Plastic Entanglements: Ecology, Aesthetics, Materials

Educator's Guide

Pre-Visit Activities

Sea Grant
University of Wisconsin

Chazen Museum *of* Art

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About the Exhibition

Plastic Entanglements: Ecology, Aesthetics, Materials
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Pleasant T. Rowland Galleries
Chazen Museum of Art
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Madison, WI

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GUIDE NAVIGATION

INTRODUCTION TO PRE-VISIT ACTIVITIES

The activities below will introduce learners to the concepts explored throughout the exhibition. The lessons are organized in a similar fashion to the exhibit itself: beginning with plastic's past, examining the present situation and speculating about the future of plastic. Each lesson plan contains background information, activity descriptions and a section identifying items in the exhibit that directly relate to each activity. After your visit, the Educator Guide: Post-Visit Activities document provides engaging ways to reflect on and learn more about what you've learned before and during the museum visit.

ACTIVITIES

Plastic's Past

Interviewing for Historical Perspectives

Background - The History of Plastic

The word "plastic" originally meant "pliable" and easily shaped. Indeed, an important attribute of plastics, and the characteristic these compounds are named for, is their "plasticity" — or capacity to be shaped and molded. It is the chemical make-up and structure — long chains of atoms arranged in repeating units (more on this in a later section) — that make plastics strong, lightweight and flexible.

Long chains of atoms arranged in repeating units are called polymers, a word meaning "of many parts." Polymers are common in nature. Perhaps the most common natural polymer is cellulose, the material that makes up the cell walls of plants.

The First Synthetic Plastic: Celluloid

Natural polymers, such as cellulose, provided the initial raw materials for man-made plastics. This first synthetic polymer was called celluloid. It was invented in 1869 by John Wesley Hyatt. Hyatt was

> …inspired by a New York firm's offer of $10,000 for anyone who could provide a substitute for ivory. The growing popularity of billiards had put a strain on the supply of natural ivory, obtained through the slaughter of wild elephants. By treating cellulose, derived from cotton fiber, with camphor, Hyatt discovered a plastic that could be crafted into a variety of shapes and made to imitate natural substances like tortoiseshell, horn, linen, and ivory… Advertisements praised celluloid as the savior of the elephant and the tortoise.
> Science History Institute, 2019 [1]

Thus, the first plastic was created as the end result of trying to address an environmental/economic issue — the limited availability of ivory, horn and shell. As we shall see, the history of plastic, and perhaps the future of plastic as well, remain intertwined with balancing environmental and economic concerns.

Celluloid, in sheet form, "was first used by the sculptor Naum Gabo… In 1920 Gabo and his elder brother published *Realistic Manifesto*, which formally established the concept of abstract art dedicated to the modern age and its materials (such as plastics)" (Anderson).[2]

The First Fully Synthetic Plastic: Bakelite

Figure 1 Photo by Lesley Postle Decolish.com

In an effort to meet the needs of a rapidly electrifying United Sates, Leo Baekeland had been searching for a fully synthetic substitute for shellac (Science History Institute, 2019). [1] In 1907 he invented Bakelite. Bakelite was "not only a good insulator; it was also durable, heat resistant, and, unlike celluloid, ideally suited for mechanical mass production. Marketed as 'the material of a thousand uses,' Bakelite could be shaped or molded into almost anything, providing endless possibilities" (Science History Institute, 2019). [1]

Bakelite, and a new form of plastic called Catalin, which was brought into use around 1929 (and which had a beautiful range of new colors), were even made into crib toys (Postle, 2009).[3] Today these old crib toys are sometimes worn as jewelry.

Plastics Become Pervasive Through Research and Development

While celluloid and Bakelite were designed with specific properties in mind, new research and development programs by chemical companies "sought new plastics for their own sake and worried about finding uses for them later" (Science History Institute, 2019).[1] Additionally, during World War II, the need to preserve natural resources made synthetic alternatives highly desirable.

> "Nylon, invented by Wallace Carothers in 1935 as a synthetic silk, was used during the war for parachutes, ropes, body armor, helmet liners, and more. Plexiglas provided an alternative to glass for aircraft windows." (Science History Institute, 2019). [1]

A Harper's magazine article noted that because of the war, "plastics have been turned to new uses and the adaptability of plastics demonstrated all over again." [4] During World War II plastic production in the United States increased by 300%. (Science History Institute, 2019).[1] In 1953, Hermann Staudinger, a German organic chemist, received the Nobel Prize in Chemistry for his discoveries in the field of macromolecular chemistry. His pioneering research had enabled engineers to develop lighter and more durable structures, which ultimately made consumer products more affordable.

