LESSON SIX: Materials and Process: Plastics

IMAGE THIRTY-ONE: W. Grancel Fitz. American, 1894–1963. *Cellophane.* 1928 or 1929. Gelatin silver print, 9 3/16 x 7 9/16" (23.3 x 19.3 cm). John Parkinson III Fund

IMAGE THIRTY-TWO: Jonathan De Pas. Italian, 1932–1991. Donato D'Urbino. Italian, born 1935. Paolo Lomazzi. Italian, born 1936. Blow Inflatable Armchair. 1967. PVC plastic, inflated: 33 x 47 1/8 x 40 1/4" (83.8 x 119.7 x 102.9 cm). Manufactured by Zanotta SpA, Italy. Gift of the manufacturer

IMAGE THIRTY-THREE: Earl S. Tupper. American, 1907–1983. Tupper Corporation USA. Pitcher and Creamer. 1946. Polyethylene, .1 (pitcher): 6 1/2 x 6 5/8 x 4 3/4" (16.5 x 16.8 x 12.1 cm), .2 (creamer): 4 1/4 x 4 1/4 x 3 3/16" (10.8 x 10.8 x 8.1 cm). Gift of the manufacturer

IMAGE THIRTY-FOUR: Arthur Young. American, 1905–1995. Bell-47D1 Helicopter. 1945. Aluminum, steel, and acrylic plastic, 9' 2 3/4" x 7' 11" x 42' 8 3/4" (281.3 x 302 x 1271.9 cm). Manufactured by Bell Helicopter, Inc., Buffalo, N.Y. Marshall Cogan Purchase Fund

IMAGE THIRTY-FIVE: Panasonic. Japan, est. 1918. Toot-A-Loop Radio (model R-72). c. 1972. ABS plastic, h. 2 3/4" (7 cm), diam. 6" (15.2 cm). Manufactured by Panasonic Company, Secaucus, N.J. Gift of Anne Dixon

IMAGE THIRTY-SIX: Panasonic. Japan, est. 1918. Toot-A-Loop Radio (model R-72). c. 1972. ABS plastic, h. 2 3/4" (7 cm), diam. 6" (15.2 cm). Manufactured by Panasonic Company, Secaucus, N.J. Gift of Anne Dixon

IMAGE THIRTY-SEVEN: Apple Computer, Inc. USA, est. 1976. Apple Industrial Design Group. USA. Jonathan Ive. British, born 1967. iPod. 2001. Polycarbonate plastic and stainless steel, 4 x 2 1/2 x 7/8" (10.2 x 6.4 x 2.2 cm). Manufactured by Apple Computer, Inc., Cupertino, Calif. Gift of the manufacturer

INTRODUCTION

"Plastic" is a general term for a wide range of synthetic and naturally occurring polymers. The word is used to describe something that can be molded or re-formed. The term "polymer" is derived from a Greek word meaning "many"; most plastic objects incorporate materials with the prefix "poly," a short way of saying polymer. A polymer is a giant molecule, or macromolecule, that consists of many smaller, repeating chemical building blocks. Different building blocks create different kinds of plastic, each of which has its own unique properties and applications. It is a common misconception that all polymers are synthetic: Some polymers occur in nature (called biopolymers) and play a significant role in the life processes of plants and animals. For example, starches (polysaccharides) are important energy sources for plants and animals, and cellulose (a different type of polysaccharide) gives plants structure. The raw materials used to make polymers come from the earth (petroleum and coal, for example) or plant matter. They also come from old plastics, which is the basis for the plastics recycling industry.

LESSON OBJECTIVES

- **Students will learn about the development of plastics in the twentieth century.**
- **Students will learn different techniques for manufacturing and casting plastics.**
- **Students will learn about the different applications of plastics in industrial design.**
- **Student will learn new vocabulary, including "polymer," "plasticity," and plasticizers.**
- **Students will learn about the impact of plastics on modern life.**

INTRODUCTION

Polymer chemistry developed over the course of the nineteenth and twentieth centuries. The new materials that resulted, called plastics, can be combined and formed into films, fibers, and objects through chemical and mechanical processes such as extrusion, blow molding, and injection. The development of plastics made it possible to create lighter, more durable, and more affordable consumer products. Today's plastics are not only sturdy and resilient but, in some cases, beautiful. This lesson will explore the impact of plastics on modern design.

INTRODUCTORY DISCUSSION

Divide your class into teams of two to four students. Give each team five minutes to explore a specific area of the classroom, looking for objects and spaces made primarily of plastics. Have them keep track of their findings, providing brief descriptions of the object or space and what it is used for. Have your students come together to share their findings. Ask them to describe one or two of the objects they selected. What do they look like? What is their function? What is it like to touch them? Are they heavy or light? Do they feel hard or soft? Ask your students to consider what the objects would look like or how they would function if they were made out of another type of material, such as metal or wood.

