DOCUMENT RESUME

ED 339 364 IR 015 327

AUTHOR Pedras, Melvin J.; Braukmann, Jim
TITLE Technology Education Practical Activities for Elementary School Teachers.
PUB DATE 91
NOTE 15p.; Paper presented at the Annual Conference of Partnerships in Education (Lewiston, ID, October 3-4, 1991). For a related paper, see IR 015 328.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Critical Thinking; Educational Technology; Elementary Education; *Learning Activities; Learning Modules; Lesson Plans; *Science Instruction; *Skill Development; Social Sciences; *Technological Literacy

ABSTRACT

This report contains four learning modules designed to support a range of objectives that include increasing technological literacy, and improving written and verbal communication skills, psychomotor skills, computational skills, geometry, analysis, problem solving, and other critical thinking skills. The activities described in each module support topics in the physical sciences and may be tied to topics in the social sciences as well. Each of the four modules provides lesson plans for a different activity: (1) manufacturing a toy wooden van; (2) designing and constructing a robot; (3) constructing an electrical telegraph communications system; and (4) manufacturing a hot air balloon. Designed for use by elementary school teachers, the lesson plans contain lists of concepts supported in the module, materials lists, tools needed, and instructions for completing the activities. It is noted that these lessons may be modified for higher or lower skill levels, or may serve as a framework for different activities. (34 figures) (DB)

TECHNOLOGY EDUCATION PRACTICAL ACTIVITIES FOR ELEMENTARY SCHOOL TEACHERS

Paper Presented at the
Partnerships in Education Annual Conference
October 3-4, 1991

Lewiston, Idaho

Dr. Melvin J. Pedras

Associate Professor of Education
Division of Teacher Education
University of Idaho
Moscow, Idaho

Dr. Jim Braukmann

Associate Professor & Chairman
Department of Technology
EasternWashington University
Cheney, Washington

TECHNOLOGY EDUCATION PRACTICAL ACTIVITIES

INTRODUCTION

Today's elementary school students will live in a society that demands an understanding of technology. As we move toward the next century, technological literacy will become increasingly important to all citizens. This is reinforced by the National Science Foundation report, Educating Americans for the 21st Century (1983), which indicates that technological literacy is a basic capability that all people need to possess. According to Daiber, Literland & Thode (1991) the time to start teaching students about technology is at the elementary level. Students at this level have an innate curiosity about their surroundings and most often they are virtually fearless when it comes to trying out new ideas and technologies.

The activities described in this article go beyond single learning objectives and are designed to support a range of objectives that include technology, written and verbal communication skills, psychomotor skills, computation skills, geometry, analysis, problem solving, and other critical thinking skills. Additionally, the activities directly support topics in the physical sciences ranging from the behavior of gasses to mechanical advantage.

Finally, suggestions are included which tie the activities to topics in the social sciences. If used in this way, the time spent on technology projects can be leveraged to support the broadest range of educational goals. Many of our students are tactile learners. Technology activities such as these offer them another medium in which to learn subjects not customarily presented with physical, manipulative activities.

Manufacturing Activity: Wooden Van

Introduction

Using inexpensive materials, easily fabricated jigs, and hand tools, a series of identical toy vans can be mass-produced in the classroom. The vans can then be decorated to suit individual tastes.

Concepts Supported

- Mass Production
- Specialization of Work
- Planning
- Small muscle motor coordination, active learning
- Self esteem, self dependence, culturalization
- Interchangeable Parts
- Conservation of Resources
- Jigs and Fixtures

Materials List for 30 Vans

- 6 board feet of 3/4" soft **wood** such as 1x4 pine.
- 10' of 1/4" diameter **dowelling**
- 11' of 1-1/4" closet pole **dowelling**

Tools

6 Handsaws; 2 hand **drills** or drill motors, 2 drill bits: 1/4" & 9/32", medium grit **abrasive paper** (80-150 grit). Optional: 4" C-clamps for attaching the jigs to the table tops.

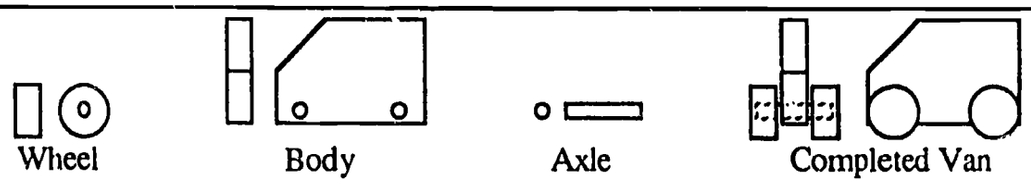


Figure 1: Van Construction Details

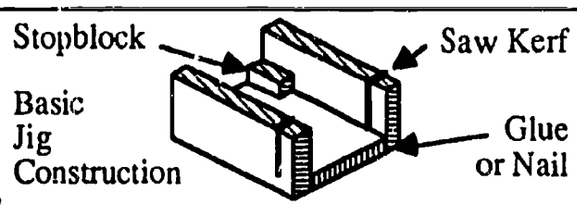


Figure 2: Basic Jig Construction Details

Instructions

1) Jigs are usually built beforehand, although it is certainly within the capabilities of 9 year olds to fabricate these jigs (Figure 2). It is advisable to clamp the jigs to the worktables if possible. Students are given demonstrations in the proper and safe use of each tool and jig.