Plastic Recycling

Because plastics are so durable, managing this waste stream is challenging. In the 1980s the plastics industry led an influential drive to promote recycling “encouraging municipalities to collect and process recyclable materials as part of their waste-management systems” (Science History Institute, 2019).[1] In 1988, the Society of the Plastics Industry (now the Plastics Industry Association) developed resin codes. Resin codes make it easier to sort and separate differing types of plastic items so that they might be re-purposed. (NOAA, 2019). [5]

Common Types of Plastic

Resin Code	Name	Product Examples
1	Polyethylene Terephthalate **(PETE, PET)**	Plastic bottles, food jars, ovenable and microwavable food trays, textiles (polyester), monofilament, carpet, and films.
2	High-Density Polyethylene **(HDPE)**	Bottles (beverage, detergent, shampoo), bags, cereal box liners, extruded pipe, and wire and cable covering.
3	Polyvinyl Chloride **(PVC)**	Packaging (clamshells, shrink wrap), pipes, siding, window frames, fencing, flooring, and medical products (blood bags, tubing).
4	Low Density Polyethylene **(LDPE)**	Bags (produce, dry cleaning, newspaper, and garbage bags), squeeze bottles, container lids, shrink wrap, toys, coatings for milk cartons and beverage cups, and wire and cable coverings.
5	Polypropylene **(PP)**	Yogurt and other food containers, medicine bottles, straws, bottle caps, fibers, appliances, and carpeting.
6	Extruded and Expanded Polystyrene **(PS)**	CD cases, yogurt containers, cups, plates, bowls, cutlery, hinged takeout containers (clamshells), electronic housings, building insulation, coat hangers, medical products, packing peanuts and other packaging foam, foamed coolers, and egg cartons.
7	Other is a resin different than the six listed above, or made from a combination of resins.	Three- and five-gallon reusable water bottles, glasses (lenses), some citrus juice and ketchup bottles, oven-baking bags, and custom packaging.

Source: NOAA[7]

To be clear, just because a plastic item has a resin code does not mean it is recyclable in your community. Additionally, just because a plastic item does *not* have a resin code (for example, many bottle caps do not have a resin code number) doesn't mean the item is *not* recyclable in your area. So, while resin codes can be helpful when considering what to recycle, they often do not provide the complete picture. The best way to know what is recyclable in your community is to check with your local waste hauler or government entity. The city of Madison, Wisconsin, has the following list on its website.

PLASTIC RECYCLING

The following **rinsed clean and dry plastic items** can be placed in your green recycling cart:

• Bottles (caps/lids on)	• Jugs & jars (caps/lids on)	• Dairy & deli tubs
• Condiment bottles	• Shell packaging like what is around electronics or toys	• Berry containers & mushroom trays
• Frozen juice containers	• Other plastic boxes, containers, or bottles with necks that are #1 through #7 plastics	• Yogurt containers

SPECIAL INSTRUCTIONS:
- Cups

Only cups that are #1, #2, and #5 plastic can go into the cart. Be sure the cups are clean and dry before placing them into the cart.

- Plastic bags/film

Visit the plastic bag website to be sure you are bundling the correct type of bags the correct way.

You can also take them back to stores.

Plastic Items that Do Not Belong in the Recycling Cart:
- Microwave dinner plates & other food-stained plastic containers
- Food stained containers
- Hoses
- Bubble wrap
- Cling wrap or cellophane
- Motor oil bottles
- Styrofoam

Student Activity

Students interview someone older, such as a grandparent, about the respondent's memories of associations with plastic. Questions may include one or more of the following question sets. Feel free to mix and match questions from different groups, or create your own. Students provide a written or oral report summarizing the responses. For an extension activity, have students answer the same questions they chose to ask.

Question Set

Provide the questions below to students, who should use them in their interviews. The answers to these questions will then lead a discussion of how the answers fit into the historical context of plastic, described below in the background section.

