Manufacturing and Design Journal

California Education and the Environment Initiative
Science Standard 6.6.c.
California Education and the Environment Initiative
Approved by the California State Board of Education, 2010

The Education and the Environment Initiative Curriculum is a cooperative endeavor of the following entities:
- California Environmental Protection Agency
- California Natural Resources Agency
- California State Board of Education
- California Department of Education
- Department of Resources Recycling and Recovery (CalRecycle)

Key Partners:
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Natural Resource Use Flowchart

Origins Chart

My Toy Company

Surfing the Choices

Toy Design Blueprint

A World of Resources

World Travelers

Resource Transportation Chart

Meet the Extractors and Harvesters

To Extract or to Harvest: That Is the Question!

Before and After Notes

The Toy’s Effects

Inputs and Outputs
Natural Formation of the Resource

Extraction or Harvesting of the Resource

Processing of Raw Material(s) from the Resource

Manufacturing of Finished Products from Raw Material(s)

Sale of Finished Products for Use

Use of the Finished Products

Disposal of the Finished Products (including reusing, recycling, and composting)
<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Natural Resource Category</th>
<th>Common Uses in Manufactured Products</th>
<th>Method of Extraction or Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite</td>
<td>Mineral ore</td>
<td>Aluminum objects</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Clay</td>
<td>Mineral ore</td>
<td>Dinnerware, pottery, tiles for floors and walls, buildings</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Copper</td>
<td>Mineral ore</td>
<td>Electrical wires, batteries, cookware, plumbing pipes, coins</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Cotton</td>
<td>Plant</td>
<td>Thread, fabric, batting, oil (cottonseed), cottonseed meal (used in livestock feed)</td>
<td>Collecting the seed pod from the plant</td>
</tr>
<tr>
<td>Gelatin</td>
<td>Animal</td>
<td>Glue</td>
<td>Rendering animal bones</td>
</tr>
<tr>
<td>Graphite</td>
<td>Mineral ore</td>
<td>Pencil lead (which contains graphite, not lead), batteries, lubricants, and paint</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Iron</td>
<td>Mineral ore</td>
<td>Frames for buildings, bridges, and other structures; tools; cookware; steel; batteries; and magnets</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Leather</td>
<td>Animal</td>
<td>Clothing, bags, fasteners</td>
<td>Skinning the hide from dead livestock</td>
</tr>
<tr>
<td>Raw Material</td>
<td>Natural Resource Category</td>
<td>Common Uses in Manufactured Products</td>
<td>Method of Extraction or Harvesting</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Limestone</td>
<td>Mineral ore</td>
<td>Fiberglass, building, roads, landscaping, and cement</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Petroleum</td>
<td>Fossil fuels</td>
<td>Plastics, paints, synthetic fabrics (PVC), synthetic rubber, foams, thread</td>
<td>Deep drilling</td>
</tr>
<tr>
<td>Resin (rosin)</td>
<td>Plant</td>
<td>Shellacs, cements, musical instrument strings</td>
<td>Collecting the sap from living trees</td>
</tr>
<tr>
<td>Rubber (natural)</td>
<td>Plant</td>
<td>Tires, gaskets, insulation, elastic fabrics and fasteners, foams, hoses</td>
<td>Collecting the sap from living trees</td>
</tr>
<tr>
<td>Silica/Quartz</td>
<td>Mineral ore</td>
<td>Glass (and fiberglass), silicon for computer chips, jewelry, lenses, concrete, electronics, abrasives</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Soda ash</td>
<td>Mineral ore</td>
<td>Glass (and fiberglass), and food sweetener</td>
<td>Underground mining</td>
</tr>
<tr>
<td>Tin</td>
<td>Mineral ore</td>
<td>Cans, containers, soldering material</td>
<td>Surface mining</td>
</tr>
<tr>
<td>Wood/timber/pulp</td>
<td>Plants</td>
<td>Houses, floors, furniture, tools, paper</td>
<td>Cutting the stalk off the root (logging)</td>
</tr>
</tbody>
</table>
Congratulations! You are the new owner of a toy company that makes toys for young children. The first decision you will need to make in your new job is what new toy you want to add to your toy line. Your company can make one of the following kinds of toys:

- **Stuffed animal** or action figure
- **Sports equipment** (balls, rackets, clubs, bats, and others)

Over the next few lessons, you will design a plan to produce your toy. Your plan will include all stages of manufacturing. These stages will include extracting or harvesting the natural resources and raw materials you need, getting the resources to the factory, and putting the toy together.