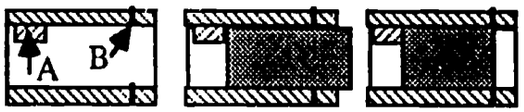
2) 

Figure 3 Figure 4 Figure 5

The jig for cutting the van body to length is based on a basic miter box design. The distance between the stop block ("A" Figures 2 & 3), and the saw kerf ("B" Figure 3) is the length of the van body. The 1x4 pine stock is inserted into the jig as indicated in Figure 4, until

the end rests against the stop block. The saw is inserted into the saw kerf and the 1x4 is cut to length as in Figure 5.

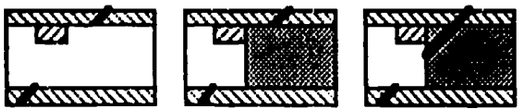
3) 

Figure 6 Figure 7 Figure 8

The jig for cutting the van window is very similar to the one for cutting the body to length. The saw kerf, however is set at an angle, and near to the stop block, as indicated in Figure 6. The van body is inserted into the jig against the stop block as indicated in Figure 7, the saw inserted into the kerf, and the window cut as in Figure 8. Save the triangular piece of wood.

4) 

Figure 9

The jig for drilling the axle holes in the van body is shown in Figure 9. A piece of wood with two pilot holes ("C") is attached to the top of the jig so that the van body slides under it. A drill bit is inserted through the pilot holes to drill holes in the van body below.

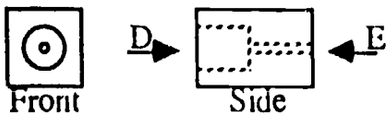
5) 

Figure 10

Similar jigs as used for the van bodies are used for cutting the axles to length (about 2") and the wheels to width (about 7/8"). The jigs are narrower because the stock is narrower (1/4" & 1-1/4" dowelling). The hole in the center of the wheel must be drilled before the wheel is cut to width. This is because after the wheel is cut to length, it is too small to be safely held while drilling the hole. These holes require a different type of jig. The one illustrated in Figure 10 fits over the end of the dowelling ("D). A drill bit is then inserted into the pilot hole ("E") and the hole drilled. Adjust the length of the drill bit sticking out from the chuck so that when the drill is pushed all the way into the jig, the hole drilled will be only 1/2" deep.

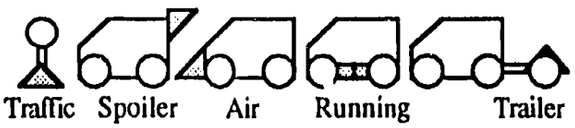
6) 

Figure 11

It is important to include conservation of resources in our manufacturing project. In order to emphasize the point, the students are asked to refer to scrap material as "residual material." In the case of the triangular piece created when the window was cut out of the van body, the student is asked to find a way to use the piece in a manner related to the van. Don't give too many hints or the residuals will all be used the same way. Some of the used designed by students are illustrated in Figure 11.

7) A typical flow chart for the total production process is shown on the following page. Students should be made aware of the system organization represented by the chart. The quality control workers are responsible to check the parts for accuracy and, if severe flaws are found that will detract from the performance of the van, to trace the flaws back to the process that is producing the flaw and find a way to decrease the number of flaws.