IMAGE-BASED DISCUSSION

Show your students *Cellophane* (Image Thirty-one), by W. Grancel Fitz, but do not tell them what it is called. Ask them to describe what they see in the image, then share the title with your students. This is an image of a woman looking at a piece of cellophane. Cellophane is a thin transparent sheet of film made from a naturally occurring polymer called cellulose, found in trees and plants. A Swiss textile engineer invented cellophane in 1908. One of its

earliest uses was wrapping food. Whitman's Candies' boxes were wrapped in cellophane, and the company was one of the largest users of cellophane in the early twentieth century.

- **Ask your students why the Whitman's Candies company might have chosen cellophane to wrap their candy boxes instead of some other kind of wrapping material.**

Cellophane is made by converting cellulose fibers to cellulose xanthate. This viscous liquid is forced through a slit-shaped die (a device for forming material), after which it coagulates back into pure cellulose to produce a solid film. The resulting material is transparent and lightweight, yet strong, and can be used in many different applications. Another material derived from cellulose is viscose, or rayon. Rayon continues to be an important fiber in the textile and apparel industry. In 1924 the Dupont Company built the first cellophane manufacturing plant in the United States. Before that, manufacturers in the United States imported the material from Europe. Cellophane continues to be a significant food packaging material and is one hundred percent biodegradable.

Have your students read the labels in some of the garments they own to see if any of them contain rayon fiber.

- **Next show your students the Blow Inflatable Armchair (Image Thirty-two), by Jonathan De Pas, Donato D'Urbino, and Paolo Lomazzi, but do not tell them what it is called. Ask them to describe the way the object looks and have them guess what material it might be made of. Have them describe what it might be like to sit in a chair like this.**

The Blow Inflatable Armchair was designed in 1967. It is made out of polyvinylchloride, or PVC. Write this word on the board for your students. Do they recognize any part of the word? Next, draw a line between the letters y and v, and between l and c. This breaks the word into three parts: poly-vinyl-chloride. Vinyl is another type of plastic film.

- **Ask your students if they know of any other items made of vinyl.**

Vinyl can be found in furniture upholstery, plastic pipes, and music records. PVC is low cost, durable, and easy to manipulate. By itself, PVC is a hard inflexible material, but it can be softened by adding plasticizers. Plastic pipes and music records are made of unplasticized PVC. When it is in a softer, more **pliable** state, it can be used to form objects like the Blow Inflatable Armchair.

- **Ask your students whether this chair would feel hard or soft to touch. Have them support their assertions with information gathered during their object observation. Tell your students the title of this chair. Does this information help answer the question?**

This is an inflatable chair, which means that air pumped into the PVC skin gives it its form. Without the air, this chair would be like a large, empty balloon. In its deflated state, the vinyl of the chair feels soft and pliable. In a fully inflated state, it feels harder and stiffer.

Once again, have your students try to imagine what it would be like to sit in this chair. Would it be comfortable? Why, or why not? Why would someone need or want an inflatable chair? What are the advantages? Why would a designer choose this particular form and material for this object?

- **Next show your students the Tupperware Pitcher and Creamer (Image Thirty-three), by Earl S. Tupper and Tupper Corporation, but do not tell them what they are called. Have them describe what they see with particular attention to each object's shape, form, scale, color, and material. Give your students the dimension of each of the objects. Ask your students to consider what these objects might be used for.**

Tell your students that they are looking at a pitcher and creamer designed by Earl S. Tupper for the Tupper Corporation in 1946. These two objects are both made out of injection-molded polyethylene. Polyethylene (PE) is the simplest form of plastic. It is a thermoplastic, which means that, to form objects, the plastic is heated and melted then injected into a mold under high pressure. After the material has cooled, the mold is opened and the object is removed.

- **Explain this process to your students and ask them what factors might have to be considered when producing an object in this way. Is there anything about the way these objects look that tells the story of how they were made?**

Although injection molding seems simple, the construction of the tools and molds, the consistency and flow of the molten plastic, and the objects' cooling times must all be precisely handled to achieve the desired outcome. For example, temperature must be strictly controlled: If the plastic is injected into the mold at too high a temperature, it will decompose; and the object may warp when it is removed from the mold if it has cooled down too fast. Tupper was the first to bring this process to the design and manufacture of plastic household items such as food containers, mugs, and the pitcher and creamer featured in this lesson. Once he had designed their forms to his desired specifications, he developed a patented Tupper Seal (modeled after a paint can) for each container. Tupper Seals enabled users to tightly close the containers to preserve the freshness of the food inside. Tupper expanded on this design, and Tupperware semi-opaque, stackable food containers became synonymous with 1950s American lifestyle. Through his work, Tupper hoped to make "woman's life" easier.[20]

- **Ask your students to consider why Tupper felt that these new objects could make women's lives easier. What is it about the way the objects look or function that would make life easier?**

Tupperware is a light, efficient, affordable, and aesthetically pleasing way to store and preserve food and other household items. Prior to Tupperware, all food storage containers were made out of glass and could not be firmly sealed shut. The company is in business today with an expanded line of household products.

