ABSTRACT

Preparing students to be successful in a rapidly changing world means showing them how to use the tools of technology and how to integrate those tools into all areas of learning. This booklet is divided into three sections: Design Activities, Experiments, and Resources. The design activities ask students to collaborate on design projects. In these cooperative learning activities, students brainstorm and discuss ideas before they design and construct. The activity titles and grade levels are: Billy Goat Launchers (K-6), What the World Needs Now—Contraptions (6-12), The M & M Cookie Company (K-6), The Toy Factory (6-12), This Way In: Designing an Entrance (6-12), UPS: The Ultimate Private Space (5-12), Ergonomics: Designing Products for People to Use (6-12), Reach Out With Robotic Arms (6-12), What's Inside: Container Design (6-12), Wind-and-Water Transportation (6-12), Getting From Here to There by Monorail (7-12), and The Auto Company (7-12). The Experiments section contains cooperative learning activities that call for research and discussion in preparation for the construction phases. The titles and grade levels are: Old MacDonald Had a Laser (K-6), Space Station: Recycled Waste (3-6), Space Station: Solar Collectors (1-6), Earth Station: Solar Collectors (7-12), Air Cushioned Vehicle: Hovercraft (9-12), Magnetic Levitation Transport (MAGLEV) (6-12), and Commercials (3-12). The final section is a resource list for equipment and information. (MKR)
RoboResource
Technology Learning Activities

Compiled and Developed by Tom Keck
1992–93 Christa McAuliffe Fellow

Written and Edited by Ellen Frye

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Acknowledgements

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The activities included in this book have been part of the technology education curriculum at U-32 Junior-Senior High School in East Montpelier, Vermont. Many of the activities have migrated to U-32 from other technology education sources. Every effort has been made to acknowledge these sources; we regret any oversights that may have occurred and will be happy to rectify them in future printings.

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Technology and Society

We live in an age of technology. We can fly across a continent in a matter of hours. We can send information to someone on the other side of the world, knowing that he or she will be reading it as we send it. The microelectronics industry, which did not exist 30 years ago, today provides us with digital computers, satellite communications, robotics, lasers, programmable ovens and space shuttles.

In this increasingly technical world, technological literacy is imperative. Students today live in a world that demands a technologically competent populace. From office workers to auto mechanics, technology influences how the job is done. Issues discussed in the media—genetic engineering, acid rain, organ transplants, military weaponry—require more than a superficial understanding of technology.

Technology is a human endeavor. Whether used to benefit or harm society, the development and application of technology is a human decision. Only a technologically educated population can assess and influence the impact of technology on society and the environment.

What is Technology Education?

Technology education is a hands-on, minds-in study of past, present and future technological systems. Through technology learning activities, students develop skills in problem-solving, creative and critical thinking, and decision-making. They research, design, engineer, and test devices and systems to solve practical problems. As they carry out their projects, they learn how to work cooperatively and how to be project managers and leaders.

With its hands-on emphasis, technology education lets students discover their own technical interests and capabilities. They work with a variety of machines, tools, work surfaces and materials; they learn how to investigate ideas and experiment with designs. As they proceed from the idea to the execution, they learn that creativity and innovation are often the keys to problem solving.

Technology education focuses on broad concepts and principles. In every field, technology changes so rapidly that no educational program can meet specific future needs. What students do need is a fundamental understanding of how technology works plus a set of skills they can adapt to changing world.

Technology education also establishes connections between theoretical concepts and their practical applications, thus providing a platform for genuine interdisciplinary study. All areas of learning—music, art, mathematics, the natural and physical sciences, social studies—have technological components.
Goals of Technology Education

Preparing students to be successful in a rapidly changing world means showing them how to use the tools of technology and how to integrate those tools into all areas of learning. The goals are to give students the ability to interact successfully with technology, to assess the impact of technology on everyday life, and to apply conceptual knowledge to solve problems. A good technology curriculum begins with placing technology learning within the social context of school and community.

Through learning activities, students

- explore areas of technology to discover their own technical abilities and interests
- develop skill in the use of technological tools and systems
- gather, organize and evaluate ideas from different sources
- find and solve problems, think and reason logically
- recognize that technology can have consequences that are desired or undesired, expected or unexpected, so that they can exercise some control over the use of technology
- synthesize concepts of mathematics, the sciences, social studies and the arts through technological activities
- acquire broad-based, transferable skills and knowledge which will be useful in future employment, further education and life's experiences

Technology education is for all students. The diverse nature of technological learning activities permits active roles for students with a variety of interests and abilities. Students who are less successful in traditional academic activities often reveal special problem-solving abilities in technical activities. The higher-level thinking skills—analyzing, synthesizing, evaluating—that students develop as they manipulate technological tools give them a solid platform on which to build their life's work.
Design Activities

The following activities ask students to collaborate on design projects. In these cooperative learning activities, students brainstorm and discuss ideas before they design and construct.

Group work lets students learn how to be effective leaders and productive team members. The best group work occurs when three or four students work together. In larger groups, productivity drops off drastically.

It is important for teachers to let the groups develop their own structure and decide for themselves how to tackle a problem. The key to learning lies in discovering a process that works.
Billy-Goat Launchers for the Billy Goats Gruff

The Problem

The three Billy Goats Gruff want to get to the meadow across the river for a dinner of fresh green grass. There's a bridge over the river, but it belongs to a dangerous troll who lives under the bridge. He won't let anybody use his bridge. Can you design an alternative way for the Billy Goats Gruff to cross the river safely?

Brainstorm

With your team of three or four, discuss different ways the Billy Goats Gruff might get across the river. Would a raft work? How about a mobile goat launcher? A tunnel under the river? Balloons? A troll trap? Make sketches of your ideas and write down how they might work.

Develop the Best Idea

Think of all the good and bad points for each of your ideas. On the chart below, list your ideas and the criteria for evaluating your ideas. When you have finished the chart, choose the idea you think has the most good points and the least bad points.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mobile Goat Launcher</th>
<th>Raft/Boat</th>
<th>Tunnel</th>
<th>Balloons</th>
<th>Your Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility: Can we build this?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost: Can we build it for a reasonable cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicality: Will this idea really work?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability: Can we trust this idea to work every time?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design the System

Draw a more detailed picture of your chosen idea and explain how it works. You can create your design as a team with one person drawing and the others adding ideas. Or you can each make a drawing and then choose the best ideas to integrate into a final drawing. The design should include answers to the following questions:

- What materials will be used?
- How will the materials be connected to each other?
- How will the Billy Goats Gruff get on the system?
- How will the system operate once the Goats are loaded?

Label all the parts of the design and explain how the parts work. Use color to show the different parts.

Gather the Materials

Make a list of all the materials you’ll need to build your transportation system. Here are some possibilities:

- cardboard
- string
- tape
- plastic soda jugs
- paper towel rolls
- fabric scraps
- packing foam
- balloons
- plastic wading pool
- wood scraps
- packing foam
- mouse traps
- hot air balloon
- rubber bands

Build and Test the System

You’ll need to decide who is going to do what. Can some parts of the system be built separately? How can you test your construction as you go along?

When you test your working model and it doesn’t work the way you want it to, go back to your design drawing and make the necessary changes. You may have to make several tests and redesigns.

Evaluation

As a group, you will want to evaluate both the design and the model. Was the design drawing easy to follow? Is the final drawing still readable? Is your construction well crafted? Did the model work?

You’ll also want to evaluate how well you worked together as a team. Did everybody contribute to the project? Did anybody try to do all the fun stuff?

Ask other teams to evaluate your design and construction model in terms of uniqueness of design and quality of construction.

Related Activities for an Integrated Curriculum

Place your system in its environment using a small wading pool for the river. Make troll and goat puppets and act out your version of “The Three Billy Goats Gruff.”

---

Billy Goat Launchers adapted from The Technology Teacher (September/October 1991).
What the World Needs Now—Contraptions

The Problem
You are being asked to design a mechanical contraption that shows action and betters humanity. Each action should cause something else to happen. That is, the movement of one part should set off the movement of another part. The second part in turn will set off the movement of a third part and so on until each of the parts has been moved and has moved another part in turn. The last movement should have an end result.

Research
Before you start brainstorming, you’ll want to look at some examples of contraptions other inventors have built. Rube Goldberg (1883–1979) was a cartoonist who created extremely intricate diagrams for machines that produced relatively simple results. Here is a Rube Goldberg type of contraption.

Ask your librarian to help you find pictures of real Rube Goldberg inventions.

You may also want to research the mechanical principles of simple machines. Think of an axe as a wedge, a see-saw as a lever and a clothes line pulley as a wheel. Then think of how a wedge, hand crank (lever) and wheel are used in a kitchen can opener. In your library or science room, look up information on levers, wheels, ramps, pulleys, hand cranks, screwing devices, gears and cams.
Brainstorm

Be wild and creative with your teammates. Sketch out as many different contraptions as you have ideas for. Use words and arrows to explain what is happening in each of your sketches.

Consider these ideas for your contraption:

- What happens in the end? Is it something useful, funny, silly, or absurd?
- What materials could you use from the kitchen? from a toybox? from a toolkit?
- What kinds of actions and movements can you create? Will parts of your contraption drop, roll, hit, push, pull, wind, bump, slide, stop, fall, fly, glide, rotate, spiral, jump, bounce or flip?
- Can you build a ramp? Could you create a series of rods and levers to push up or down other rods and levers? Can you build a hand crank? a waterwheel? a windmill? How could you make a lopsided ramp or a wheel that spins at an angle?

Develop the Best Idea

Look at all your sketches and decide which one you like and can actually build. Be realistic. Work together to create a detailed drawing of your contraption idea. Draw each action that is happening and show how it sets off the next action or how it turns into the next movement.

Keep in mind the end result of your contraption. Will it be functional or funny or both?

Your design should include answers to the following questions:
  - How will the parts be built?
  - What materials will be used to build each part?
  - How will each part be connected to the next part?

Gather the Materials

Here is a list of possible materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>sheet cardboard</td>
<td>silverware and kitchen utensils</td>
</tr>
<tr>
<td>construction paper</td>
<td>plastic and paper cups pots and pans</td>
</tr>
<tr>
<td>wood scraps</td>
<td>plastic containers mousetraps</td>
</tr>
<tr>
<td>dowels and broomsticks</td>
<td>pulleys, hinges, levers motors, electric fans</td>
</tr>
<tr>
<td>acrylic plastic</td>
<td>weighing scales books</td>
</tr>
<tr>
<td>sheet metal</td>
<td>marbles plastic building blocks</td>
</tr>
<tr>
<td>aluminum foil</td>
<td>garden hose pieces push pins</td>
</tr>
<tr>
<td>plastic bag material</td>
<td>staples, nails, tacks</td>
</tr>
<tr>
<td>cardboard boxes</td>
<td>masking and duct tape</td>
</tr>
<tr>
<td>PVC pipe and tubing</td>
<td>white glue, hot glue</td>
</tr>
<tr>
<td>flexible electrical wire tubing</td>
<td>wire, string, rope</td>
</tr>
<tr>
<td>food and product packages</td>
<td>rubber bands</td>
</tr>
<tr>
<td></td>
<td>clocks and clock motors</td>
</tr>
<tr>
<td></td>
<td>toy train tracks</td>
</tr>
<tr>
<td></td>
<td>ramps and slides</td>
</tr>
<tr>
<td></td>
<td>radios, televisions</td>
</tr>
</tbody>
</table>
Design the Contraption

Label all the parts of the design and explain how the parts work. Use color to show the different parts. When you have a finished drawing, recheck your design. As you look at each part, ask yourself

Will this part be easy or difficult to build?
Is there an easier way to make this action or movement?
Change and redraw your design as needed.

Build and Test Your Contraption

You’ll need to decide who is going to do what. Can some parts of the contraption be built separately? Will you need a pattern to transfer part of the design from paper to your chosen material? How can you test each part of your contraption as you go along?

Start with the important actions. Be careful not to get “contraption fever” and add too many details and actions. If you do want to add an action, go back to your drawing design and make sure it will fit into the whole design. Use craft to build everything, even the simplest parts.