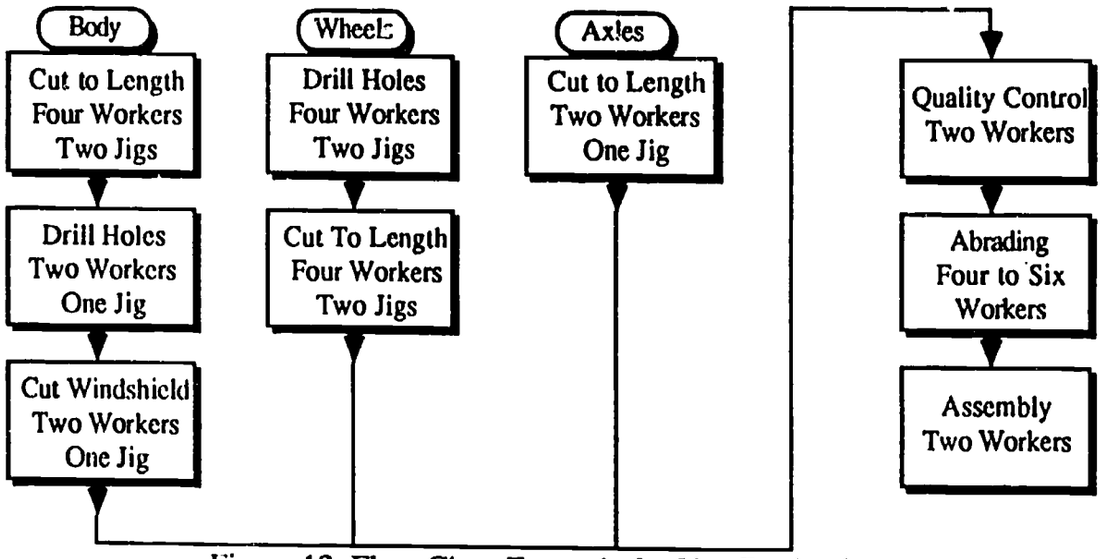


Figure 12: Flow Chart Example for Van Production

8) After the vans are completed, finishing and decoration may be done with mass-production, or you may decide to ask the students to customize their vans. Tempura paint, mineral oil, decoupage, crayons, markers, and stickers work well as finishes. Vans could be finished in appropriate ways to illustrate different service industries that use such transportation, or in ways that illustrate the history of transportation.

9) Discuss with the class the pros and cons of mass production. Issues and topics could well include interchangeable parts, quality control, specialization of work, worker skill, fatigue & boredom, advantages of jigs, and applicability of this system to the manufacture of other products.

Correlation of Learning

• Study the **impact of mass production** on our current society, and on the history of our society.
• Give an **oral report** on a specific important historical event involving the automobile or mass production.
• **Calculate** the total number board feet of wood needed for the project.
• List **jobs** related to the transportation and manufacturing industries.
• **Invite** an employee from a local woodworking shop, automobile repair shop, or other manufacturing to visit the classroom and answer questions about how they operate.
• Construct a **display** of a modern transportation system.

Power/Design Activity: Robot

Introduction

Using inexpensive materials and hand tools, a servo or remote controlled device can be constructed to perform a wide range of possible operations. In this open-ended project, students work together in small design teams to plan, design, fabricate and troubleshoot the device. The device is designed around a hydraulic actuator fashioned from two syringes connected by a 1/4" flexible hose. Many parts may be precut by the teacher, or made individually by students.

Concepts Demonstrated/Supported

- Hydraulics, pneumatics, pressure, flow
- Leverage, relationships between force and distance
- History and impact of technology
- Small muscle motor coordination, active learning
- Self esteem, self dependence, culturalization
- Servo mechanisms
- Systematic designing
- Troubleshooting

Materials List for a Single Project

- 12cc Syringes (without the needles!) can be obtained from a veterinary supply for about 25¢ each. Two are needed for each actuator, four to six for each project.
- About 4' of 1/4" tubing for each project can be obtained from a hardware or aquarium supply.
- 1/4" dowelling for pivots and other assorted uses
- About 2 board feet of soft wood such as pine, depending on the specific design, in two general sizes, long 3/4" square pieces for basic construction, and a base of about 6" x 12" on which to mount the device.
- White glue
- 1" nails
- Optional: clamps for wood gluing

Tools

Hammer, screwdriver, electric or hand **drill** with 1/4" and 9/32" bits, warm or hot **glue gun**, crosscut and coping **hand saws**.

Actuator Construction Details

It is important to demonstrate the actuators and the simple lever mechanisms that can use the actuator. However, it may be advisable to avoid demonstrating a fully functional "robot" device because the students will tend to closely mimic the example. If creative thinking is to be fostered, the students must have the "freedom" that comes from having as few preconceptions as possible!

When two syringes are connected and filled with water, pressing one will cause fluid to move through the tube and, in term, cause the second syringe to extend (Figure 1). Pulling on the first syringe will cause the second to contract. This extension and contraction can be used to move levers and wheels. The system will also work with only air in the tube, but the action is "spongy" and somewhat more difficult to control.

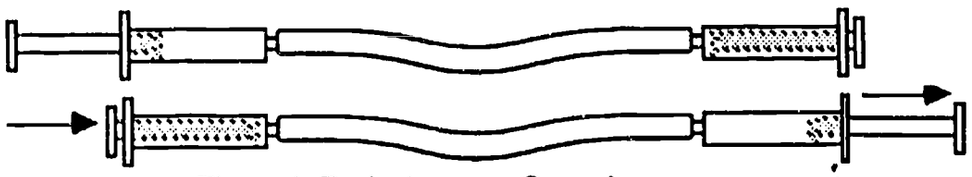


Figure 1: Basic Actuator Operation

Figures 2, 3 & 4 illustrate some basic actuator operations. Many other types of movement can be achieved with string, rubber bands, and imagination. The final designs will typically use several combinations of such devices.