**Instructions**: Follow these steps to get started.

1. Decide on the type of toy your company will make. Write the name and type of toy here:

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

   Name: _______________________________
2. List the parts of your toy in the first column below. Make sure you include at least three parts. Using the Origins Chart on pages 3–4 as a guide, identify the raw materials and natural resources you might use to make each part of your toy. Try to think of at least two possible kinds of materials for each part. You will be able to change your choices later.

<table>
<thead>
<tr>
<th>Parts of Toy</th>
<th>Natural Resources/Raw Materials Needed for Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Name: ________________________________
**My Toy Company Scoring Tool**

<table>
<thead>
<tr>
<th>Score</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Student lists three toy parts and two natural resources for each part.</td>
</tr>
<tr>
<td>4</td>
<td>Student lists three toy parts and one or two natural resources for each part.</td>
</tr>
<tr>
<td>3</td>
<td>Student lists two toy parts and two natural resources for each part.</td>
</tr>
<tr>
<td>2</td>
<td>Student lists only one toy part and two related natural resources, or, Student lists two toy parts and only one natural resource for each part.</td>
</tr>
<tr>
<td>1</td>
<td>Student lists only one toy part and one related natural resource.</td>
</tr>
</tbody>
</table>
Instructions: Read each question and select materials to use in making a surfboard.

1. Which material do you want to use for your surfboard blank (deck, nose, rail, and tail)? (Check one.)

   Polyurethane foam is one of the easiest materials to shape. Decks made from polyurethane have a smooth finish, which surfers like. Polyurethane is also the least expensive of the materials used for the body of a surfboard. Polyurethane foam is made from petroleum, which is a fossil fuel.

   Polystyrene foam is used to make the foam cups you might get at take-out restaurants in some cities. It is one of the most lightweight options available for building surfboards, which means that surfboards made from polystyrene float well in the ocean. Some polystyrene absorbs a lot of water, and polystyrene is not as strong as polyurethane foam. To make it stronger and more waterproof, manufacturers seal the outside of polystyrene blanks with fiberglass. But even a tiny hole in the fiberglass shell can ruin a surfboard. Polystyrene is also made from petroleum, a fossil fuel.

   Wood comes from plants and is a renewable resource. In well-managed forests, new trees are planted to replace older ones that are harvested, while protecting soil, air, fish, wildlife, and water resources. Wood is strong and floats, but a wood surfboard is a lot heavier than one made of foam. According to some surfers, wood boards do not perform as well as foam boards. It can also be more expensive to make a surfboard out of wood than out of foam.

   Biofoam is made from the sap of plants, which is renewable. This type of foam is easy to shape and has a smooth finish, but can vary in color and in how paint sticks to it. Biofoam can be mixed with polyurethane foam to make it stronger and more even in color.

2. Which material do you want to use for your surfboard stringer? (Check one.)

   Wood is a renewable resource with strength and flexibility, but it is expensive.

   Epoxy is made from petroleum, like polystyrene foam. It is easy to cut. Fiberglass is made from glass threads. Petroleum is a fossil fuel, and silica, which goes into the glass, is a mineral ore. Both are less expensive and lighter in weight than wood.
Which material do you want to use for your surfboard fin(s)? (Check one.)

______ Epoxy manufacturers pour petroleum-based epoxy resin into molds and let it harden. Epoxy fins are lightweight and inexpensive.