1. Can you think of a time you used a plastic item rather than a similar item made of a different material?
   a. Why did you choose to use the plastic item?
   b. Did using the plastic item work out the way you thought it would?
2. Can you describe any toys that you had that were made of plastic?
   a. What qualities of the plastic toy made it better or worse than your other toys?
   b. When you were young, if you had to give up all your toys that were made of plastic, would you have had any toys left?
3. Do you think you produce more or less trash per week now than what you did when you were a child?
4. Please help me fill out this chart:
   a. When you were younger, what type(s) of container(s) did these items come in?
   b. Were you able to return some of the containers for a refill or to get a deposit back?

Sample response for question 4

	Past (someone born in 1965)	**Present** (someone born in 2010)
Milk	Glass bottle, typically a deposit on it	Paper carton, plastic jug, plastic bag
Shampoo	Glass bottle, plastic bottle	Plastic bottle
Sandwich	Wax paper bag	Plastic bag, paper wrapper
Bread	Paper bag, plastic bag	Paper bag, plastic bag
Soda pop	Metal can, glass bottle, some states had a deposit	Metal can, plastic bottle, some states have a deposit
Vegetables	Nothing, can, glass jar, cardboard box (frozen)	Nothing, can, glass jar, cardboard box (frozen), plastic bag
Soap	Nothing, paper	Paper, plastic bag, plastic bottle

What to View When You Visit

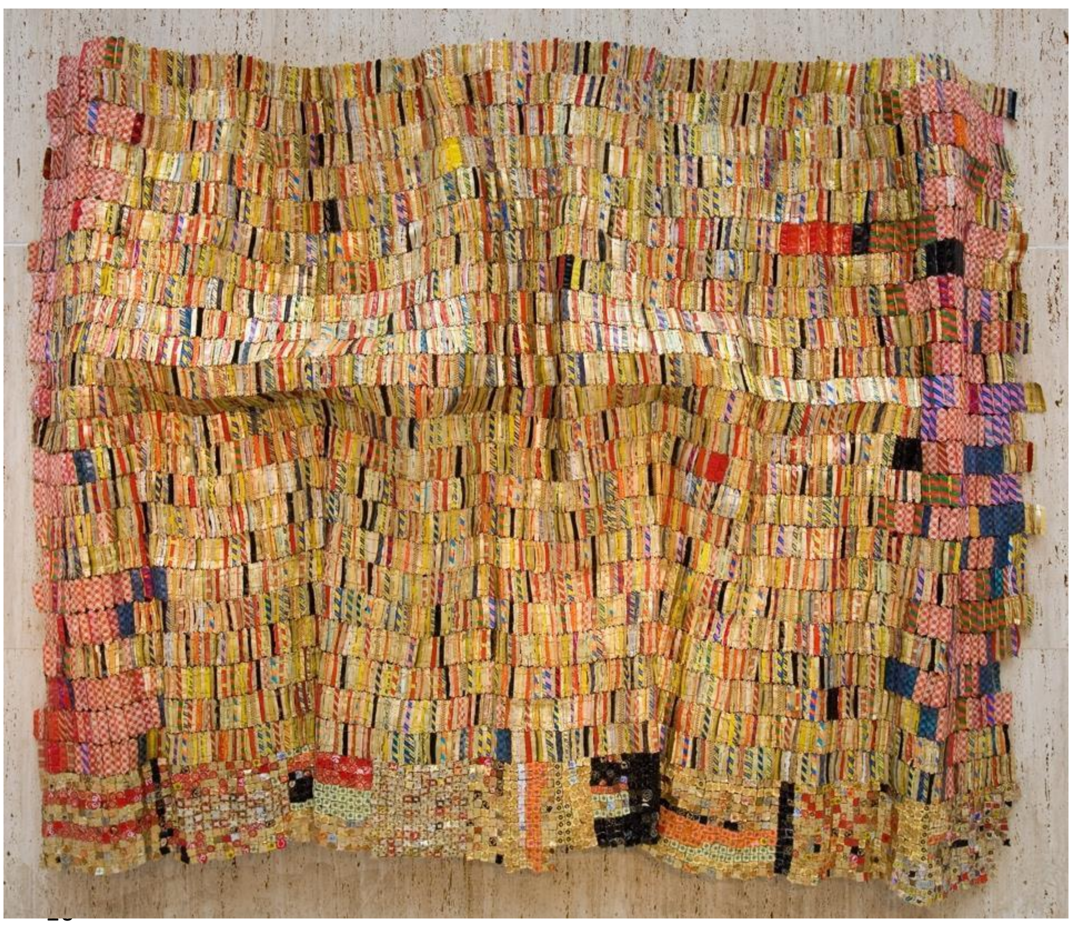
Plastics are all around us! When you visit the Chazen Museum, keep track of the artworks you view that contain some plastic. Observe what other materials the artwork is made from. Do you think the artist purchased the material or used materials that were discarded? Why do you think they chose the materials?