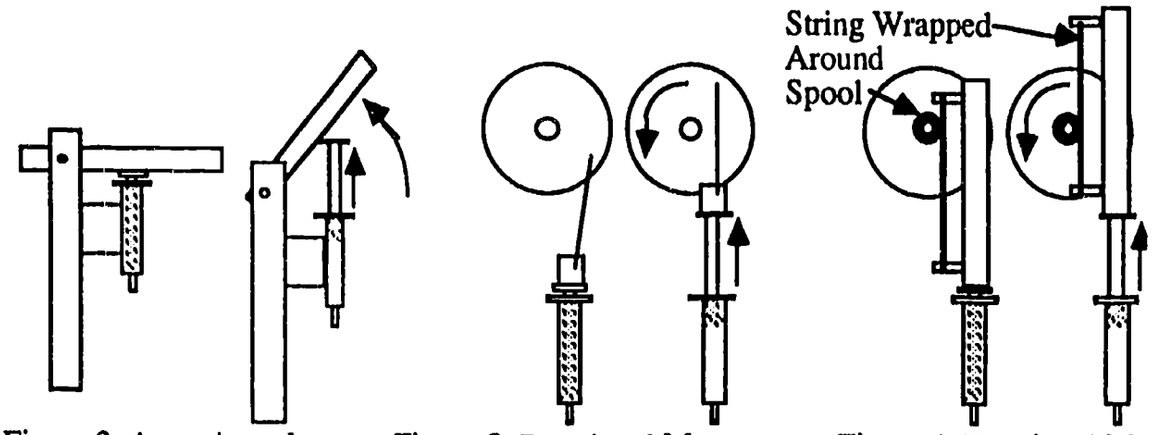


Figure 2: Actuating a Lever. Figure 3: Rotational Movement. Figure 4: Rotational Movement.

Design Instructions

1) Students should work in groups of two or three, and should be assigned to groups so that each group represents a cross-section of the class. Avoid matching high achievers with each other, or low achievers with each other.

2) In order to maximize intrinsic motivation, ask each team to set it's own overall design goal. The goal must be written down before the group can continue to the next step. Examples of such goals might include:

To build a machine to pick up marbles and place them in a cup;
To build a machine to make a puppet dance;
To build a machine to launch ping-pong balls at a target six feet away;
To build a remote control gravity marble maze;
To build a game that will allow one operator to direct a thumb tack to pop a balloon while another operator directs the balloon away from the thumb tack!

3) Once the overall goal is established, the group must decide on specific design criteria for their project. Try to have each group come up with at least six criteria. These criteria will drive the design process and will be used later to evaluate the prototype and are quite important in the overall design process. Examples of such criteria might include:

The device must be able to lift 7 oz of weight.
The device must be accurate to within 1/8".
The device must fit into a 12" x 16" x 24" locker space.
The device must be durable enough to transport on a school bus.
The device must be easily taken apart for transportation.
The device must be easily repairable.
The device must look like an 11th century catapult.

4) Possible design solutions identified with brainstorming techniques are sketched by the group and the most promising one selected for a more detailed drawing. It is important to note that the final design must be completely represented in a drawing before prototype construction begins. These final drawings, along with the list of criteria (step 3), must be "OK'd" by the teacher. Evaluation of the drawings should include whether the drawings *clearly* describe the mechanism, and whether any obvious critical design flaws exist. If such flaws are evident in the drawings, the teacher should point out the problem but not a specific solution. The design team should solve the problem in their own way.

5) Evaluation of the prototype should be based on: first, does it work reasonably well? and, second: does it satisfactorily meet the design criteria? If the answers to these questions are at least a qualified yes, the project has been successfully completed. If a major criteria has not been met, but the team has concrete suggestions as to how the project might be modified to meet the criteria, the project should also be considered successfully completed.

6) Students should present their projects to the class, and explain the design process in detail including their criteria and perhaps some ideas they decided not to use. It is important that they also think up ways in which they could use the same type of systematic process on very different problems such as toxic waste removal, conservation of natural resources, or inner-city crime. If they really see the process underlying the project, transfer of learning will occur.

Construction Instructions

1) Wooden components can be attached in several ways depending on the structural demands on the joint. Nails or hot glue work well for quick bonding that is not subject to high stress. For joints that will be subject to higher stress, white glue and clamping or white glue with nails are suggested.

2) Syringes can be attached to wooden supports with the warm or hot glue gun. It is suggested that the newer "warm" glue guns be used with younger students. White glue is not satisfactory with the plastic syringe cases. Abrading the side of the syringe with 100 grit abrasive paper will insure a better hot/warm glue bond. Apply a 1/4" x 1" bead of glue to the side of the syringe and quickly press it to the wood, rocking it to make certain the glue adheres to the wood. Then hold the syringe steady for 15-20 seconds for the glue to set. The device can be used almost immediately.