When you have a working part, test it. If it doesn’t work the way you want it to, go back to your design drawing and make the necessary changes. Keep a cool head while you are testing. If you begin to feel frustrated, take a deep breath and pause for a minute. Call in a teammate to help you troubleshoot the problem. Brainstorm. Then choose the best solution and start again.

When you have finished your contraption and are sure that the whole thing works, make a title card that lists the name of the contraption, its designers and builders, how to start and reset the contraption and an explanation of what the contraption does in the end.

Evaluation

As a group, evaluate both the design and the construction. Was the design drawing easy to follow? Is the design still readable? Is the contraption well built? Does it work?

Evaluate how well you worked together as a team. Did everybody contribute to the project? Did anybody try to do all the fun stuff?

Ask other teams to evaluate your design and your contraption in terms of uniqueness of design and quality of construction.
Related Activities for an Integrated Curriculum

Write a technical report on how you designed and built your contraption. Compare your completed contraption with the sketches you drew when you brainstormed and the final design drawing. Explain how your contraption changed and why.

Make a formal presentation of your contraption to classmates, friends, family or a local business. Ask a local business to display your contraption.

Do a research project at the local library on the life and work of contraption cartoonist Rube Goldberg.

Plan an Invention Show.

Study patent laws and write a patent for your invention.

Resources

Television: Smithsonian Discovery Channel, Invention Tapes 1-3 (very good with a variety of short topics)

Book: What the World Needs Now by Steven Johnson

Movies: “Goonies,” (about kid inventions); “Gizmo,” a newsreel of invention
The Contraption Planning Sheet

Name of Contraption

Team Members

<table>
<thead>
<tr>
<th>Name of Part</th>
<th>Sketch of Part</th>
<th>Materials Needed</th>
<th>Team Member Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
The M&M Cookie Company

The Problem

You have a great idea to produce a new product—M & M cookies. But Kübler and Nabisco are not interested. Remember how Ben and Jerry started their own ice cream company? Could you form your own cookie company?

The First Step: Organize

Before you can think about making cookies, you have to organize your company. What are some of the jobs in a cookie company? Will you need a Chief Executive Officer (CEO) or Company President. Make a list of some of the other jobs needed and discuss what qualifications someone would have to have for each position. Here are some possibilities:

- M & M Sorters and Counters
- Cookie Designers
- Measurers
- Packers
- Quality Controllers
- Logo Designers
- Taste Testers
- Labor Union Representative
- Production Manager
- Bookkeeper

Brainstorm

You need to design the cookie. What will it look like? Where will the M&Ms go? Make some sketches of cookie designs and discuss the different designs. Which will be the most marketable? Your final design will probably be a composite of several designs.

Discuss your marketing ideas. How will you tell people about your new cookie? What will your company logo look like?

Gather the Materials

- cookie dough or vanilla wafers
- M & Ms
- tubes of frosting
- aluminum foil
- rolls of butcher block paper
- rulers for measuring
- stop watch for timing
- plastic or rubber gloves
- felt tip pens
- cardboard
- Saran Wrap

Organize the Tasks

Workers responsible for making the cookies will have to set up an assembly area. What will you wear when you are making the cookies to make sure you don’t touch the cookies with your hands? How will you keep the assembly area clean?

Workers responsible for marketing the cookies will have to design the company logo and map out the advertising campaign.

Use the Task List on the M & M Cookie Company Planning Sheet (page 17) to list all the workers in the company and their tasks.
Evaluation

As a group, you will want to evaluate each task completed. Was the task well planned? Was it finished in time to dovetail with other tasks? Was the product attractive? Did it taste good?

Select as a group your evaluation standard; for example, a scale of 1 to 5. Then mark each task in the evaluation column on your Task List.

Ask other teams or other classes to evaluate your cookies both in terms of design and quality.

Related Activities for an Integrated Curriculum

Create a Jobs Fair or Employment Clearing House. List each company job with its job requirements. Make up student résumés. Assign someone to be a Personnel Manager and match the résumés with the jobs.

Use math tools to perform cost analyses of the cookie production for school sales. Draw a graph showing daily cookie production and sales.

Organize a union to negotiate with management for better wages and working conditions.

Use art materials to design a logo for your cookie company and a good-looking package for the cookies.

Design a marketing survey to determine what kind of cookies might sell best and what price might bring the most sales. Perform market research to find out competitive cookie prices.
The M & M Cookie Company Planning Sheet

Task List

<table>
<thead>
<tr>
<th>Tasks to do</th>
<th>Designated</th>
<th>Performed</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>logo design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cookie design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>advertising plans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assembly line setup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cookie making</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>taste testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>packing</td>
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<td></td>
</tr>
</tbody>
</table>
The Toy Factory

The Problem

You have been asked to design and construct a toy for preschool children. You want to build something that will be safe and long-lasting, something that will be fun to play with and yet will be educational. You want to build something that will stand the ultimate test: a preschool child’s playtime.

Brainstorm

In your small group, discuss what kind of a toy you want to build. How big is a two-year-old? a five-year-old? What might be attractive to a preschooler? Will your toy be a large-muscle toy? a small toy? Will it have movable parts? What materials can you use that are non-toxic? What other safety features are necessary for a toy for preschool children? Draw sketches of all the different toys you might make.

Develop the Best Idea

Think of all the good and bad points for each of your ideas. Make a chart like the one below and list your ideas and the criteria for evaluating your ideas. When you have finished the chart, choose the idea you think has the most good points and the least bad points.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Idea 1</th>
<th>Idea 2</th>
<th>Idea 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility: Can we build this toy?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cost: Can we build it for a reasonable cost?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicality: Will this toy be attractive to preschoolers?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety: Is this toy safe for preschoolers to use?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Gather the Materials

Here are some possible materials:

- wood
- metal
- plastics
- cloth
- paper
- foam packing
- magnets
- yarn
- string
- velcro
- cardboard
- aluminum plates
- computers
- toy wheels
- bells, rattles
- dowels
- food trays
- aluminum stick-on paper
- magnets
- yarn
- string
- velcro
- cardboard
- aluminum plates
- computers
- toy wheels
- bells, rattles
- dowels
- food trays
- aluminum stick-on paper
- computers
- toy wheels
- bells, rattles
- dowels
- food trays
- aluminum stick-on paper

Design and Build the Toy

Make sketches of your different ideas. When you have chosen the best idea, collaborate on a detailed design drawing of the toy. As you design, make sure you’ve answered these questions.

- What materials will be used?
- How will the materials be connected to each other?
- How will the child use the toy?
- Are all parts of the toy safe for a child?

Label all the parts of the design and explain how the parts work. Use color to show the different parts.

As you build your toy, make sure all its different parts work the way you designed them. If a part doesn’t work, analyze the problem and then redesign that part of the toy. Keep in mind the age of the child for whom you are designing the toy.

Field Test Your Toy

With all the other teams working on this project, make arrangements to visit a kindergarten class or preschool in your area. Before you visit, discuss your objectives with the children’s teachers. You’ll want to be sure that a large open space is available and that the children will not be worn out or excited from a previous activity.

When you visit the kindergarten or preschool, be sure you take both your toys and your evaluation logs. Put all the toys in the middle of the children’s room. Place the large-muscle toys away from the smaller toys. Leave plenty of space between each toy. Tell the children that they must walk around the room twice without saying anything and not touch a toy until one of you gives the signal. You might ask the teachers what signals they used to begin activities.

Just watch quietly while the children are playing. As evaluators, you do not want to influence the children’s own curiosity. Let the children play for twenty to thirty minutes. Then ask each of them the questions on your Evaluation Log.
Evaluation

You'll want to evaluate yourselves as well as your toys. Was your design drawing easy to follow? Is the final drawing still readable and attractive?

Is your toy well crafted?

You'll also want to evaluate how well you worked together as a team. Did everybody contribute to the project? Did anybody try to do all the fun stuff?

Ask the preschool teachers to evaluate your design and construction model in terms of appropriateness of design and quality of construction.

Related Activities for an Integrated Curriculum

Mass produce one of the most popular toys and offer it for sale.

Display your toys in your district office or a local business.

Ask some parents to evaluate your toy.

Visit a toy store.

The Toy Company Evaluation Log

You want to evaluate your toy in terms of its attractiveness to children, its durability and its educational value. As the children are playing with all the toys, focus on your own toy and collect the following data.

1. Is the toy attractive to its target population?

<table>
<thead>
<tr>
<th>How many children chose this toy to play with?</th>
<th>Number</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>How long did each child play with it?</th>
<th>Number</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Is the toy durable?

(Is it in the same shape when a child leaves it as when she or he began?)
3. What is the toy's educational value?

(Describe each action a child performs with this toy and the number of times that action recurs.)

<table>
<thead>
<tr>
<th>Action</th>
<th>Number of times action performed</th>
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</table>

4. Rate Your Toy on a Scale of 1 to 5.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractive to target population</td>
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<tr>
<td>Durable</td>
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<tr>
<td>Educational Value</td>
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</table>
This Way In: Designing an Entrance

Some Problems

Problem A. Scotty has just beamed you into a structure in a hostile environment. The outside is coming in all around you. Design an entrance that will keep the environment out and still let you come and go as you need.

Problem B. You are an archeologist and you have stumbled across a building. You think it's a house of worship. The building is intact except for the entryway which was destroyed by a natural disaster. In order to get your money from National Geographic Society, you must build a new entry based on the available information.

Problem C. You stole the giant's magic harp and slid down the beanstalk. Now, as you reach your hut, you hear the giant sliding down behind you. You don't want to kill the giant; you just want to keep him in his beanstalk land. Design a door at the bottom of the beanstalk to keep the giant from reaching the ground.

Problem D. You have decided to follow in the footsteps of Walt Disney. You hired the world's most expensive architect to design your new recreational facility. Two hours before the grand opening, you realize that there is no way for the public to come in.

Problem E. It is the year 2050, and the environmental activists have succeeded. The animals are running rampant over the land. You are faced with a choice: you can either confine the animals or confine yourself. Design the connection between the two.

Brainstorm

With your teammates, discuss all the aspects of your problem. What makes a good entrance? How can an entrance let those inside go in and out but not allow those outside to come in?

Make a series of sketches of how you'd like the entrance to look. Use ideas from all the sketches to create your final design. As you discuss your ideas, keep in mind that

- you may use whatever raw materials you can think of but all parts must be manufactured by the group
- you may use hand tools, drill press, band saw and power sander
- you have ten class periods to complete the design and manufacturing
Evaluation

When your entrance is completed, discuss how well you accomplished the task. Assess yourselves on design and construction. Is your entrance design creative? Is it functional? Did you complete the construction within the time limit? Is your construction well executed?

Organize a panel of students who are not in your class to come in and evaluate your project.

Related Activities for an Integrated Curriculum

Research the design and scale of entrances to ancient temples.

Discuss the psychology of gang membership. What do those in a gang fear?

Research recreational facilities. Review the Disney Theme Park entrance.

Compare and contrast the entrance designs in igloos, tents, a Japanese home, your own house, etc.

Resources

Book: Mythology, Archeology and Architecture (The Learning Works, 1982).
Designing an Entrance Planning Sheet

Preliminary Sketch

Final Drawing
UPS: The Ultimate Private Space

The Problem

You're sick and tired of the room you share with your brother or sister. You'd like your own private space. If you could create the room of your dreams, what would you design?

Brainstorm

Pair up with someone you think may share your dream and ask yourselves some questions.
- What do you want to happen in your private space?
- What kind of “look” should it have?
Make some sketches and talk about possibilities. What are some possible lengths and widths that will yield the 400 square-foot limit listed below?

Study the Parameters

Here are the parameters for your UPS design:
- Work with a scale of 1 inch = 1 foot.
- Maximum size of your UPS is 400 square feet. If you want to add a bathroom, you may add 100 square feet to the size.
- You may not use any ready-made materials; you must make everything yourself, even plumbing fixtures.