______ Fiberglass fins include layers of cloth made from glass thread are criss-crossed and pressed together. Fiberglass fins are strong.

______ Carbon is actually graphite, a mineral ore. Manufacturers mold it into shape for lightweight, strong, and flexible fins, which bend but do not break.

______ Aluminum manufacturers form threads of aluminum (made from the mineral ore bauxite) into a cloth and sandwich cloth layers together for thickness and strength. Aluminum is the lightest material used in making fins.
Today’s Task

Instructions: Create a blueprint for the toy you want to manufacture. Draw two views of your toy, a map view on this page and a profile view on page 11. Label the parts of your toy on each drawing.

Toy Name: _____________________________________

Map View (1 cell = 1 inch)
Profile View (1 cell = 1 inch)
Instructions: List parts of your toy in the first column, include at least three. List the raw materials and natural resources needed for the parts in the second column.

<table>
<thead>
<tr>
<th>Parts of Toy</th>
<th>Natural Resources/Raw Materials Needed for Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Toy Design Blueprint Scoring Tool

<table>
<thead>
<tr>
<th>Score</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Student shows map and profile views of toy, labels at least three major parts, and lists at least two raw materials or natural resources to be used for each part.</td>
</tr>
<tr>
<td>4</td>
<td>Student shows map or profile view of toy, labels at least three major parts, and lists at least two raw materials or natural resources to be used for each part.</td>
</tr>
<tr>
<td>3</td>
<td>Student shows one view of the toy, indicates and labels three or more major parts, and lists one or two raw materials or natural resources to be used for each part.</td>
</tr>
<tr>
<td>2</td>
<td>Student shows one view of the toy, indicates and labels fewer than three parts, and/or lists only one raw material or natural resource to be used for each part.</td>
</tr>
<tr>
<td>1</td>
<td>Student draws the toy, but does not label parts or identify raw materials or natural resources.</td>
</tr>
</tbody>
</table>
Instructions: Complete the following tasks in the spaces provided. (1 point for completing each line)

Step 1: Write the names of three resources you need to make your toy on the lines labeled “Natural Resource #1,” “Natural Resource #2,” and “Natural Resource #3.”

Step 2: Look at the Resource Transportation Chart on page 15. Find your resources on the chart and write the estimated distance on the line labeled “Distance transported.”

Step 3: Circle your choice of how you will transport each resource to California.

Step 4: Add all the distances for a total estimate of how far the resources will travel.

Natural resource #1: ____________________________________________________________

Distance transported (estimate in miles) = __________________________________________

Type of Transportation Needed (circle one):

- Truck
- Train
- Aircraft
- Ship

Natural resource #2: ____________________________________________________________

Distance transported (estimate in miles) = __________________________________________

Type of Transportation Needed (circle one):

- Truck
- Train
- Aircraft
- Ship

Natural resource #3: ____________________________________________________________

Distance transported (estimate in miles) = __________________________________________

Type of Transportation Needed (circle one):