The Chazen Museum displays Gabo's *Construction in Space: Arch*, 1929-1937. It is on view in Gallery IX. While made of plexiglass, rather than celluloid, the work provides an early example of art produced from plastic materials.

Naum Gabo (American, b. Russia 1890-1977). *Construction in Space: Arch*, 1929-1937. Rhodoid with Perspex substitutions and base. 1997.75.
On View: Gallery IX

Honey Bee and Danu (below) are great examples of artwork created using discarded pieces of plastic, metal and other materials. Also check out a photograph of a famous mosaic artwork by Vik Muniz (below). A mosaic is a picture or pattern that is made by carefully arranging small pieces of material. The material might be stone, tile, glass or even plastic.

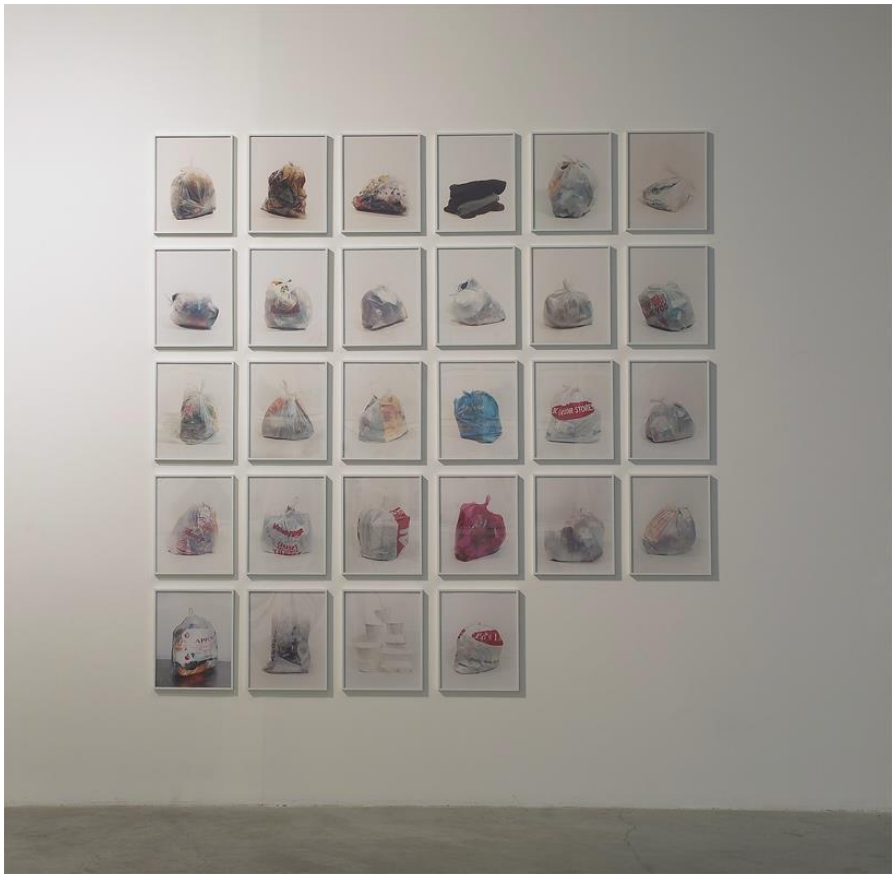
Judy Pfaff (American, b. England 1946). *Honey Bee, for Holly Solomon*, 1987. Mixed media, 2001.46. On View: Gallery XIII



El Anatsui (Ghanaian, active in Nigeria, b. 1944). *Danu*, 8662. Aluminum, copper wire, 2006.35. On View: Gallery XVII

Vik Muniz
American, b.
Brazil, b. 1961
Sarah Bernhardt
from *Rebus*, 2010
Digital C-print
84 x 71 inches
Purchased with
funds provided
by the Friends of
the Palmer
Museum of Art
2011.25

Lastly, explore the ways that the art included in *Plastic Entanglements* is working to remind us that plastic never really goes away, even after it is thrown out. For example, over a series of five years, artist Kelley Wood photographed her garbage.



