team of students, each of which has chosen a particular Dow stock to focus on. Check the newspaper every day for two months. Chart what happens to your stock, its ups and downs. Then get together to compare stocks and discuss reasons for price fluctuations.
- ▲ Find out more about the general field of bionics or concentrate on a specific aspect, such as artificial hearts.
- ▲ Interview someone who works at a job with some potential for danger, such as a member of the ground crew at an airport. What is done to minimize the risks?

Suggested Science Fair Projects

- ▲ What is the effect of temperature on oil viscosity (that is, whether the oil flows smoothly or not)?
- ▲ How do food additives affect food?
- ▲ How is the human hand constructed and how does it function?
- ▲ What is the effect of grease versus petroleum versus synthetic lubricant on energy loss in a system of gears?
- ▲ Do adults and children agree on what is the world's greatest problem? (survey)

Resource Center

Books to recommend:

- The Animal Rights Controversy** by Laurence Pringle (HBJ, 1989)
- The Artificial Heart** by Melvin Berger (Watts, 1987)
- Daring the Unknown: A History of NASA** by Howard E. Smith (HBJ/Gulliver, 1987)
- Medical Dilemmas** by Margaret O. Hyde and Elizabeth H. Forsyth (Putnam, 1990)
- Money Basics** by G. David Wallace (Prentice, 1984)
- Oil Rig** by Neil Potter (Macdonald, 1977)
- Radical Robots: Can You Be Replaced?** by George Harron (Simon, 1990)
- Spare Parts for People** by Margery and Howard Facklam (HBJ, 1987)

Organizations to contact:

- American Geological Institute**
4220 King Street Alexandria, VA 22302
- American Petroleum Institute**
Public Relations
2101 L Street, NW Washington, DC 20037
- AMOCO Oil Co.**
200 E. Randolph Drive Chicago, IL 60601
- The Arthritis Foundation**
475 Riverside Drive New York, NY 10027
- Dow Corning Wright Corp.**
Midland, MI 48686
- Ken-A-Vision Manufacturing Co. Inc.**
5616 Raytown Road Kansas City, MO 64133
(scientific equipment: microprojectors and microscopes)
- National Petroleum Council**
Director of Information
1625 K Street NW Washington, DC 20006
- Sargent-Welch Scientists Co.**
7300 N. Linder Avenue Skokie, IL 60076
(scientific equipment, including computerized robotics)
- Society of Petroleum Engineers**
P.O. Box 833836 Richardson, TX 75083
- U.S. Geological Survey**
790 National Center Reston, VA 22092

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