Special Safety Considerations

Hot glue guns reach a temperature of 410 degrees F. The glue can easily cause first degree burns if it comes in direct contact with skin. Warm glue guns operate at 225 degrees F. Glue guns are quite safe, however, if used carefully and under supervision.

Correlation of Learning

- Study the use of robots in industry in different countries.
- Study the **impact of mass production and automation** on our current society, and on the history of our society.
- Give an **oral report** on a specific important historical event involving automation or mass production.
- **Calculate** multiplication or division of force and distance in a lever device.
- **Calculate** the pressure per square inch as the actuator lifts a known weight.
- List **jobs** related to manufacturing industries.
- List the types of **skills and education** needed to work with industrial robots.
- **Invite** an employee from local industry to visit the classroom and answer questions about how they operate.

Communications/Electricity Activity: Telegraph

Introduction

Using inexpensive materials and hand tools, a device can be constructed to communicate over a distance via wires. The sending unit is a simple switch or "key." The receiving unit or "actuator" is an electromagnet with a metal strip that is attracted to the electromagnet when the electric current is applied, and produces an audible "click." The system is powered by a C or D size flashlight battery. Parts may be precut by the teacher, made individually by students, or mass-produced by the students.

Concep' Demonstrated/Supported

- Electric circuit, electrical switch, electromagnet
- Serial data transmission, digital signals, power transfer, communication Morse or ASCII code
- Encoding and decoding of signals
- Troubleshooting
- History and impact of technology on society
- Small muscle motor coordination, active learning
- Self esteem, self dependence, culturalization

Materials List for a Single Project

- 10' of insulated copper **wire**, stranded or solid, 26 gauge or greater.
  Inexpensive bell wire works well.
- 3 ea **1/2" #6 wood or machine screws**, or similar.
- 1 ea **2" #8 wood or machine screw**, or similar, or a 16d box or common nail.
- 1/3 board foot of 3/4" soft **wood** such as pine, cut into two blocks.
- 8 square inches of **thin steel**, cut into two strips, approximately 1" x 4".

Tools

Hammer to drive nails for screw holes; **screwdriver**; **tin snips** for cutting sheet metal; **pliers** for stripping the insulation from the ends of the wires; medium grit **abrasive paper** (80-150). Optional: a **soldering iron** and resin core solder may be used to attach wires to the battery, and optionally to attach the wires to a light bulb, if a bulb is used in place of the electromagnet.