Kelly Wood
Canadian, b. 1962
Year Five: March 15, 2002–March 14, 2003 from *The Continuous Garbage Project, 1998–2003*, 2002–03
28 framed color photographs
20 x 16 inches each
Courtesy of the artist

While plastics do take a long time to decompose, the Chazen Museum does have a sculpture that is experiencing reversion.

Claes Oldenburg (American, b. Sweden 1929). *Soft Screw*, 1975. Polyurethane, wood, paint. 2012.54.44.6. On View: Object Study Room

Object description from Chazen Museum:
This sculpture is number twelve in an edition of twenty-four sculptures that were made by Gemini G.E.L. in collaboration with Claes Oldenburg between 1974 and 1976. It was made with elastomeric polyurethane that was cast in a mold in 1975. After over twenty-five years, this sculpture began showing signs of reversion, or the conversion of solid polyurethane into a viscous liquid state. That is what you see happening at the tip of the sculpture. Reversion is an irreversible process that occurs in response to environmental conditions and continues in the areas that come into contact with the liquefied form.

Plastic's Present

Plastic in My Life – An Inventory

Background - Plastic's Present

The uses for plastics exploded and changed the way we live. Indeed, as we look around, it is hard to imagine a world without plastics. According to author Susan Freinkel (2011), "In product after product, market after market, plastics challenged traditional materials and won, taking the place of steel in cars, paper and glass in packaging, and wood in furniture." [5]

> "The possibilities of plastics gave some observers an almost utopian vision of a future with abundant material wealth thanks to an inexpensive, safe, sanitary substance that could be shaped by humans to their every whim (Science History Institute, 2019)." [1]

Today, plastics package our food, provide lightweight durable containers for shipping and storing, constitute many of the sterile implements used in medical practice and are a part of our daily lives in so many ways. "Replacing natural materials with plastic has made many of our possessions cheaper, lighter, safer, and stronger" (Science History Institute, 2019). [1]

Did you know that in 2009 Americans purchased about 50 billion water bottles per year, equivalent to about 1,500 bottles per second, averaging about 13 bottles per month for every person in the U.S?! (AIGA, 2009).[6] That means "by using a reusable water bottle, you could save an average of 156 plastic bottles annually" (AIGA, 2009). [6]

Student Activity

One way to look at plastic's present is to take a look at plastic in our own lives. Ask students to collect as many plastic products they come into contact with during a specified period of time (for example, the time between when they wake up and when they arrive at school). The goal is to demonstrate how ubiquitous plastic is and how much we depend on the many different types of plastic. A possible classroom connect would be to use the collected plastic pieces and create an art sculpture. One way to do that would be to hang a hula hoop in the classroom and string the plastic objects from it, creating a chandelier, in the style of the Willie Cole piece (on the next page) as seen in the Chazen's entry.

A second way to look at the plastic in our lives is to list out the places students see plastic in their environment (whether in their classroom, at home or on the playground). Be sure to look closely: plastic can be hiding in plain sight.

<u>What to View When You Visit</u>

Artwork often consists of recurring patterns. When you visit the Chazen, notice the patterns that are everywhere. From the floor tiles, to the wall paneling, to the chandelier on the ceiling, people have used repeating materials to make the buildings in which we live, work and play.

While visiting the Chazen, view American artist Willie Cole's shimmering Chandelier (2015), composed entirely of plastic water bottles. It demonstrates the translucency of this enticing modern material.

Willie Cole
American, b. 1955
Chandelier, 2015
Plastic bottles and
metal armature
Diameter: 72 inches;
Length: 96 inches
Courtesy of the artist

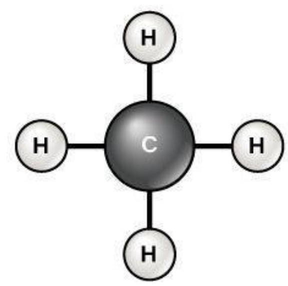
Different Types of Plastic

Background - The chemistry of plastic

The word "plastic" is used to describe a category of materials made up of polymers. The capacity to be shaped and molded is a characteristic of the chemistry of plastics. The actual properties of the various plastics differ widely. Some, like ketchup and shampoo bottles, are "squeezable." Others, like food wrap, are thin and somewhat stretchable. Still other plastics, like plumbing pipes, are fairly rigid and strong. What makes these diverse materials the same — all plastics — yet so different in their physical properties? The answer is the chemistry of the materials.