Gather the Materials

For this task, you can use any common construction materials except materials that are radioactive. Some possible materials are:

- cardboard
- cloth
- acrylic plastic
- cardboard tubes
- wall coverings
- electric wire
- popsicle sticks
- plastic bags
- wood scraps
- aluminum foil
- reflective material
- plexiglass
- batteries/power supply
- acrylic or latex paint
- small speakers
- straws
- rocks or gravel
- flashlight bulbs
- duct tape

This project directs students to design and construct a private space model suitable for teenage habitation.

Grade Level: 5–12.

Pan-me-ter:
A term used to describe something arbitrary that restricts and thus determines the final expression.
Organize the Tasks

Some of the tasks you'll need to do are in the list on the worksheet on the following page. You may want to add others to the list. Decide which of you is responsible for each task and which tasks you will do together.

Evaluation

As a team, evaluate each task completed. Was the task planned well? Was it finished in time to dovetail with other tasks? Was the final product attractive? Did it work?

Select your evaluation standard; for example, a scale of 1-10 or a grade of A-F. Then mark each task in the evaluation column on your task chart (see above). Give yourselves an overall mark that reflects how well you worked together as a team.

Ask other teams to evaluate your finished products in terms of design, quality of construction, accuracy of scale, neatness, details.

Related Activities for an Integrated Curriculum

Electrify your UPS.

Join with other teams to produce a home show. You'll need to advertise the home show and write stories for the newspaper.

Use a computer to write a small book that shows the process you used to design your UPS.

Translate your sketches and designs into scaled computer graphics.

Study the mathematics of measuring.

Visit an architect's office. Read a blueprint.

Ask a local psychologist to analyze your UPS in terms of design and color.
Ergonomics: Designing Products for People to Use

The Problem

You are an electronic engineer working for a large company. You have an idea that will help the United States compete with Japanese electronic products. Your idea is to build a combination television-VCR-AM/FM alarm clock radio. Since each product would usually require a separate power supply and amplifier, your combination product will be cheaper and more versatile. Your research manager has just given you the go-ahead to design a prototype.

Brainstorm

With your team, discuss all the design possibilities.
- How will you use symmetry and balance in your design?
- Where will you place the important switches?
- How big will the switches and buttons be?
- How will your user distinguish the important switches in the dark?
- How will you group the other controls?
- How will you have your machine provide feedback for programming the alarm and any automatic recording?

Make sketches of all the different possibilities for arranging the controls and the different parts of the product.

Design Your Product

Each of you should make one or two sketches of an integrated product. Look at all the sketches and discuss their good and bad points. Take the feedback into consideration as you make your final design drawing.

Write the Product Manual

Each of you should write your own user's manual. The manual will describe the product in general and then give specific directions for its safe operation. Each aspect of the integrated product should be documented separately.

When you have finished your manual, trade both product design and manual with your partner. Without talking with your partner, follow the manual and check for any errors.

Make changes as needed in both the design and the product manual.
Related Activities for an Integrated Curriculum

Study some anthropometric charts. Then measure school furniture to determine how appropriate this furniture is for the age group using it.

Use a large pair of outside calipers to measure your own body parts. (Boys should measure boys and girls should measure girls.) Transpose these measurements onto cardboard and make a student model. Add clothes, sunglasses, hair, etc.

Resources

"Ergonomics" slides from B.P.

Human scale charts published by MIT Press (available from Trans Tech-Creative Learning)
Ergonomics Design Drawings

Preliminary Sketch

Final Drawing
Reach Out With Robotic Arms

The Problem

Your radioactive hen has laid a dozen radioactive eggs. You can’t touch the eggs but you must get them into an egg carton so that they can be sent to the laboratory for analysis. All you need is the arm of a robot. Can you design one that will do the job?

Research

You’ll need to do some research so that you understand both pneumatics and hydraulics. Study the diagram below and discuss how a hydraulic or pneumatic system made from two syringes and a piece of plastic tubing might be used to lift an egg.

Organize

Form a team and decide who will do what. All of you will work together on the design of the robotic arm, but you may want to specialize for some of the other tasks. You may need, for example,

- a reader who reads and supervises directions
- an engineer who puts together the modules for the experiments
- a documenter who records the experimental data
- a mathematician who writes down the data and calculates

Brainstorm and Design

Discuss with your teammates how you want your robotic arm to work. Figure out how the different parts of the arm move and how to control the up-and-down motion. Each individual team member should make a rough design sketch. As a group, discuss your rough sketches. Try to integrate all the ideas into a single preliminary design drawing.

Gather the Materials

You may use any of the following materials:

- wood scraps
- metal scraps
- plastic scraps
- syringes
- scale measuring in grams or pounds
- clear tubing, 1/8" diameter
- junk including broken toys, axels, toy DC motors, hinges, etc.

This project directs students to design and construct a functional hydraulic robot.

Grade Level: 6-12

Hy-drau-lic: something operated by liquid under pressure.

Pneu-md-tic: something operated by air under pressure.
Construct and Test a System

Before you build your robotic arm, you'll need to build and test your pneumatic or hydraulic system. Read these directions through completely and discuss each task before you begin. Some tasks you will do individually, some you will do together as a group.

1. Construct a pressure tester by building a holder for one of the syringes over a scale.

2. Place one of the syringes in the holder.

3. Construct a pneumatic system by connecting the syringe in the holder to another syringe with plastic tubing. When you connect the tubing, the plunger of the syringe in the holder should be all the way in while the plunger of the other syringe should be all the way out.

4. Pressure test your pneumatic system by pushing the plunger of the syringe in your hand all the way in. As you depress the plunger, the plunger of the syringe in the holder comes out and pushes down on the scale.

5. When the scale is fully depressed, read the number of pounds or grams. This is the measure of the pneumatic pressure. Enter the data onto your data sheet.

6. Construct a hydraulic system by disconnecting the plastic tubing and filling the syringe in your hand with water. As you connect the tubing, the plunger of the syringe in your hand should be all the way out and the plunger of the syringe in the holder should be all the way in.

7. Pressure test your hydraulic system by pushing in the plunger of the syringe in your hand. As you depress the plunger, the water moves from one syringe to the other and the scale is pushed down by the plunger in the holder.

8. When the syringe in the holder is full of water, the scale tells you how much pressure in grams or pounds has been applied. Enter the data on your data sheet.
Construct and Test a Robotic Arm

1. Construct your robotic arm using the materials you gathered.
2. Test the robotic arm. Make it pick up a wooden egg from the nest and transport it to an egg carton.
3. Refine your engineering design.
4. Repeat Steps 2 and 3 as needed.
5. Create a finished design drawing.
6. Time test the robotic arm. Measure the distance the egg travels and enter the data on the data sheet. If your pressure tests were in pounds, measure the distance in inches. If the pressure tests were in grams, measure the distance in centimeters.
7. Use the work formula to calculate the amount of work your robotic arm accomplished over a given time period and enter your calculation onto the data sheet.
8. Write a technical report on the design and testing process and the results.
9. Assemble your experiment portfolio. It should include
   • your preliminary research sheet
   • one of your preliminary design drawing
   • your finished design drawing
   • your data sheet with the results of the pressure tests, the results of the robotic arm tests and your math calculations of work done
   • your technical report signed by all members of the team

Evaluation

As a group, you will want to evaluate each task completed. Did each task dovetail with the other tasks as needed? Did you work well as a team? Did you complete the robotic arm? Did it work?

Ask other teams to evaluate your project on the basis of both the construction and disassembly of the robotic arm and your experiment portfolio.

Related Activities for an Integrated Curriculum

Investigate the labor, production, and safety issues relating to the automobile industry and/or the nuclear power industry.

Acquire a five-axis robotic arm with joy sticks and simulate picking up items.

Acquire a robotic arm which interfaces with a computer and learn how to program it.

Resources

Book: Usborn Introduction to Robotics
**Robotic Arm Data Sheet**

**Research Results**

<table>
<thead>
<tr>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
</tr>
<tr>
<td>Pneumatics</td>
</tr>
<tr>
<td>Hydraulics</td>
</tr>
<tr>
<td>Axis</td>
</tr>
<tr>
<td>Syringe</td>
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</tbody>
</table>

**Pressure Test Results**

NOTE: Be sure that the pneumatic pressure and the hydraulic pressure is measured in the same unit, either pounds or grams.

<table>
<thead>
<tr>
<th>Pressure in pounds or grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic Syringe</td>
</tr>
<tr>
<td>Hydraulic Syringe</td>
</tr>
</tbody>
</table>
This project directs students to design and construct a container for a chosen product. The problem given is for an export container. A similar project could be developed around the design of a fast-food container.

Grade Level: 6–12

Pa-rá-me-ter:
A term used to describe something arbitrary that restricts and thus determines the final expression.

What's Inside: Container Design

The Problem
You are part of a packaging company. You have been invited to put in a bid for designing the container for a specific product for a foreign exporter.

Brainstorm
With your teammates, study a world map and identify several developing countries. Use pins to identify them by name and by major products.

Choose one of the countries and research all of the products it might export. Pick one of those products that might be packaged in a simple container. Some questions you'll need to ask yourselves:
- What kind of container might best suit this product?
- Will this product be sold by weight or by volume?
Make some sketches and talk about possibilities.

Study the Parameters
Here are the parameters for your container design:
- It must be able to support 5 kilograms of weight.
- When it is empty, it must have an airspace of 1000 cubic centimeters ± 100 cubic centimeters.
- The assembly must not require additional materials such as glue, tape or staples.
- The container must identify the contents in at least two languages.

Gather the Materials
For this task, you can use any common construction materials. Some possible materials are
- cardboard
- acrylic plastic
- wood

Organize the Tasks
Some of the tasks you'll need to do are in the list below. Decide who is responsible for each task and which tasks you will do together. Use the task list on page 38 to keep track of each task.
- Design the container
- Construct a prototype
- Test for strength and refine design
- Design a company logo or product logo
- Design marketing materials
- Create assembly instructions without using any words
- Design and build a display to market the export product
- Determine the cost of construction for 100 pieces, 1000 pieces and 10,000 pieces
Evaluation

As a team, you will want to evaluate each task completed. Was the task planned well? Was it finished in time to dovetail with other tasks? Was the container attractive? Was it cost-effective? Could the containers be stacked? Was it an economical and appropriate usage of materials?

If your container was designed for food, evaluate the product in terms of usage with hot food. Was there difficulty in getting the food in or out? Were there any structural changes from usage? Did the box hold heat? Did it color the taste or smell of the food?

Select your evaluation standard; for example, a scale of 1–10 or a grade of A–F. Then mark each task in the evaluation column in your task chart (see above). Give yourselves an overall mark that reflects how well you worked together as a team.

Ask other teams to evaluate your finished products in terms of design of container, design of marketing materials, product display, professional appearance of product.

Related Activities for an Integrated Curriculum

Use a computer to create a brochure for your packaging company.

Translate your sketches and designs into scaled computer graphics.

Study the mathematics of volume. Use algebra to determine the greatest possible volume of a rectangular container.

Evaluate the packaging of a variety of products on your local supermarket shelves. Bring in 5 containers and describe the merits and faults of each.

Interview older friends or relatives who have immigrated to America from other countries. Write foreign embassies for economic information.

Contact the Vermont Public Interest Resource Group (VPIRG) for information about the packaging bill under study in the Vermont Legislature. Discuss the ramifications of the bill for fast-food marketers and for the environment.

If your project was for fast food, organize a cookout with the living arts or home economics department. Sell the extra food during lunch as a fund raiser.
<table>
<thead>
<tr>
<th>Tasks to do</th>
<th>Designated</th>
<th>Performed</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container Design</td>
<td></td>
<td></td>
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<tr>
<td>Prototype Construction</td>
<td></td>
<td></td>
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<tr>
<td>Strength Test</td>
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<tr>
<td>Logo Design</td>
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<tr>
<td>Marketing Plans</td>
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<tr>
<td>Assembly Instructions</td>
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<tr>
<td>Display Design</td>
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<td></td>
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<tr>
<td>Cost Analysis</td>
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</tbody>
</table>
Wind-and-Water Transportation

The Problem

What if you were a sailor who lived in Spain in the fifteenth century and you thought you could find a new trade route to the Orient by sailing west instead of east? Suppose your queen had given you the go-ahead to build three ships. Wouldn't you want to build a model first to discover the best design for a sailing ship?