Figure 1: Switch Construction Details

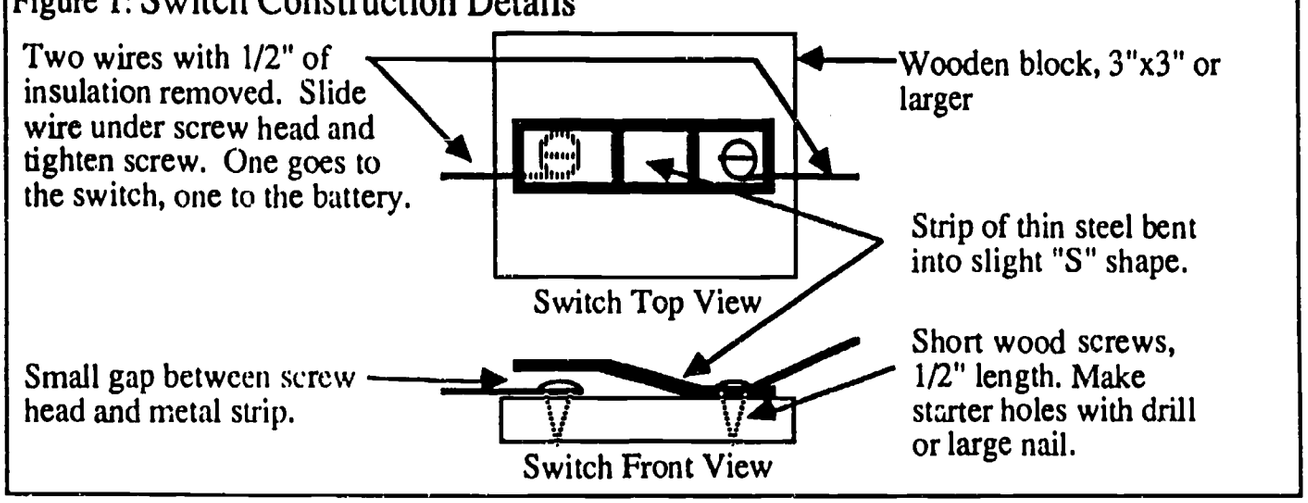


Figure 2: Communications Actuator Construction Details

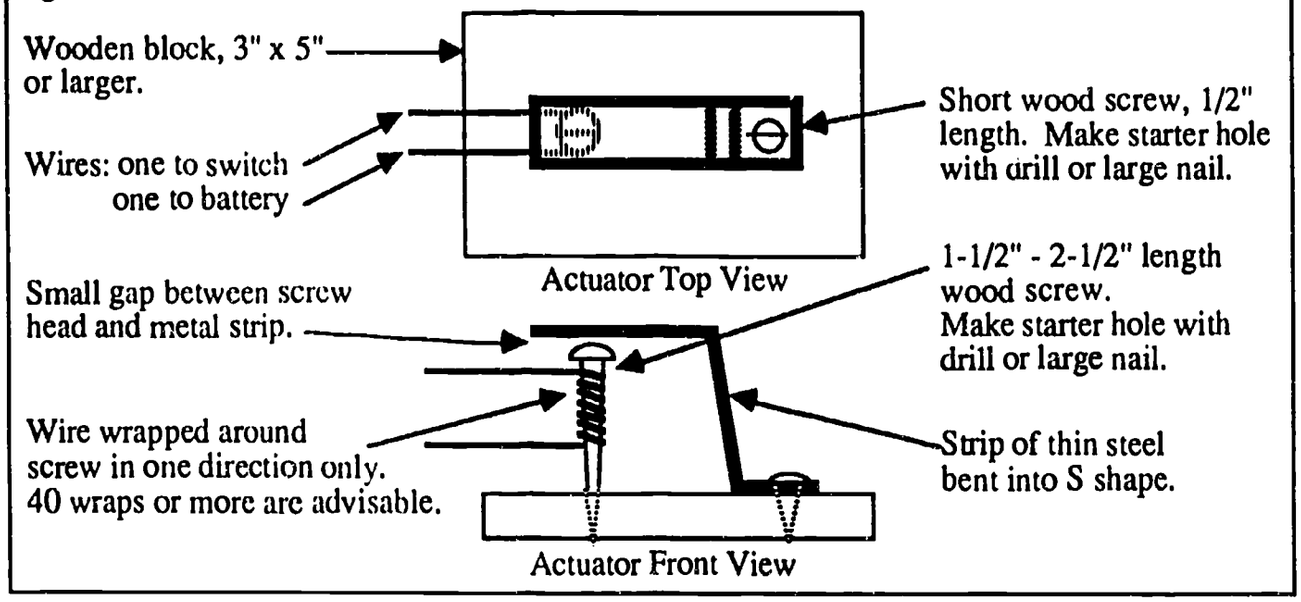


Figure 3: Completed Circuit

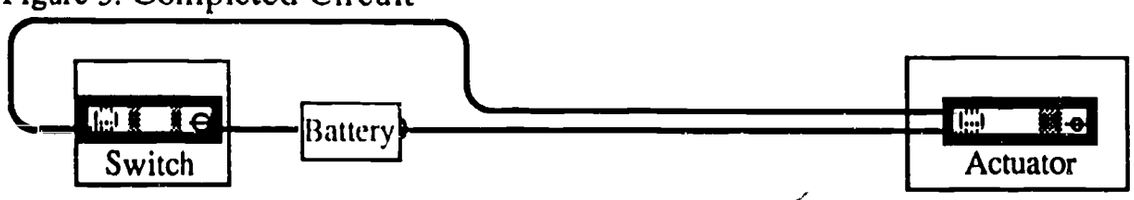
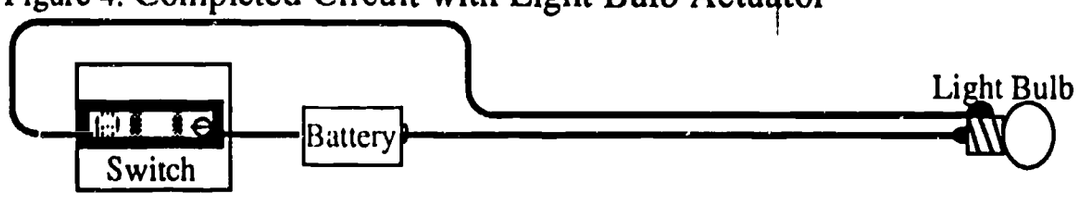


Figure 4: Completed Circuit with Light Bulb Actuator



Instructions:

1) Using pliers or a diagonal wire cutter, cut a 3' to 4' length of wire. Leaving about a 3" length of wire for connection, begin wrapping the wire tightly around a 2" screw until almost all the wire is wrapped. Leave about 3" for connection. The coil may be several layers deep.

Note: Do not change direction as you wind. If you begin in a clockwise direction, continue clockwise until all the wire is used. (Changing the direction of winding will cause a reversal of the magnetic field and the electromagnet will work against itself!) This completes the construction of the electromagnet.

2) Use a large nail (16d-20d) to make a small starter hole for the electromagnet in one of the blocks. Tap the nail into the block to a depth of about 1/4" then pull it out. Turn the electromagnet screw into the block until it is secure.