Most plastics are made by humans. The raw material to produce plastics is typically oil. Natural gas and coal, and less commonly corn and other natural products, are also used. The chemistry of plastics has two atoms at its core: carbon and hydrogen atoms.

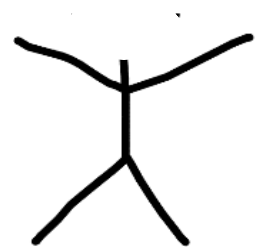
Methane



The carbon atom can link to other atoms with up to four chemical bonds. The simplest carbon molecule (a molecule has two or more different types of atoms) is methane. To create the methane molecule (figure on the right), a carbon atom is linked to four hydrogen atoms.

A jack (figure to the left) has a similar structural shape to a methane molecule. Imagine a hydrogen atom located at each sphere at four ends of the jack. The carbon is represented by the central axis of the jack (the one without the spheres on the ends).

Another somewhat analogous structure to a methane molecule is a headless stick figure (right). Imagine the figure's body as the carbon atom, two hands as hydrogen atoms and two feet as the remaining two hydrogen atoms.



Plastics are created from building blocks called monomers that are joined together to form polymers (more on this later). Each of the monomer building blocks has a distinct pattern of how the carbon and hydrogen atoms are arranged when forming the molecule. Methane is one type of monomer. Any of the hydrogen atoms within the methane molecule can be replaced. Within plastics, replacement atoms typically include carbon, oxygen, nitrogen, chlorine and sulfur. When another carbon atom replaces two hydrogen atoms, the second carbon atom covalently bonds to the first carbon atom to from a double bond.

Student Activity

Variation 1: Students take on the roles of various atoms (carbon, hydrogen, chlorine) as they build various monomers and polymers of plastic.

Variation 2: Students conduct a variety of tests to determine the physical and chemical properties of plastics.

Variation 1

Objective: Students learn that plastics are made of different chemical structures that typically contain carbon and hydrogen atoms.

Materials needed: Eight 4-inch diameter circles labeled "C" for carbon. Twenty 2-inch diameter circles labeled "H" for hydrogen. Two 3-inch diameter circles labeled "Cl" for chlorine. Production template cards for each type of monomer to be built. (For the production cards, see page 20.) Plastic items made from different types of polymers (see resin chart on page 7 or individual production cards for guidance).

Space requirements: This activity requires sufficient space for students to physically position themselves into the monomer configurations and then ideally link together to form polymers.

Note: Depending on grade level and time available, it may be appropriate to be selective regarding which monomers and polymers students are introduced to through this activity.

Steps for activity

1. Distribute five carbon circles and 20 hydrogen circles to students within the class. Display the methane production card to the class. Allow the students time to think critically and then have students stand and physically arrange themselves to form five molecules of methane. Read the back of the methane production card aloud.
   Tip: If the students need a hint as to how to arrange themselves, the easiest way to represent a methane molecule is for the student representing the carbon atom to extend his/her arms and legs away from their body core and have the students representing hydrogen atoms position themselves at each of "carbon's" hands and feet.

2. Display the ethene (ethylene) production card to the class. Have two methane molecules combine to form ethene. Allow the students time to think critically and then have students stand and physically arrange themselves to form the ethene molecules.
   Tip: If students need a hint, point out that the carbon atoms come together to form a double bond.
   Have the students representing carbon position one of each of their hands and one of each of their feet next to that of the other carbon atom. In order to do this, four hydrogen atoms (two from each carbon) need to get out of the way. The molecule is left with just four hydrogen atoms (two for each carbon-one at a hand and one at a foot position.)

   Note that because five methane molecules were built in step one—you will have an "extra" methane molecule that doesn't have another methane to pair up with. Not to worry, they'll join in step four!

3. Display the vinyl chloride production card to the class. Allow time for critical thinking.
   Tip: Result should be to have the previously formed ethene molecules (from step 2) remove a hydrogen atom and replace it with a chlorine atom to form two vinyl chloride molecules.