- Truck
- Train
- Aircraft
- Ship

Total estimated distance all cargo will travel: ________ miles
<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Source of Materials</th>
<th>Estimated Distance Transported (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite</td>
<td>Brazil</td>
<td>6510 miles</td>
</tr>
<tr>
<td>Clay</td>
<td>California</td>
<td>100 miles</td>
</tr>
<tr>
<td>Copper</td>
<td>Arizona</td>
<td>700 miles</td>
</tr>
<tr>
<td>Cotton</td>
<td>Alabama</td>
<td>2125 miles</td>
</tr>
<tr>
<td>Gelatin</td>
<td>California</td>
<td>150 miles</td>
</tr>
<tr>
<td>Graphite</td>
<td>Arizona</td>
<td>700 miles</td>
</tr>
<tr>
<td>Iron</td>
<td>Minnesota</td>
<td>1560 miles</td>
</tr>
<tr>
<td>Leather</td>
<td>Texas</td>
<td>1540 miles</td>
</tr>
<tr>
<td>Limestone</td>
<td>California</td>
<td>200 miles</td>
</tr>
<tr>
<td>Petroleum</td>
<td>Texas</td>
<td>1700 miles</td>
</tr>
<tr>
<td>Resin (rosin)</td>
<td>China</td>
<td>6500 miles</td>
</tr>
<tr>
<td>Rubber (natural)</td>
<td>Venezuela</td>
<td>4306 miles</td>
</tr>
<tr>
<td>Silica/Quartz</td>
<td>California</td>
<td>150 miles</td>
</tr>
<tr>
<td>Soda ash</td>
<td>Montana</td>
<td>912 miles</td>
</tr>
<tr>
<td>Tin</td>
<td>New Mexico</td>
<td>1000 miles</td>
</tr>
<tr>
<td>Wood/timber</td>
<td>California</td>
<td>300 miles</td>
</tr>
</tbody>
</table>
Meet the Extractors and Harvesters
Lesson 4 | page 1 of 5

Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Copper Extractor (Miner)
1. How do you do your job? What types of machines, materials, and energy do you use?

2. What is the raw material that you extract?

3. Is the raw material processed before it can be used? How?
Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Cotton Harvester (Farmer)

1. How do you do your job? What types of machines, materials, and energy do you use?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. What is the raw material that you extract?

________________________________________________________________________

3. Is the raw material processed before it can be used? How?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

**Petroleum Extractor**

1. How do you do your job? What types of machines, materials, and energy do you use?

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

2. What is the raw material that you extract?

   ____________________________________________

3. Is the raw material processed before it can be used? How?

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________

   ____________________________________________
Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

Silica Extractor (Miner)
1. How do you do your job? What types of machines, materials, and energy do you use?

2. What is the raw material that you extract?

3. Is the raw material processed before it can be used? How?
Instructions: As you learn about these extractors and harvesters, answer the following questions in the spaces provided.

**Wood Harvester (Logger)**
1. How do you do your job? What types of machines, materials, and energy do you use?

2. What is the raw material that you extract?

3. Is the raw material processed before it can be used? How?
Instructions: Look at the design blueprint(s) of your toy on pages 10–11 and select one natural resource that you will use in making your toy.

Fill in the information below about the extraction or harvesting method used to obtain that resource. Use information from the Extraction and Harvesting Convention. (5 points)

Natural resource needed:

________________________________________________________________________________________

Method of getting the resource: (circle one)

Extraction or Harvesting

Describe how this resource is extracted or harvested:

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________
Instructions: Take notes during the lesson on how these activities change ecosystems.
Name: _____________________________________

Instructions: Answer the following questions about how the creation of your toy could affect natural systems. Include at least two examples in each of your answers. (3 points each)

1. How can extracting or harvesting the resources used in your toy affect natural systems?

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

2. How can transporting the resources to the factory that makes your toy affect natural systems?

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

3. How can making your toy in a factory affect natural systems?

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
4. How can **transporting** the finished toy to stores affect natural systems?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

5. Can your toy affect natural systems after it is used? How?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

6. How would you design your toy so it uses fewer resources?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Instructions: Draw an input-output diagram like the one you just created with the class. You may use any of the information in this Manufacturing and Design Journal to help you.

Think about:

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ natural resources</td>
<td>■ changes to water, land, plants, or animals</td>
</tr>
<tr>
<td>■ raw materials</td>
<td>■ leftover materials, emissions</td>
</tr>
<tr>
<td>■ energy</td>
<td></td>
</tr>
<tr>
<td>■ money</td>
<td></td>
</tr>
</tbody>
</table>

Write the name of your toy in the circle on the next page.

For each input you can think of for your toy, draw an arrow pointing toward the circle. On the arrow, write what the input is. Show as many inputs as you can.

On the next page, make a diagram like the one below. Draw arrows pointing away from the circle for each output you can think of. On each arrow, write what the output is. Show as many outputs as you can.