3) Use the tin snips to cut two strips of metal, one about 3/4" x 5" for the actuator and one about 3/4" x 3" for the switch. Very short strips of metal may not work as well for the actuator because the strips will be too stiff. Longer and wider strips usually work well and create both louder and more interesting sounds. Remove any sharp edges by rubbing the edges against abrasive paper. Bend the strips into the shapes indicated in Figures 1 and 2.

4) Place the actuator strip in the position shown in Figure 2 on the block and use a hammer and large nail to punch a hole through the metal and into the block. When the nail is completely through the metal, stop and remove the nail. Use the hole created as a pilot hole for a short screw, and tighten the screw until it is flush.

5) Repeat the procedure in #4 for the switch, but do not tighten the screws until the connecting wires are wrapped around the screw heads.

6) The wires may be connected to the battery in several ways. Choose one. (In this circuit the battery will work with the positive terminal connected to either the switch or the actuator.)

A) Wires may be taped onto the battery terminals.
B) Wires may be soldered to the battery terminals.
C) Another small block of wood with two L shaped pieces of thin metal can be used to make a reusable battery holder as shown in the following figure:

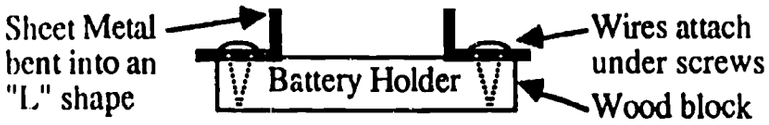


Figure 5:

7) Connect the wires as in figure 3 or 4 and test the apparatus. The wires can be twisted tightly together or soldered for a more durable connection. If the wires are made very long, say 20', the switch and battery can be located in one room, and the actuator in another. Of course, two complete circuits will be needed for two-way communication.

8) Troubleshooting and evaluation. Evaluation is simple: Does it work? If it does not work, how can we systematically check it to see how we can fix it? Does it differ from the diagram in any significant way? Can we retrace our steps? Does the battery work? How can we test it? Can we substitute a component that we know works for a component that we are not certain of, and try it again? Is the gap between the electromagnet and the metal strip to large? Remember, understanding the process of troubleshooting is much more valuable in the long run than an apparatus that works perfectly the first time.

Correlation of Learning:

• **Encode** or **decode** information into a form that can be transmitted by electrical pulses using Morse or ASCII code.
• Understand the concept of **data transfer** with computers.
• Study the **impact of telecommunication** on our current society, and on the history of our society.
• Give an **oral report** on a specific important historical event involving the telegraph.
• **Calculate the current** flowing in this circuit. Does the number of wire turns in the electromagnet make a difference?
• **Calculate the power** delivered by the battery in this system.
• List **jobs** related to the communications and electronics industries.
• **Invite** an employee from the local telephone company to visit the classroom and answer questions about how information travels through telephones.
• Construct a **display** of a modern communication system (see the resource package)
• Share information with other computer users or classes via **modems**.
• Study the generation and **transfer of power** over wires from coal, nuclear, hydroelectric, geothermal, and solar sources.
• Divide the class into **teams** of two. Give a "quiz" with one member filling in the missing words on the test and the second member at the other end of a table with an open book. The second member can supply correct answers to the first student via the team's communication system.

(Activity Under Development)
Manufacturing Activity: Hot Air Balloon

Introduction

Using inexpensive materials, easily fabricated templates, and hand tools, a series of operational hot air balloons can produced in the classroom. The balloons can be customized to suit individual tastes.

Concepts Supported

- Mass Production
- Three-dimensional geometry
- Small muscle motor coordination, active learning
- Self esteem, self dependence, culturalization
- Behavior of Gasses
- Technical Drawing

Materials List for 30 Balloons

- 1200 sq ft of floral or tissue paper (40 sq/ft per balloon) This material is tough, lightweight, and has low permeability.
- Paper Glue (Possibly glue sticks or paper paste)

Tools

- Pencils or narrow markers
- Scissors
- Heat source such as a heat gun. It may be possible to use a Bunsen burner or a hair dryer.