Brainstorm and Research

What did Europeans know about the world in 1492? How did people travel from one country to another? How big were the ships that sailed the Mediterranean? How fast did they sail? How did they know where they were going? Discuss Columbus' trip in the 90-foot Santa Maria. If you had been Columbus, how would you have made things different?

In your group, talk about how a boat floats on the water and how wind can push a sail to make the boat go forward. Discuss what kinds of materials would be best for the boat hull and what kind would be best for the sails. How will you hold the sails up? Do you want one sail or two?

Decide how the materials should be joined together. You'll want your boat to be buoyant, to be capable of using the wind to move it at least twelve feet and remain sturdy enough for another voyage.

Gather the Materials

For your test ocean, you'll need to build a 4' x 12' wooden frame out of these materials.

- 3 twelve-foot two-by-fours
- 1 T50 stapler with quarter-inch staples
- 1 roll of 4-mil plastic
- 2 four-foot two-by-fours
- 1 pound eightpenny nails
- wind source (hair dryer or electric fan)
- stopwatch

You can use any of the following materials to make your ship model:

- plasticine
- styrofoam
- wood scraps
- plastic containers and lids
- fabric scraps
- plastic wrap
- popsicle sticks
- yarn
- cardboard
- dowels
- string
- rubber bands

This activity challenges students to design and build model sailboats.

Grade Level: 3-6
### Build the Test Ocean

Follow these directions to build your ocean.

1. Lay the three twelve-foot two-by-fours parallel to each other and fasten the two four-foot pieces at either end as shown in the diagram below. Each two-by-four is resting on the 2" side.
2. Drape the plastic over the frame to form two troughs.
3. Staple the plastic securely to the outside and the middle of the frame.
4. Fill each trough with water.
5. Place an electric fan or hair dryer at one end of the ocean to create wind.

![Diagram of test ocean](image)

### Design and Build the Sailboat

Select your best idea and draw a detailed design of the boat. Designate the materials for the hull, the mast and the sails. Indicate how each part goes together. When your design is done, build and test your boat in the water. If it fails, troubleshoot what went wrong and modify your design. Retest until the sailboat can sail the entire length of the ocean.

When your sailboat is seaworthy, speed test it against a sailboat built by another team. Make sure the fan directs the wind evenly over the test area.

Record your test results in your test log.

### Evaluation

Evaluate your project both in terms of design and construction. Was the original design easy to work from? Were you able to make the necessary changes to make the system work? Is the finished product well crafted?

Compare your sailboat to the sailboats other teams made in terms of design and construction. Ask other teams to evaluate your sailboat.
Related Activities for an Integrated Curriculum

Research the different kinds of sailing ships (sloop, brigantine, schooner, bark, etc.). Research the names of the sails and parts of the ship.

Locate the path of Columbus' trip using maps and globes. Research other explorers such as Cabot, Magellan, Hudson, Champlain.

Obtain a nautical chart and locate landmarks, longitude and latitude, and depth markings. Chart a course from one point to another. Graph the results of your time and distance trials.

Research the navigation aids that are in use today.

Practice seamanship by learning how to tie different knots such as the sheepshank or the bowline.

Use a computer to create a timeline that shows the development of sea vessels from log rafts to paddle-wheels to tankers.
Sailboat Planning Sheet and Test Log

Name of Sailboat Model

Team Members

Materials List

Test Log

If your sailing model travels less than the entire length of the test ocean, measure its traveling distance with a tape measure.

Use a stopwatch to determine the time.

Use the formula, Rate equals Distance divided by Time, to calculate the speed at which your sailing model travels on each test.

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<thead>
<tr>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Test 4</th>
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<tbody>
<tr>
<td>Distance</td>
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<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate</td>
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</tbody>
</table>
Getting From Here to There by Monorail

The Problem

You are being asked to design a fixed route transportation system which will transport a single clothespin between two points. A transportation guideway between Point A and Point B is provided.

Brainstorm

List all the transportation systems you know about and discuss how each one works. Then, with your team, brainstorm ideas for your own system. Make a list of all the ideas suggested, no matter how "weird." Make rough sketches of several of the ideas.

Study the Parameters

You may only use the materials listed below.

- 2 long-style balloons
- 2 large rubber bands
- 2 paper clips
- 2 large drinking straws
- 4 popsicle sticks
- 20" of masking tape
- 2 pipe cleaners
- 1 strip of aluminum foil
- 2 napkins
- 1 clothespin

Scissors, stapler, razor, knife, etc., may be used as needed.

The power source must be part of the system. No external sources, such as human muscle power, throwing or blowing may be used. Your system must operate without assistance. Human hands may touch the system only before vehicle departure and after arrival.

Design and Build the System

Select your best idea and draw a detailed design of the entire system. Your drawing should include materials used and how each part goes together. When your design is done, build and test your prototype. If it fails, troubleshoot what went wrong and modify your design. Retest until the system works. Record your test results in your test log.

Once the prototype has had several successful runs, build a production model and demonstrate it to the rest of the class.

Grade Level: 7-12

Para-me-ter:
A term used to describe something arbitrary that restricts and thus determines the final expression.
Evaluation

Evaluate your project both in terms of design and construction. Was the original design easy to work from? Were you able to make the necessary changes to make the system work? Is the finished product well crafted?

Did your system fail to get to the end of the line on any of its tests? Were you able to troubleshoot the problem quickly and efficiently?

Ask other teams to assess your system in terms of design and construction.

Debriefing

Discuss the essential features of any transportation system. Does every system need
- power and transmission
- support and cover
- guidance and control

How does your system compare with jets and rockets? With trains and ski lifts?

Discuss what occurred during the project. Did any group steal an idea from another group? Does that kind of piracy occur in the industrial world? What is a copyright? What is a patent?

Discuss Newton’s Third Law of Motion: “For every action, there is always an equal and opposite reaction.” Does this law apply to your system? How?

Related Activities for an Integrated Curriculum

Weigh your entire system to the nearest gram.

Run several tests to determine the average speed of your system. Use a tape measure to measure the distance traveled. Use a stopwatch to measure the time it took to travel each distance. Calculate the total distance traveled and the total time (for all tests combined). Then use the formula Average rate equals total distance divided by total time (r = d/t) to calculate the average speed of your system.
Monorail Planning Sheet and Test Log

Name of System

Team Members

Materials List

Test Log

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance Traveled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason for Failure</td>
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</tbody>
</table>

PoboResource 41
The Auto Company

The Problem

You’ve got a great idea for a car. Nobody has ever seen one like it. But General Motors isn’t interested; Ford and Chrysler won’t return your calls. Why not start your own company? Why not design and market your own car?

The First Step: Organize

Create a company structure. List the skills of each person in the group. How do those skills fit with the traditional positions in a company? Are there positions you want to create in addition to the ones below?

- Chief Executive Officer (CEO) or President
- Design Engineer
- Production Engineer
- Director of Marketing

If your company has the four branches shown, in which branch is your position located?

| Research and Development | Sales and Marketing | Production/Manufacturing | Administration and Finance |

Brainstorm

Some questions you’ll need to ask yourselves:

- Who is your target audience?
- What is unique about your design?
- What about your design is the same as cars you know about?

Make some sketches and talk about their possibilities. Collect auto brochures and analyze them. What can you do better? Make up a catchy name for your company that will reflect your ideas.

Study the Parameters

Here are your parameters for your car design:

- Draw a rectangle that measures 4” by 12” (10 cm x 30 cm). Your car must fit into this box.
- Your car must have at least two working axels; it may have more than two.
- Anything you use to color the car may not add to its structural strength.
- Your license plates must identify your company.

For this task, you are limited to the following materials:

- aluminum offset printing plates
- wooden dowels (used for axels only)
- writing materials as needed
- hot glue
- sheetrock knife
- scissors
- duct tape
- latex paint
Organize the Tasks

Some of the tasks you'll need to do are in the list below. You may want to add others to the list. Decide which officer of the company is responsible for each task.

- Vehicle design
- Wheel design
- Display design
- Engineering Drawing (two-view drawing)
- Pattern Layout
- Wheel Layout
- Assembly
- Prototype Production
- Logo design
- Media Plans
- Ad Layout
- Pictorial View

Evaluation

As a group, evaluate each task completed. Was the task planned well? Was it finished in time to dovetail with other tasks? Was the product attractive? Did it work?

Select as a group your evaluation standard; for example, a scale of 1-10 or a grade of A-F. Then mark each task in the evaluation column in your task chart (see above). Give yourselves an overall mark that reflects how well you worked together as a team.

Ask another team to evaluate your finished products (both the automobile prototype and the marketing displays) in terms of uniqueness of design and quality of construction.

Related Activities for an Integrated Curriculum

Join with other teams to produce an automobile show. Advertise the car show and write stories for the newspaper.

Use a computer to write a design pamphlet that shows the process you used to design your car. Translate your sketches and designs into computer graphics.

Use the Car Builder software to design and construct an automobile. Test your design for coefficient of drag, handling and speed.

Research the mathematics of gear ratios. Research alternative energy sources such as solar-powered motors or electric autos. Research solutions to car pollution. Study Consumer Reports Auto Section.

Discuss the social impact of cars as a country moves from an agrarian to an industrial economy. Discuss the effects of car exhaust fumes on the environment. Discuss mass transportation systems.

Resources

Software: CarBuilder.

Videos: "Tucker: the Man and His Machine"; "Sunracer"
The Auto Company Planning Sheet

Task List

<table>
<thead>
<tr>
<th>Tasks to do</th>
<th>Designated</th>
<th>Performed</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>logo design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vehicle design</td>
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<tr>
<td>wheel design</td>
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<tr>
<td>display design</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>media plans</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>two-view drawing</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>pattern design</td>
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<td>wheel layout</td>
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<td>ad layout</td>
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<td></td>
</tr>
<tr>
<td>pictorial view</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>assembly</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Experiments

The following activities ask students to collaborate in an experiment. These are cooperative learning activities that call for research and discussion in preparation for the construction phases.

Group work lets students learn how to be effective leaders and productive team members. The best group work occurs when three or four students work together. In larger groups, productivity drops off drastically.

It is important for teachers to let the groups develop their own structure and decide for themselves how to tackle a problem. The key to learning lies in discovering a process that works.
Old MacDonald Had a Laser

The Problem
You have a laser and you want to know how it works. What can it do in your world that is useful? Could you build a fence with it?

Research
Look up laser in a dictionary or world book. Ask your teacher to show you the “Laser Information Guide.” Watch the video “Lasers Unlimited.” Discuss some uses of lasers that you have seen or heard about.

Study the Safety Rules
A laser beam is safe so long as you obey some basic safety rules.

1. Post WARNING signs whenever you are using the laser.
2. Make sure the overhead lights in the room are on.
3. Wear goggles or protective glasses.
4. NEVER look directly into the laser beam or into the reflection of the beam in a mirror.
5. NEVER point the laser beam into anybody’s eyes.
6. NEVER operate the laser without permission.
7. NEVER leave the laser unattended.
8. Turn off the laser when you finish using it.

Gather the Materials
In addition to your laser, you’ll need the following materials:

- 1 laser
- 1 white cardboard square
- 6 mirrors
- 14 dowel rods for fenceposts
- 2' x 3' cardboard box with sand (1/4" or 1/2" x 5")

Change the Direction of a Laser Beam
Before you build your laser fence, you need to know how to change the direction of your laser beam.

1. Set up the laser, one mirror and a white cardboard square as shown below.

2. Move the mirror until you can see the laser beam on the white cardboard.

Why does the laser beam change direction? Does any of the laser beam pass through the mirror? How could you use two mirrors to make a right angle with the laser beam?
Build Your Laser Fence

Now you are ready to build a fence using the laser beam. Study the diagram and follow the directions below. Notice how the right angles are made with two mirrors instead of one.

1. Pour two to three inches of sand into your cardboard box.
2. Set the laser on the outside of the box as shown. The beam should be approximately 6" above the table height.
3. Punch a small hole in the outside of the box to allow the laser beam to penetrate the box interior.
4. Align two mirrors in the corner opposite the laser so that the laser beam turns the 90° angle.
5. Install the fence posts under the laser beam.
6. Repeat Steps 4 and 5 until all the fence posts are installed.