- **Ask your students to imagine what it would be like if these everyday objects were made of glass. Would life be more difficult? If so, why?**

Next show your students the Bell-47D1 Helicopter (Image Thirty-four), and draw their attention to the cockpit of the helicopter. Have your students describe this part of the helicopter. Ask your students to think about the types of activities that take place in the cockpit of a helicopter. What does a pilot need to be able to do to operate a helicopter properly and efficiently?

This helicopter was designed and produced in 1945. What set it apart from other helicopters of its time was the acrylic plastic blow-molded cockpit. Blow molding is a process by which hollow plastic parts are formed from a single sheet of polymer film. The film is heated above its softening point and then pressed against a mold by a blast of compressed air. Through this process, the cockpit shell of this helicopter was made from one piece of acrylic plastic

20. Earl S. Tupper, quoted in *Objects of Design*, 104.

rather than sections joined by metal seams. The result is a lighter shell with a more unified appearance. The Bell-47D1 Helicopter was used widely during the Korean War as an aerial ambulance. Like Tupperware, its design was revolutionary in its time.

- **Ask your students to think about objects they would consider revolutionary in current times. Have them cite specific examples of objects whose form or function makes them stand out from other objects that perform a similar function. What kinds of materials are used in the production of these objects?**

Organize your students into pairs. Assign one student to be the "drawer" and the other to be the "describer." Give pencils and paper to the drawers and give the describers the image of the Toot-A-Loop Radio (model R-72) (Image Thirty-five), by Panasonic. Then, ask the describers to explain what they see. The drawers should draw what they hear being described, without ever seeing the image, and the describers should limit their comments to descriptions of the image—they must not comment on the drawing that is being created. Various additional rules can be applied to this exercise. For instance, the drawer may be prohibited from asking the describer any questions, or the describer may not be allowed to see what the drawer is drawing. Decide which rules you want to apply, or take turns trying them all out. The activity works best when the drawers and describers switch roles. You can give describers the alternate view of the Toot-A-Loop Radio (Image Thirty-six) when your students switch roles. After ten minutes of describing and drawing, discuss the process with your students. What was the most challenging part of the exercise? Talk to your students about the ways individual perception and language play into this exercise.

- **Next show all your students both images of the Toot-A-Loop Radio (Images Thirty-five and Thirty-six). Have them compare what they see to the drawings they just made. Have your students describe the shape of these objects. What other forms are they reminded of?**

Tell your students that this object is the Toot-A-Loop Radio, designed by Panasonic around 1972. Explain to your students that the Toot-A-Loop Radio was designed to be worn as a bracelet. This particular radio is white, but the Toot-a-Loop was also manufactured in red, orange, and blue to give the user a variety of options. To tune the radio, users twist the loop open to form an S-shape, revealing the tuner inside.

- **Have your students look at both views of this radio and see if they can determine how the object functions (as both radio and bracelet) based on what they see.**

The Toot-A-Loop Radio was cast in acrylonitrile butadiene styrene (ABS) plastic. ABS is an acronym for the three distinct sub-units of the polymer, which, taken together, form a strong material that can be molded into many different forms while maintaining its strength and lightness. This kind of polymer incorporates the attributes of each sub-unit to form a polymer whose properties include the strengths of each individual material. Lego building blocks are made of ABS.

Next show your students the iPod (Image Thirty-seven) by Apple Computer, Inc., Apple Industrial Design Group, and Jonathan Ive. Have each student divide a piece of paper vertically to form two columns. Have them label the left column "Similarities" and the right column "Differences." Have your students list all of the similarities and differences they see between the Toot-A-Loop Radio and the iPod. Debrief by grouping your students' comparisons by category or type. Have your students consider which observations are objective and based on what is visually evident and which observations are subjective and based on what they already know about these objects.

The iPod shell is made out of polycarbonate plastic and stainless steel. Similar to ABS, polycarbonate, a transparent plastic, can be molded into a wide variety of forms. In addition, it can withstand high impact and temperature changes.

- **Ask your students why the designers chose this specific material for the iPod. Why not choose the same material as the designers of the Toot-A-Loop Radio? Ask your students to consider changes in technology between 1972, when the radio was released, and 2001, when the iPod debuted. Ask your students to envision what the iPod might look like in the year 2030. Will it still exist, or will there be a new object in its place?**

ACTIVITIES

Object Timeline

Create an object timeline by organizing the objects discussed in this lesson by the manufacturing date. As a group, discuss the objects based on the information you have generated in the lesson. Ask your students make connections based on materials, process, form, and function. What do the objects have in common aesthetically and functionally? Why did the designers make the choices that they did for each object?

Have your students consider the social, economic, and cultural factors that influenced the design of the objects. Do the objects tell us anything about aspects of society at the time that they were developed? If so, what?

Plastics and the Environment

Have your students work in teams to conduct online research into the environmental impact of plastics. What steps have been taken to mitigate the impact that the use of plastic has on our environment?