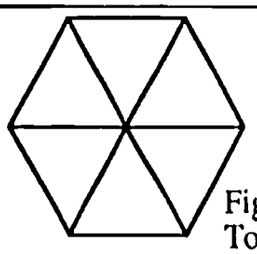


Figure 1
Top View

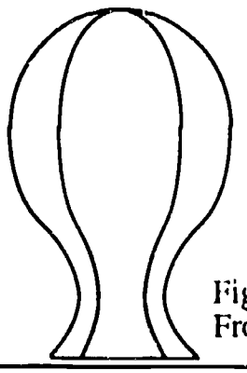


Figure 2
Front View

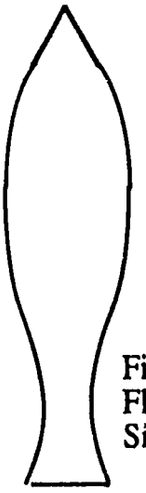


Figure 3
Flat Outline of
Single Section

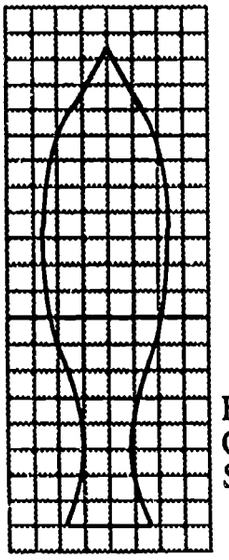
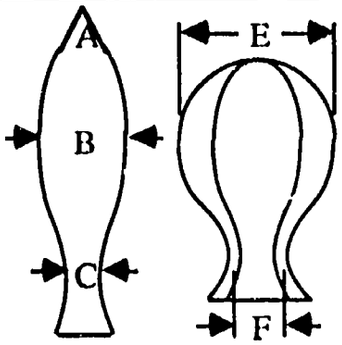


Figure 4
Grid Pattern of
Single Section

Instructions

1) A variety of designs can be used. Figure 5 gives general design considerations for a six sided balloon. The balloon should not be less than 2' diameter, and not less than 3' in length. A balloon that is as wide as it is tall will tend to tip over and spill the hot air. However, students can experiment with different shapes and sizes.



Design Criteria for a 6 sided balloon:
A wide variety of shapes and sizes may be tried.
However, a few principles are constant

- The angle A must be 60 degrees for the top of the balloon to be flat.
- The width of the section at B is 1/2 of diameter E.
- The width of the section at C is 1/2 of diameter F.
- After drawing the section outline, add 3/8" to one edge for gluing.

Figure 5: Design Criteria for a 6 sided balloon.

2) Draw the outline of a section (Figures 3 & 4) on one piece of paper. The individual squares in Figure 4 should be 3" to 4" on a side. The outlines can be traced from a template, or can be drawn "freehand" over a full sized 3" to 4" (or larger) grid using the corresponding intersection points shown in a pattern such as Figure 4. Dimension B (Figure 5) should be at least 18", and the total length of a section should be at least 40". All six sections can be stacked and cut at the same time. Additionally, if the sheets are folded in half, both sides of each section can be cut at the same time. Using more than one color of paper would allow the fabrication of a patterned balloon design.

This product can easily be mass-produced. Individual workstations would be set up for marking, cutting, quality control, and gluing.

3) Floral tissue paper has a waxed coating on one side. The glue should be applied to the non-waxed side for proper adhesion. Using an even number of sections, such as four or six, allows sections to be arranged waxed side out, then waxed side in, and so on around the balloon. Non-waxed sides can always be back to back at the glue joint. Using the glue stick, apply a narrow but continuous line of glue along one edge of one section. Starting at one end, press the second section to the first with a minimum amount of overlap. It may be advisable to glue only about 18 inches at a time as the glue dries quickly. The seam must have no gaps.

4) Continue adding sections in this manner until the balloon is complete.

5) It may be necessary to weight the bottom of the balloon to keep it from tipping as it is released. Paper clips, tape, or a miniature gondola might be used. A larger balloon has a better lift to weight ratio and will rise with lower temperature air. Smaller balloons need hotter air and potential hazards increase with the use of higher temperature heat sources. Potential sources of heat include Bunsen burners, hair dryers, and heat guns (Designed for removing paint and bending plastic). Heat guns often have adjustable temperature settings.

Correlation of Learning

- Study the **impact of mass production** on our current society, and on the history of our society.
- Give an **oral report** on a specific important historical event involving human flight.
- **Calculate** the square feet of material for a balloon of a given size.
- List **jobs** related to the air transport industries.
- Construct a **display** of a modern transportation system, or of the history of aviation.
- It is possible that a soaring competition might be arranged. Students might:
  - Trim away any excess paper at the seams to minimize unnecessary weight;
  - Experiment with shape and size of balloon for maximum performance;
  - Find a means to measure the height reached by a balloon on release (triangulation?);
  - Find the minimum weight necessary to add for stability;

SUMMARY

Designing an appropriate technology education practical activity is not difficult. The examples included here may be easily modified for higher or lower skill levels, or may serve as a framework for very different activities. However, appropriate activities should embody the following principles:

1) The outcome should represent a solution to a problem. It should accomplish useful work in a way that is quicker, faster, or easier.

2) The activity should involve the manipulation of tools and materials.

3) As much as possible, the activity should involve the students in problem-solving, research, collaboration, planning, evaluation, troubleshooting, mass-production, or a combination of these processes.

4) The activity should be tied to learning objectives in mathematics and the physical sciences and should apply the knowledge of those subjects.

5) The activity should also be tied to learning objectives in the social sciences.

Technology education activities can be designed to support a range of objectives that include technology literacy, written and verbal communication skills, psychomotor skills, computation skills, geometry, analysis, problem solving, as well as the physical and social sciences. All tnis can be done in a manner that emphasizes an active, manipulative learning style.