NOTE: A humidifier with a flexible hose or a water spray bottle will allow you to put water droplets in the path of the laser beam to make it more visible.

Related Activities for an Integrated Curriculum

Measure the perimeter and area of the fenced-in area. Measure the angles. Change the dimensions until you have the length and width that will give you the greatest area.

Research the medical uses of lasers. Research how lasers are used in excavating and construction.

Resources

Video: "Lasers Unlimited"

Space Station: Recycled Waste

The Problem

You have landed on Space Station Zebra. The project you are working on is going to take longer than you expected, and your clean water supply is running low. You have to design and construct a water filtration system so that you can reuse water.

Preliminary Research

With your teammates, research and discuss how water and other fluids are purified by passing through successive layers of filtering material. Some questions you’ll want to ask yourselves include:

- What is a closed environment? Is the earth itself a closed environment?
- Why recycle water?
- On a space station, does it make sense to have a large system of surplus water?
- What are the pros and cons of returning liquid waste to earth?
- What are the pros and cons of resupplying liquids by way of a space shuttle?

The diagram below shows how water is naturally recycled on farms in Vermont. How do you think the rain water gets purified? Where would you put the cow barn in this diagram? Why? Why is well water cleaner than river water?

Research the weight and volume of a gallon of water. Do you think it is more practical for astronauts to recycle their water or to provide several gallons per person?
Gather the Materials

To make your own water purification system, you'll need the following materials:

- one 2-liter plastic bottle
- plywood
- sharp-pointed scissors
- rubber band
- gravel
- sand
- activated charcoal
- cheese cloth
- oxygen kit
- a drinking glass
- dirty dish water
- pond water
- urine

Build the System

The diagram in the margin shows a simple water purification system. Compare it to the natural system shown above.

Read the following instructions carefully. Discuss each step before you begin to build.

1. Cut the bottom out of the 2-liter bottle.
2. Place the cheese cloth over the mouth of the bottle and secure it with a rubber band.
3. Turn the bottle upside down and pour a layer of charcoal followed by layers of sand and gravel.
4. Construct a stand for the bottle out of two pieces of plywood. Use a large rubber band to attach the bottle to the stand.
5. Place the drinking glass under the neck of the bottle to catch the clean filtered fluid.
6. Measure one of the unfiltered fluids and record its volume on the data sheet on the following page.
7. Pour the unfiltered fluid into the bottle and wait for it to pass through the purification system and into the glass.
8. Measure the fluid in the glass. Record its volume on the data sheet.
9. Repeat Steps 7 and 8 for the other unfiltered fluids.

Evaluation

After you have completed your data sheet, discuss the results. Ask yourselves the following questions:

- How well did your purifier purify?
- What could you do to make it work better?

Related Activities for an Integrated Curriculum

Study and design a septic system or leach field.

Research the average daily water consumption per person in the state of Vermont or in the United States. How much is consumed by intake, washing, toilet flushing, etc.?

Research the use of litmus paper to measure pH. What is the pH of pure water? What is the pH of your filtered fluid?

Calculate the percentage of fluid retrieved from your purification system.
Recycled Waste Data Sheet

Table of Data

<table>
<thead>
<tr>
<th></th>
<th>Dish water</th>
<th>Pond Water</th>
<th>Urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ounces poured in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ounces received out</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ounces consumed in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>filtering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in clarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Different in odor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen ??</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations

Write a summary of your team discussion about recycling water.
Space Station: Solar Collectors

The Problem
You are on Space Station Zebra and you have decided to cook an apple but there's no stove and no cooking pot. You can't light a fire in space. The sun is your only source of energy.

Research
How do you think light from the sun can be turned into energy? Look up photovoltaic and solar radiation in a dictionary or science book. What does solar collector mean? Could you cook an apple using only sunlight?

Gather the Materials
You need the following materials to make your solar collector:
- cardboard
- 4 paper cups, unwaxed
- white paper
- aluminum foil
- scissors
- newspaper
- tape
- slices of apple
- black paper
- plastic wrap
- 2 thermometers

Build the Solar Collectors
Read the directions carefully before you begin.
1. Line a paper cup with black paper.
2. Place a slice of apple in it.
3. Cover the top of the cup with plastic wrap.
4. Make a cone out of white paper and wrap it around the cup.
5. Place the cone with the cup inside it into another cup. Make sure it can stand up by itself.
6. Repeat Steps 1 through 5 for a second solar collector. For this collector, make the cone out of white paper lined with aluminum foil.
7. Crumple newspaper around the base of both outside cups.
Test the Collectors

You can test your solar collectors on any sunny day, although a warm sunny day will provide the best results. Be patient and allow plenty of time to complete the testing.

1. Set your two solar collectors on a window ledge that gets plenty of sun.
2. Tape the thermometers to cardboard strips and lower one into each cone. The thermometer should be positioned between the cone and the cup.
3. Check the temperatures at different times. Record the time and the temperatures in your log.
4. Leave the solar collectors in the sun until the apples are cooked.
5. Taste the apple slices from each cooker. Record your impressions in your log.

Analyze the Results

Discuss the results of your test. Here are some questions you will want to ask yourselves.

1. Which solar collector cooked the apple slices the fastest?
2. Which apple slices tasted better?
3. How did the solar collector work? Explain why or how the aluminum foil worked.

In a space station solar collector, there are mirrors that reflect and concentrate the sun's rays. Can you think of any kinds of natural solar collectors here on earth?

Related Activities for an Integrated Curriculum

Calculate the difference in cooking time between the two solar collectors. What is the percentage of total cooking time saved by using the faster collector?

Design an experiment to test the importance of the cone size. What do you predict? How can you test your prediction?
## Solar Collector Log

<table>
<thead>
<tr>
<th>Solar Collector 1</th>
<th>Time 1 Temperature</th>
<th>Time 2 Temperature</th>
<th>Time 3 Temperature</th>
<th>Total Time for Cooking Apples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar Collector 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Earth Station: Solar Collectors

The Problem

You have been hired to design and construct a hot water system using solar energy.

Research

You will need to know how solar energy works. Find a book on solar energy in your library or science room.

- How is the sun's energy used naturally to heat water?
- What is indirect solar energy and how does it work?
- How could you collect the sun's energy?

Gather the Materials

You'll need the following materials to build your active solar collector.

- cardboard box or piece of cardboard to make a box
- one 1-meter clear plastic tubing, 3/8" to 1/2" in diameter
- plastic funnel to fit inside plastic tubing
- protractor
- razor blade or utility knife
- tape or stapler
- rubber cement
- two styrofoam cups
- two 40-cm square pieces 3- or 4-m
- clear plastic or Saran Wrap
- flat black spray paint or latex flat black roll of heavy-weight aluminum foil
- food dye
- foam or fiber glass insulation
- thermometer ranged 32°-212° F

Build the Collector Housing

You can either use a recycled box or construct one from cardboard. If you use a recycled box, measure it carefully so you can compare the differences when using different sized boxes.

1. If you are making your own box, draw the pattern below on the cardboard square.

   ![Drawing of a box pattern]

2. Cut on the solid lines, fold on the dotted lines.
3. Fold and staple or tape the cardboard to make the box.
4. Fit aluminum foil onto the flaps to create reflectors.
Assemble the Collector

1. Insert insulation into the bottom of the box so that it is one or two inches thick across the bottom area.
2. Fit a piece of cardboard on top of the insulation.
3. Insert the plastic tubing through the holes in the sides of the box and make an S-shape with the tubing inside the box.
4. Tape the slots tightly closed.
5. Fold and tape the plastic to make a tight but removable cover.

Test the Collector

A warm sunny day will provide the best results. Be patient and allow plenty of time to complete the testing.

1. Set your solar collector on a windowsill that gets plenty of sun. Make sure it is facing the sun.
2. Place one of the styrofoam cups directly below one of the extending pieces of plastic tubing.
3. Fill the other styrofoam cup with exactly 100 ml of water.
4. Record the temperature of the 100 ml of water.
5. Pour the water through the plastic funnel into the other extending piece of plastic tubing.
6. When the water is collected in the other styrofoam cup, record its temperature.
7. Using the same water, repeat Steps 5–6 until there is a ten-degree difference between the two temperatures. Allow 5 seconds between pourings.
Additional experiments

- Run the test using 50 ml of water.
- Vary the angles at which the collector faces the sun.
- Fill the collector tubing with water and allow it to stand for ten minutes before it flows out.
- Add 2–5 drops of different food colorings to the water before you pour it through. Pour each color ten times.
- Add colored salts (copper sulfate, chromium chloride or potassium permanganate) to the water before you pour it through.

Analyze the Results

Discuss the results of your test. Here are some questions you will want to ask yourselves.

- How many pourings did it take for the ten-degree rise in temperature?
- Which was the best angle for the collector?
- Which color liquid absorbs the most solar energy?
- What is the latitude of your state?
- What is the angle of the sun at this time of year?
- If you used different sized boxes, how did the different sizes affect the temperature increases?

Related Activities for an Integrated Curriculum

Design and construct a parabolic reflector.

Study Vermont's latitude and the solar calendar. At what time and angle is the optimum sun?

Discuss how would you design a solar tracking system or a closed loop system using a storage tank.
Solar Collector Data Sheet

Team members

________________________________________
________________________________________
________________________________________
________________________________________

Specifications of the solar collector

Area of bottom of box _______________________

Type of insulation used _______________________

Temperatures

<table>
<thead>
<tr>
<th></th>
<th>1st pour</th>
<th>2nd pour</th>
<th>3rd pour</th>
<th>4th pour</th>
<th>5th pour</th>
<th>6th pour</th>
<th>7th pour</th>
<th>8th pour</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ml H₂O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 ml H₂O</td>
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<td></td>
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<tr>
<td>50 ml with food coloring (color:</td>
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<td>50 ml with food coloring (color:</td>
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<tr>
<td>50 ml with colored salts (type:</td>
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<td></td>
</tr>
</tbody>
</table>
Graph: change in temperature vs the time it takes to change

Graph: time it takes for the temperature to change 10° vs area of the bottom of the box
Air-Cushioned Vehicle: Hovercraft

The Problem

The best blackberries in the country are on an island in a lake. You used to go there every summer, but now the aquatic weed milfoil has invaded the lake. The milfoil is so thick now, you can’t swim or boat without getting tangled in the weed. The blackberries will go to waste...unless you can figure out a way to transport yourself across the water without touching down.

Research

With your teammates, discuss how something could travel on air without wings. How could you control such a machine? What would be its advantages? What would be its disadvantages? What would be the uses of an air-cushioned vehicle?

You'll need to research how to calculate the minimum pressure required to lift a given weight. The basic formula is given on the Air-Cushioned Vehicle Data Sheet on page 66. Look for more information in a science book or encyclopedia.

Make some preliminary sketches of what you'd like your air-cushioned vehicle to look like.

Gather the Materials and Equipment

You'll need the following materials and equipment:

1 sheet 3/4” plywood measuring 4’ x 4’
1 blue reinforced tarp or 6-mil plastic measuring 56” x 56”
1 plastic lid from a 3-lb. coffee can

one roll of duct tape
one T-50 staple gun with 1/4” staples
one 1” x 1/4” bolt and nut
two 1/4” fender washers

1 string-and-pencil compass
1 portable vacuum cleaner or shop vacuum

This project directs students to design and construct a vehicle that can travel on a cushion of compressed air. Air blown under the vehicle will create the pressure to lift the vehicle off the ground. An aircraft propeller attached to the vehicle will create the thrust that will move the vehicle forward.

Grade Level: 8-12.
Construct Your Hovercraft

Read through the instructions carefully. Discuss each task before you begin.

1. Use a string-and-pencil compass to draw a circle on the plywood for the base of your vehicle. Make it the maximum size you can get from the 4-foot square.
2. Under the guidance of your instructor, cut out the circle with a sabre saw.
3. Measure the diameter of the hose of your vacuum (usually 1 1/4” in diameter).
4. Use a sabre saw, a hole saw or spade drill bit of the appropriate diameter to cut a hole in the plywood circle exactly 6” from its center. The diameter of the hole should match the diameter of your vacuum.
5. Use your compass to draw a circle 8 inches inside the edge of the plywood circle. Draw three lines through the center of this circle so that the angles the lines form are each 60°. Then use the intersection of the lines and the inner circle to draw six circles with diameters of 6 inches. THESE CIRCLES ARE GUIDELINES ONLY. DO NOT CUT THEM OUT.
6. Turn the panel upside-down and tightly stretch the 6-mil plastic across the bottom of the plywood circle. Staple it to the top and then seal it with the duct tape.
7. Use a sheetrock screw to fasten the coffee can lid to the center of the bottom (plastic-side) of the plywood circle.
8. Using the 6 drawn circles that show through the plastic, cut 6 equally spaced 4” holes in the plastic. Before you start cutting, remeasure the holes to make sure they are 60° apart and 8” from the outer edge of the circle.
9. Place the plywood circle on the floor with the plastic-side down.
10. Insert the vacuum hose into the hole on the top of the plywood circle.
Test Your Hovercraft

Test your air-cushioned vehicle by placing a chair on the plywood circle and turning on the vacuum. If the craft will lift the chair alone, have a team member sit on the chair and push the vehicle around the room.

Once your air-cushioned vehicle has had its trial voyage, you should run a series of tests and enter your findings on the data sheet.

Evaluation

Evaluate your work process by answering these questions:

- Did you read the instructions carefully?
- Did you discuss each task before you began it?

Ask another team to evaluate your vehicle in terms of construction and usability.

Related Activities for an Integrated Curriculum

Study the geometry of a circle. How many degrees are in a circle? What is the circumference of a circle? What is its radius? What is its diameter? What is $\pi$?

Design and paint the top of your vehicle. Sculpt a large animal or tree on top of your vehicle.
Air-Cushioned Vehicle Data Sheet

Name of Vehicle

Team Members

Formulae

The minimum amount of pressure needed to lift a weight off the floor is equal to the weight of the load (the plywood circle plus the chair plus the student) divided by the area of the inflated plastic coming in contact with the floor while under pressure.

The area of a circle is \( \pi r^2 \), where \( r \) is the radius.

<table>
<thead>
<tr>
<th>Formula for Pressure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Load</td>
<td></td>
</tr>
<tr>
<td>Surface Area of Vehicle</td>
<td></td>
</tr>
<tr>
<td>Minimum Pressure Required</td>
<td></td>
</tr>
</tbody>
</table>

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62 RoboResource
Magnetic Levitation Transport (MAGLEV)

Grade Level: 1–12. The Problem

You are to design and build a magnetic levitation vehicle that can traverse an 8-foot track in the shortest period of time. You have several options for powering your vehicle, including external wind power, electrified track or some kind of mechanical or electrical system on the vehicle itself.

Magnet Research

You'll need to find out all you can about magnets and how they work. What are magnetic poles? Why does a suspended magnetic bar lie in a general north-south direction? What is the biggest magnet you know?

Use the flat ceramic magnets your teacher gives you to conduct some preliminary tests. How can you tell the north end of a magnet from the south end? When you place the north end of one magnet next to the north end of another, what happens? What happens when you place the north end of one magnet next to the south end of the other?

Your teacher has a special track for magnetic levitation. Examine the track. Measure its width. Notice the two rows of magnets on the track. Test their polarity by moving a free magnet close to them. Is the polarity the same for all the track magnets? Is it the same for a single row of magnets? Is each row of a same or different polarity?
Research Superconductivity

Before you design and construct your MAGLEV transport, you may want to see how a rare earth magnet can be levitated over a superconducting material that has been cooled in liquid nitrogen. You'll need the following materials:

- Superconductor kit
- Liquid nitrogen in a Dewars flask
- Rare earth magnet (Cobalt Samarium)
- Tweezers
- Shallow styrofoam cup
- Non-magnetic tweezers
- Safety glasses or chemical goggles

1. Pour the liquid nitrogen into the shallow styrofoam cup.
2. Use the non-magnetic tweezers to pick up the magnet and place it over the liquid nitrogen.

You can enhance the demonstration by placing an overhead projector on its side to project the floating magnet image onto a screen or wall.

Brainstorm Your Own MAGLEV Vehicle

Your MAGLEV vehicle can be powered by an external source or by a self-contained source. One external source might be an electric fan located a foot from the beginning of the track and standing on the same level as the track. If you want to use wind power, discuss what kind of sail or other windcatcher you could design to propel your vehicle.

If you want your vehicle to be self-contained, consider power systems created out of balloons, rubber bands, springs, or batteries.

If you want to research electrical power, find out how to electrify the track using a variable power supply of no more than 15 volts, 1 ampere.
Gather the Materials

You can build your MAGLEV device from any of the following materials:

- possible vehicle materials
  - cardboard
  - paper
  - foam board
  - plastics
  - balsa
  - aluminum sheets
  - eight 1"x3/4" ceramic magnets

- possible power source materials
  - cloth for sails
  - rubber bands
  - springs
  - small DC motors
  - balloons
  - propeller
  - wire

Design the System

Once you have chosen your power supply, make a drawing of the entire system. Include in your design the materials used and directional arrows for the power source.

Construct Your MAGLEV Vehicle Body

Read the directions through completely before you begin.

1. Cut out your vehicle body from your selected material. The width must be exactly 2 1/2" so that it will fit the track. The length of the vehicle can be anywhere from 3 1/2" to 6".

2. Following the diagram below, test mount two rows of magnets to the bottom of your vehicle. Use loops of masking tape (sticky side out) to mount each magnet, making sure that none of the magnets hang over the side of the vehicle.

   - free magnet
   - magnets that repel
   - magnets that attract

3. Use a free magnet to test the polarity of each magnet mounted to the vehicle. If the polarity is not correct on any magnet, flip it over and test it again.

4. Test run your vehicle down the track by pushing it with your hand. If any of the magnets overhang the vehicle body, they will snag. Remount them and test the vehicle again. If the vehicle sticks to the track, rotate it 180° so that both sides repel instead of attract.

5. When you are certain that each magnet position and polarity is correct, you are ready to permanently mount the magnets. Be sure you are ready. Once you have hot glued the magnets to your vehicle, you will not be able to remove them. If you are not sure, repeat Steps 3 and 4. If you are sure, mark with a pencil the location of each magnet on your vehicle.

6. Use the hot glue gun to mount each magnet.

NOTE: Systems must operate free of human control. No sling shots, CO₂ cartridges, compressed air, rocket engines or model airplane engines are allowed.
Construct Your MAGLEV Vehicle Power Source

With your vehicle body complete, you can focus on constructing the power supply. Follow your design closely and test the construction at each stage. If the design needs to be modified, make the changes on the drawing first, taking the entire design into consideration.

When your vehicle and power supply are complete, test run it on the track several times. Use a stopwatch to time it. If you have ideas to make it go faster, go back to your original design and make the changes there first. Then modify your vehicle and test run it again.

Evaluation:

When you have made a number of test runs and are satisfied with your vehicle's performance, evaluate it yourself. Is your vehicle attractive? Is it well constructed? Does it run well? How fast is it in comparison to your classmates' vehicles?

Related Activities for an Integrated Curriculum

Write a technical report on how you designed and constructed your MAGLEV vehicle.

Research the British, German and new Disney MAGLEV and give an oral report comparing them.

Use the Science Tool Kit and a computer to time the vehicles.
MAGLEV Transportation Data Sheet

Name of Vehicle

Team Members


Formulae

Use the formula Distance equals the time multiplied by the rate \((d = rt)\) or Rate equals the distance divided by time \((r = d/t)\) to calculate the speed of your vehicle for each test run.

Make a chart or graph to illustrate the speeds for the different test runs.

<table>
<thead>
<tr>
<th></th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate or Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Commercials

The Problem

Your company has asked you to design a television advertising campaign for its product. Before you begin your design, you want to see what the competition is doing.

Research

Discuss with your teammates what products the following types of commercials might be best for.

- a story-line commercial tells a story with a beginning, middle and end
- a testimonial presents a famous person who uses the product
- a demonstration shows how the product works.
- an analogy attempts to make a viewer associate a product with a feeling or situation.

Conduct Your Test View

During the evenings of a single week, watch 15 commercials and record your findings on the Commercial Data Sheet on the following page. In the comments column, write your reasons for whether or not you would buy this product.

Related Activities for an Integrated Curriculum

Listen to several different radio stations and compare radio commercials to television commercials.

Research how products were advertised before the advent of radio and television.

Create a storyboard for a commercial for a product you like.

Borrow video equipment and produce a television commercial for a make-believe product.
# Commercial Data Sheet

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<th>Station</th>
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</table>
Equipment

TechnoTool Tips

Teaching technology is more rewarding for students and staff when you have the right tools to do the job. In each of the learning activities, a short list of essential materials is given. However, the variety of the solutions to the problems may depend on what further materials are at hand.

The following standard consumable supplies should be available:

- plastic drinks bottles
- plastic detergent bottles
- polyethylene bags/sheets
- polyethylene tubing
- art straws
- plastic milk straws
- softboard pieces
- cardboard boxes
- stiff card
- beads
- paper clips
- plastic tubs
- soft iron wire
- material scraps
- sticky tape
- colored pens
- aluminum foil
- magnets
- plastic-covered electric wire
- thread
- string
- elastic bands
- plastic disposable syringes
- hardware scraps
- hobby shop scraps
- toy electric motors
- balloons
- brass paper fasteners
- pipe cleaners
- plasticine
- darning needles
- marbles
- tin lids
- polystyrene trays
- different glues
- electric & clockwork-powered toy vehicles
- 0.5-volt batteries
- popsicle sticks
- cup hooks
- drawing pins
- plastic disposable syringes
- hardware scraps
- hobby shop scraps
- toy electric motors
- balloons
- brass paper fasteners
- pipe cleaners
- plasticine
- darning needles
- marbles
- tin lids
- polystyrene trays
- different glues
- electric & clockwork-powered toy vehicles
- 0.5-volt batteries
- popsicle sticks
- cup hooks
- drawing pins
- plastic disposable syringes
- hardware scraps
- hobby shop scraps
- toy electric motors
- balloons
- brass paper fasteners
- pipe cleaners
- plasticine
- darning needles
- marbles
- tin lids
- polystyrene trays
- different glues
- electric & clockwork-powered toy vehicles
- 0.5-volt batteries
- popsicle sticks
- cup hooks
- drawing pins

In addition to standard classroom supplies, the basic TechnoTool Kit described below will get you off to a good start. You may want to host a “tool drive” and discover how many families are happy to donate a used tool to their child’s class. Eisenhower II funds are also available for purchase of this type of equipment.

When you shop, here are some tips to help you make good selections.

**Storage.** A sturdy storage container makes all the difference between tools stored properly and tools no one can find. The Rubbermaid Action Packer listed below has proved to be extremely durable, surviving even the test of junior high school.

**Drills.** Electric drills vary. If you have a choice, a rechargeable drill eliminates the hazard of dragging electrical cords and makes sharing a single drill easier. Rechargeable drills come in voltages of 4.6, 7.2, 9 and 12 volts; the higher the charging voltage, the better the drill.

**Saws.** Coping saw blades are notoriously fragile. A fine-toothed blade is the proper blade for these activities; the 14” hardened blade is the best choice for straight cuts.

**Knives.** Exacto knives do not cut it. A retractable sheet rock knife has a longer blade and allows the kind of pressure required for many of the activities.

**Glue guns.** Low temperature glue guns are recommended for younger students. Although the glue sticks are expensive, having a safe tool for children with limited coordination is worth it. For older students, the trigger feed hot glue gun conserves glue better than the non-trigger type. Cordless guns eliminate power cord hazards.
Basic TechnoTool Kit

The materials listed below make up a basic kit for a class of 20 students. The total cost of each kit is approximately $500.00, depending on donations of used tools and sales. Most of these items are commonly found at reduced prices in smaller hardware stores and lumberyards. Some hardware stores may even donate equipment.

<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Rubbermaid Action Packer 24 Gallon Tote Locker</td>
<td>K-Mart</td>
<td>$22.00</td>
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<tr>
<td>1 3/8&quot; variable speed drill or Makita rechargeable or comparable twist drill set 1/16&quot; to 1/4&quot; flat spade bit set, 1/4&quot; to 1&quot; Sandvik 14&quot; hand saws, model 300-155T</td>
<td>hardware store</td>
<td>$30.00</td>
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<td>$12.00</td>
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<td>hardware store</td>
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<td>Tool Warehouse, Barre-Montpelier Road</td>
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<td>So-Fro Fabrics</td>
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*for elementary students
**for middle and secondary students
# Special Equipment

## Robotic Arms Equipment

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<thead>
<tr>
<th>Product</th>
<th>Source</th>
<th>Cost</th>
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<tbody>
<tr>
<td>5-axis robotic arm model 2000 &amp; battery powered 2/2 joy sticks</td>
<td>Kelvin Electronics</td>
<td>$58.00 each</td>
</tr>
<tr>
<td>Battery recharger 8Ni-CAD</td>
<td>Kelvin Electronics</td>
<td>$18.00</td>
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<tr>
<td>Battery for robotic arm</td>
<td>Kelvin Electronics</td>
<td>$8.00 each</td>
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<td>Computerized 5-axis arm</td>
<td>Kelvin Electronics</td>
<td>$199.00 each</td>
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<tr>
<td>C. C. Robot</td>
<td>Pneumatic Technology</td>
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## Laser Surveyor Equipment

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<tr>
<td>1 mw modulated laser</td>
<td>Merridith Instruments</td>
<td>$328.00</td>
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<tr>
<td>Sound receiver for laser</td>
<td>Merridith Instruments</td>
<td>$88.00</td>
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<tr>
<td>0.5 mw–1.0 mw laser (non-modulated)</td>
<td>Pasco Scientific; Arbor</td>
<td>$260.00–529.00</td>
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<tr>
<td>Plastic mirrors, 8.9 cm x 5.9 cm</td>
<td>Scientific, Scientific Laser Connection</td>
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<tr>
<td>Metal mirror supports</td>
<td>Sargent-Welch Scientific</td>
<td>$8.29/6-pack</td>
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<tr>
<td></td>
<td>Science Kit &amp; Boreal Lab</td>
<td>$13.39/6-pack</td>
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## Magnetic Levitation Equipment

<table>
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<tr>
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<th>Source</th>
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<tbody>
<tr>
<td>MagLev Track with magnets</td>
<td>Kelvin Electronics</td>
<td>$89.00</td>
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<tr>
<td>Flat ceramic magnets</td>
<td>Kelvin Electronics</td>
<td>$36.00/200 magnets</td>
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## Equipment for Miscellaneous Activities

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<th>Product</th>
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<tr>
<td>Thin 2’ x 3’ aluminum sheets (use for modeling, can be cut with scissors)</td>
<td>local newspaper</td>
<td>$0.25 each</td>
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<tr>
<td>Clear plastic containers large (30–50 cc) and small (5–10 cc) syringes</td>
<td>local salad bar</td>
<td>recycle $0.59–$1.19 each</td>
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<tr>
<td>assorted beads, wood, containers, etc.</td>
<td>Local veterinary or farm supply</td>
<td>$0.05–$0.99 each</td>
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<tr>
<td>Blue board with foam Kevlar material scraps</td>
<td>Re-store</td>
<td>recycle</td>
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<tr>
<td></td>
<td>construction dumpsters sailboat supply</td>
<td>free (bring plastic bag)</td>
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<tr>
<td>large-gauge iron wire</td>
<td>coat hangers</td>
<td>free</td>
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<tr>
<td>Acrylic plastic scraps</td>
<td>Sign Company</td>
<td>free</td>
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<tr>
<td>Broken fluorescent light covers safety glasses (stylish) electronic &amp; solar kits (inexpensive)</td>
<td>School custodian MFASCO Graymark</td>
<td>free</td>
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<td>Books, furniture, computers, etc.</td>
<td>NAEIR</td>
<td>$2.35/pair $4.25-$19.95</td>
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### Information

#### Periodicals

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<td>Air and Space</td>
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<td>subscription, $18/year</td>
<td>National Air &amp; Science Museum</td>
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<td>hands-on math/science, $24.50/year</td>
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<td>Consumer Report</td>
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<td>Design</td>
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<td>system design</td>
<td>Mercury Airfreight International</td>
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<td>Computer Action Ltd.</td>
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<td>Croydon CRO 1YD, UK</td>
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<td>The Exploration Store</td>
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<td>NASA Tech Briefs</td>
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<td>Peterborough, NH 03458-1454</td>
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<td>Odyssey</td>
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<td>science that’s out of this world</td>
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<td>Popular Science</td>
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<td>subscription, $13.94/12 issues</td>
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<td>Boulder, CO 80322-4095</td>
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<td>Probe</td>
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<td>P.O. Box 5833</td>
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<td>Denver, CO 80217-9937</td>
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<td>Scientific American</td>
<td>9-12</td>
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*RoboResource Book 73*
<p>| Publication                | Level | Type                          | Address                                                       |
|---------------------------|-------|-------------------------------|                                                               |
| Sci-Net                   | teacher | bulletin of events, science information, free | Vermont Dept of Education 120 State Street Montpelier, VT 05602 |
| Science Scope             | 6-8   | issues/yr                     | National Science Teachers Associate 1724 Connecticut Ave. NW Washington, DC 20009 |
| Technological Horizons in Education Journal | teacher | free subscription | T.H.E. Journal Circulation Department 150 El Camino Real, Ste 112 Tustin, CA 92680-3670 |
| Technology Today          | teacher |                              | International Technology Education Association Reston, VA |
| The Big Paper             | K-6   | 6 issues/yr                   | The Design Council Subscription Department Central House, 27 Park St Croydon CR01YD, UK |
| The Futurist              |        | subscription                  | World Future Society 7910 Woodmont Ave. Bethesda, MD 20814 |
| The Planetary Report      | 9-12  | $25 membership to the Planetary Society | The Planetary Society 65 North Catalina Avenue Pasadena, CA 91106 |
| The Technology Teacher    | K-12  | membership in ITEA           | International Technology Education Association 1914 Association Drive Reston, VA 22091 |
| Ties Magazine             | teacher | $10 donation                 | 3219 Arch St. Philadelphia, PA 19104 |
| Tops Ideas                | teacher | hands-on learning donation    | Tops Learning Systems 10970 S. Mulfild Rd. Canby, OR 97013 |
| USA Today                 | K-12  | technology information, $110/year | P.O. Box 79040 Baltimore, MD 21279-0040 |
| Video Systems             | 9-12  | free subscription             | Reader Service P.O. BOX 12946 Shawnee Mission, KS 66282 |
| Zillions: Consumer Reports for Kids | middle | subscription, $12/year | P.O. Box 54832 Boulder, CO 80322-4832 |</p>
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<tr>
<td>Amazing Models series by Peter Holland (Water Power, Balloon Power, Rubber Band Power)</td>
<td>$7.95 each</td>
<td>Tab Books, Inc. Blue Ridge Summit, PA 17294-0850</td>
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<tr>
<td>An Introduction to Craft, Design and Technology by Stuart Dunn</td>
<td></td>
<td>Small World Technology P.O. Box 607 Hillsboro, OR 97123</td>
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<tr>
<td>Arco Book of Electronics series by Helena Sturridge: (Robots: Reel to Real, Lasers: Lightwave of the Future, The Electricity Story)</td>
<td>$11.95 each regular, $4.98 each special</td>
<td>Arco Publishing Company New York, NY</td>
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<tr>
<td>Communications Systems by Charles Johnson</td>
<td>$24.95</td>
<td>The Goodheart-Wilcox Company South Holland, IL</td>
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<tr>
<td>Craft Design and Technology by Stuart Dunn</td>
<td></td>
<td>Small World Technology P.O. Box 607 Hillsboro, OR 07123</td>
</tr>
<tr>
<td>Creative Technology: A Classroom Resource by J. Aitken and G. Mills</td>
<td>$118.00 (and worth it)</td>
<td>Small World Technology P.O. Box 607 Hillsboro, OR 07123</td>
</tr>
<tr>
<td>Earth Science by Robert Bonnet &amp; Daniel Keen (science projects)</td>
<td>$9.95</td>
<td>Tab Books Blue Ridge Summit, PA 17294-0850</td>
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<tr>
<td>Electronic Projects Made Easy by Stuart Dunn</td>
<td></td>
<td>Small World Technology P.O. Box 607 Hillsboro, OR 07123</td>
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<tr>
<td>Exploratorium Science Snack Book by Exploratorium Teachers Institute</td>
<td>$19.95</td>
<td>Exploratorium Mail Order 3601 Lyon Street San Francisco, CA 94123</td>
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<tr>
<td>Exploring Technology (second edition) by E. Allen Bame &amp; Paul Cummings</td>
<td>$24.95</td>
<td>Davis Publications, Inc. Worcester, MA</td>
</tr>
<tr>
<td>Exploring Transportation by Johnson, Farrah-Hunter</td>
<td>$11.95+$2.50</td>
<td>Idea Factory, Inc 10710 Dixon Drive Riverview, FL 33569</td>
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<tr>
<td>Food for Thought: Edible Earth Science</td>
<td></td>
<td>John Wiley &amp; Son New York, NY</td>
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<tr>
<td>Flying Circus of Physics with Answers by Jearl Walker</td>
<td>$14.95</td>
<td>Tab Books Blue Ridge Summit, PA 17294-0850</td>
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<tr>
<td>Gravity Power</td>
<td>$7.95</td>
<td>Chartwell Books, Inc. 110 Enterprise Avenue Secaucus, NJ 07094</td>
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<tr>
<td>Great Unsolved Mysteries of Science by John Grant</td>
<td>$6.98 special</td>
<td>The Sewall Co. Box 529 Lincoln, MA 01773</td>
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<tr>
<td>Hand on Nature edited by Jenepher Lingelback</td>
<td>$16.95</td>
<td></td>
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<tr>
<td>Title</td>
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<tr>
<td>Handbook for Space Colonists by Harry Stine</td>
<td>$11.95</td>
<td>An Owl Book</td>
</tr>
<tr>
<td>Handbook for Space Pioneers by Stephen Wolfe and Roy L. Lysack</td>
<td>$12.00</td>
<td>Westbridge Books</td>
</tr>
<tr>
<td>The Hologram Book by Steven A. Feller and Joseph E. Kasper</td>
<td>$12.95</td>
<td>Prentice-Hall, Inc.</td>
</tr>
<tr>
<td>Hydroponics for the Home Gardener by Steward Kenyon</td>
<td>$12.95</td>
<td>Key Porter Books</td>
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<tr>
<td>Illusion of Lifelike Robots by Gene William Poor</td>
<td>$12.95</td>
<td>Small World Technology</td>
</tr>
<tr>
<td>Laser Activities for the Classroom by Harold Wood, Joe Verboys and George Evans</td>
<td>$7.98 special</td>
<td>Davis Publications, Inc.</td>
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<tr>
<td>Laser Cookbook: 88 Practical Projects by Gordon McComb</td>
<td>$7.98 special</td>
<td>Tab Books, Inc.</td>
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<tr>
<td>Solar System Log by Andrew Wilson</td>
<td>$15.00 regular</td>
<td>Jane's Publishing, Inc.</td>
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<tr>
<td>Superconductivity: The New Alchemy by John Langone</td>
<td>$19.95 regular</td>
<td>Contemporary Books</td>
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<tr>
<td>Technology Activities Idea Book 1</td>
<td>$7.95 or $6.95 each</td>
<td>International Technology Education Association</td>
</tr>
<tr>
<td>Usborne Illustrated Series Invention &amp; Discover</td>
<td>$7.95 each</td>
<td>Usborne Publishing Ltd.</td>
</tr>
<tr>
<td>(Robotics, Lasers, Ecology, Physics and other titles)</td>
<td></td>
<td>20 Farrick Street</td>
</tr>
<tr>
<td>What the World Needs Now by Steven Johnson</td>
<td>$7.95</td>
<td>Ten Speed Press</td>
</tr>
<tr>
<td>Young Scientist Series (Jets, Electricity, Stars &amp; Planets, Space Flight, Undersea, Human Body)</td>
<td>$7.95 each</td>
<td>EDC Publishing Co.</td>
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</tbody>
</table>

**Costs:**
- **Regular:** Various prices ranging from $3.98 to $21.95
- **Special:** Prices range from $2.98 to $4.49

**Sources:**
- An Owl Book
- Holt, Rinehart and Winston
- New York, NY
- Westbridge Books
- A Division of Davis & Charles
- Prentice-Hall, Inc.
- Key Porter Books
- 70 The Esplanade
- Toronto, Ontario, Canada M5E R2
- Small World Technology
- P.O. Box 607
- Hillsboro, OR 97123
- Davis Publications, Inc.
- Worcester, MA 01608
- Tab Books, Inc.
- Blue Ridge Summit, PA 17294-0850
- Arco Publishing, Inc.
- New York, NY
- Jane's Publishing, Inc.
- 115 Fifth Avenue
- New York, NY 10003
- Contemporary Books
- Chicago, IL
- International Technology Education Association
- 1914 Association Drive
- Reston, VA
- Usborne Publishing Ltd.
- 20 Farrick Street
- London WC 2E 9BJ
- UK
- Ten Speed Press
- Berkeley, CA
- EDC Publishing Co.
- 10302 E. 55th Place
- Tulsa, OK 74146
### Software

<table>
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<tr>
<th>Software</th>
<th>Level</th>
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<tr>
<td>Car Builder (Apple II)</td>
<td>8-12</td>
<td>simulation design, construction, testing of automobiles</td>
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<tr>
<td>Science Tool Kit (Apple II, IBM)</td>
<td>4-9</td>
<td>3 modules: Speed and Motion, Earthquake Lab and Body Lab</td>
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<tr>
<td>Robot Builder I &amp; II (Apple II)</td>
<td>7-12</td>
<td>robot design problems (challenging)</td>
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<tr>
<td>Sim Earth (Macintosh, IBM)</td>
<td>9-12</td>
<td>simulation of 4 time scales: Geologic, Evolution, Civilization, Technologic</td>
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<tr>
<td>Earthquest; Ecology (Macintosh)</td>
<td>6-12</td>
<td>hypercard stacks of interactive games &amp; simulations</td>
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<tr>
<td>Physics (Macintosh)</td>
<td>9-12</td>
<td>mechanics, velocity, orbital motion</td>
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<tr>
<td>Interactive Nova (Macintosh &amp; videodisc)</td>
<td>5-12</td>
<td>WGBH science series on animals, life science, global ecology</td>
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<tr>
<td>Science Explorers (Apple, IBM)</td>
<td>1-6</td>
<td>interactive discovery science including weather, simple machines</td>
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<tr>
<td>Appleworks Science Database (Apple II)</td>
<td>7-12</td>
<td>weather &amp; climate lab</td>
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<tr>
<td>Playing w/ Science: Temperature (Apple II)</td>
<td>K-7</td>
<td>experiments in temperature</td>
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<tr>
<td>Sun Lab (Apple II)</td>
<td>4-8</td>
<td>simulations of astronomy</td>
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<tr>
<td>Build a Circuit (Apple II)</td>
<td>4-8</td>
<td>simulation of electric circuitry</td>
</tr>
<tr>
<td>Data Insights (Apple II)</td>
<td>7-12</td>
<td>science activities using data from life, earth, physical, biological sciences</td>
</tr>
<tr>
<td>Experiments in Physical Science (Apple II)</td>
<td>4-8</td>
<td>measure light, temperature, sound data for analysis</td>
</tr>
<tr>
<td>Space Databases (Apple II)</td>
<td>4-12</td>
<td>database files on manned space missions &amp; space probes</td>
</tr>
<tr>
<td>The Explorer Series (Macintosh)</td>
<td>8-12</td>
<td>simulations in biological &amp; physical sciences: AC/DC circuits, diffraction, gravity, population ecology</td>
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**Source**

- Modern School Supply
- Broderbund
- Kitchen Software
- Earthquest Inc.
- Scholastic
- Wings for Learning/Sunburst
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<tr>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>Astro Smiles, Space Suit, L&amp;A, Mars, Toys in Space</td>
<td>video: camera in space, imaging</td>
<td>NASA Resource Center; available from Vermont College Computer Resource Center</td>
</tr>
<tr>
<td>Beyond 2000</td>
<td>television</td>
<td>PBS, cable TV</td>
</tr>
<tr>
<td>Discovery Channel: Inventions I, II &amp; III</td>
<td>video</td>
<td>Smithsonian Institute</td>
</tr>
<tr>
<td>Ergonomics</td>
<td>slide set</td>
<td>BP Educational Service</td>
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<tr>
<td>Solar: Four Square Feet of Sunshine</td>
<td>18 minute video on cooker box construction</td>
<td>Solar Box Cookers International</td>
</tr>
<tr>
<td>Sun Racer</td>
<td>video: solar power auto race across Australia</td>
<td>General Motors; out of print, copy available from Tom Keck</td>
</tr>
<tr>
<td>Tucker: The Man and His Machine</td>
<td>video of grass root auto company</td>
<td>video rental store</td>
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## Resource Addresses

### Sources for Special Equipment

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>Contact Information</th>
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<tbody>
<tr>
<td>All Electronics Corp.</td>
<td>P.O. Box 567, Van Nuys, CA 91408</td>
<td>1-800-645-4722</td>
</tr>
<tr>
<td>Chaney Electronics, Inc.</td>
<td>P.O. Box 4116, Scottsdale, AZ 85261</td>
<td></td>
</tr>
<tr>
<td>Edlie Electronics</td>
<td>2700 Hempstead Tpke, Levittown, NY 11756-</td>
<td>1-800-645-4722</td>
</tr>
<tr>
<td>Herbach and Rademan</td>
<td>18 Canal Street, Bristol, PA 19007-0122</td>
<td>1-800-645-4722</td>
</tr>
<tr>
<td>Learning Spectrum</td>
<td>1390 Westridge Drive, Portola Valley, CA 94028</td>
<td>1-800-USE-SOS-2</td>
</tr>
<tr>
<td>MFASCO</td>
<td>P.O. Box 386, Roseville, MI 48066-0386</td>
<td>1-800-221-9222</td>
</tr>
<tr>
<td>Omnitrion Electronics</td>
<td>280 N. Midland Avenue, Bldg. 2-2A, Saddle Brook, NJ 07662</td>
<td>1-800-221-9222</td>
</tr>
<tr>
<td>Sailworks</td>
<td>Pike St, Burlington, VT 05401</td>
<td></td>
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<tr>
<td>Scientific Laser</td>
<td>P.O. Box 433, Glendale, AZ 85311</td>
<td></td>
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<tr>
<td>Technology Creators</td>
<td>HC 1 Box 1625, Soldotna, AK 99669</td>
<td>1-800-728-3174</td>
</tr>
</tbody>
</table>

| American Science & Surplus | 601 Linden Place, Evanston, IL 60202 | 1-800-367-6695          |
| Cymar Scientific          | 131 N. Broad St., P.O. Box 530, Carlinville, IL 62626 | 1-800-533-5843          |
| Edmund Scientific         | 101 East Gloucester Pike, Barrington, NJ 08007-1380 | 1-800-367-6695          |
| IASCO Plastics            | 5724 West 36th St., Minneapolis, MN 55416 1-800-328-4927x2662 | 1-800-367-6695          |
| Learning Things, Inc.     | 68A Broadway, P.O. Box 436, Arlington, MA 02714 | 1-800-367-6695          |
| NAEIR                     | P.O. Box 8076, Galesburg, IL 61401           |                            |
| Pasco Scientific         | P.O. Box 619011, 10101 Foothills Blvd., Roseville, CA 95661-9011 1-800-772-8700 | 1-800-367-6695          |
| Sargent Welch Scientific | PO Box 1026, Skokie, IL 60076-1026           |                            |
| Small World Technology   | P.O. Box 607, 2092 East Main Street, Hillsboro, OR 97123 1-800-542-3555 | 1-800-367-6695          |
| TESCO                    | 5724 West 36 Street, Minneapolis, MN 55416-2594 1-800-328-4827, ext. 2662 | 1-800-367-6695          |

| Arbor Scientific         | P.O. Box 2750, Ann Arbor, MI 48106 1-800-367-6695 | 1-800-367-6695          |
| Devics Plastic, Inc.     | P.O. Box 651043, 133 West haven Ave., Salt Lake City, UT 84165 1-800-533-5843 | 1-800-367-6695          |
| Global Computer Supplies, Dept 3A | 11 Harbor Park Drive, Pt Washington, NY11050 1-800-227-1296 | 1-800-367-6695          |
| Kelvin Electronics       | 10 Hub Drive, Melville, NY 11747 1-800-645-9212 | 1-800-367-6695          |
| Merridith Instruments    | P.O. Box 1724, Glendale, AZ 85301             |                            |
| Northern Hydraulics Inc. | P.O. Box 1724, Glendale, AZ 85301             |                            |
| Plisco                   | 1004 East Adams, Pittsburg, KS 66762 1-800-835-7777 | 1-800-367-6695          |
| Science Kit & Boreal Lab| Tonawanda, NY 14150 1-800-828-7777            |                            |
| Surplus Center           | 1015 WEST "O" STREET, P.O. Box 82209, Lincoln, NE 68501-2209 1-800-228-3407 | 1-800-367-6695          |
| Trans Tech Creative      | Learning Systems, Inc. 9899 Hibert, Suite C, San Diego, CA 92131 1-800-458-2880 | 1-800-367-6695          |
Software Developers and Distributors

Auto Desk
2320 Marinship Way
Sausalito, CA 94965

Broderbund Software-Direct
Dept 15
P.O. Box 6125
Novato, CA 94948-6125

Earthquest Inc.
125 University Ave.
Palo Alto, CA 94301

Edu Soft “A”
45 Route 4 West
Woodstock, VT 05091
802-457-4161

Educational Resources
1500 Executive Drive
Elgin, IL 60123
1-800-624-2926

Education Department
State of Vermont
120 State Street
Montpelier, VT 05620
Attn: Robert Dunn

Fas-Track Computer Products, Dept CI
7030C Huntley Road
1-800-927-3936

Kitchen Software
903 Knebworth Ct.
Westerville, OH 43081

MacWarehouse
P.O. Box 3012
Lakewood, NJ 08701
1-800-255-6227

Modern School Supply
P.O. Box 958
Hartford, CT 06143
1-800-243-2329

Pre-Engineering Software
1266 Kimbko Drive
Baton Rouge, LA 70808
1-504-769-3728

Scholastic Inc
2931 E. McCarly St., PO Box 7502
Jefferson City, MO 65102
1-800-541-5513

Wings for Learning/Sunburst
1600 Green Hills Rd.
PO Box 660002
Scotts Valley, CA 95067
1-800-321-7511

Veriner Software
2920 SW 89th Street
Portland, OR 97225

Multimedia Sources

BP Educational Service
Britannic House
Moor Lane
London EC2Y 9BV, UK

Computer Resource Center
Vermont College
Montpelier, VT 05602

ICS Warehouse, Inc.
1802 East 18th Street
Tucson, AZ 85719-6509
1-800-528-1593

Lousiana Nature and Science Center
11000 Lake Forest Blvd.
New Orleans, LA 70127.
Telephone 504-246-5672.

National Audio Visual Supply
1 Madison Street
E. Rutherford, NJ 07073
1-800-528-1593

NASA Central Operation of Resources for Educators
Lorain County Joint Vocational School
15181 Route 58 South
Oberlin, OH 44074

PBS Video
1320 Braddock Place
Alexandria, VA 22314-1698

Smithsonian Institute
1000 Jefferson Drive SW
Washington, DC 20560

Solar Box Cookers International
1724 11th Street
Sacramento, CA 95814

RoboResource Book