4. Display the propene production card to the class. Allow time for critical thinking.
   Tip: Result should be to have the previously formed vinyl chloride molecules (from step 3) remove a chlorine atom and replace it with the methane molecule (from step one and you'll need to create one more methyl group) to form two propene molecules.

5. Display the butene production card to the class. Allow time for critical thinking.
   Tip: Each of the propene molecules (step 4) will need to remove a hydrogen atom and replace it with one more methyl group. Depending on where the methyl groups are positioned (two feet, two hands or one foot and one hand) the butene will either be cis-butene or trans-butene.
   Tip: The "trans" molecule is the one with the methyl group locations diagonally across from each other. Think of "transportation," a trip across a distance.

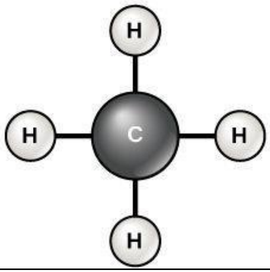
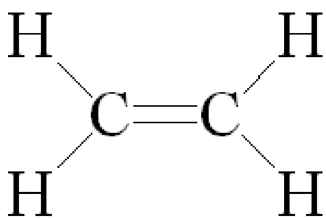
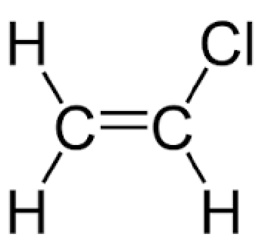
6. Display the benzene production card to the class. Allow time for critical thinking.
   Tip: If students need a hint, point out that producing this molecule will require students to move from a linear format used for the previous molecules, to a hexagonal structure. It will also require six carbon atoms and six hydrogen atoms per benzene molecule, so it may be necessary for some students to trade the type of molecule they were previously representing for a new molecule (e.g., carbon instead of hydrogen).

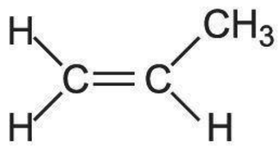
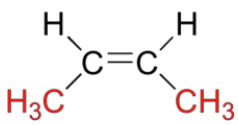
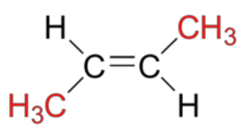
7. Display the styrene production card to the class. Allow time for critical thinking.
   Tip: if students need a hint, point out that styrene is similar in structure to ethene but instead of having four atoms of hydrogen attached, there are three atoms of hydrogen and a benzene molecule.

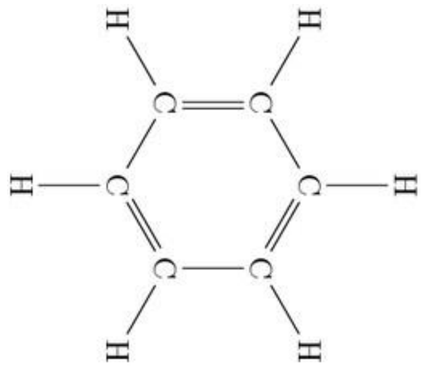
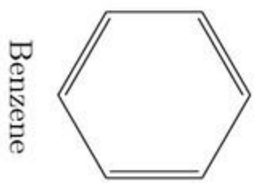
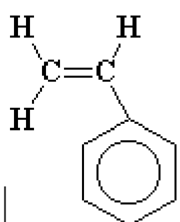
8. Point out that if multiple monomers of the same type are linked together, then a polymer is formed. Many times, the polymer has the name poly_____________. For example, if ethylene (ethene) molecules are linked together to form a polymer we call the resulting plastic polyethylene. If multiple vinyl chloride molecules are linked together to form a polymer we call the resulting plastic polyvinylchloride. If multiple propylene (propene) molecules are linked together to form a polymer we call the resulting plastic polypropylene. What do they think multiple styrene molecules that are linked together to form a polymer called? Yes! Polystyrene!

9. Display the common types of plastic image (page 7). Keep this image displayed while step 10 is completed

10. Read the back of each production card one-by-one. As each card is read an example product made from that particular polymer can be shown.

Front of Production Card	**Back of Production Card**
Methane 	*Methane* The simplest carbon molecule (a molecule has two or more different types of atoms) is methane. To create the methane molecule, a carbon atom is linked to four hydrogen atoms.
Ethene (Ethylene) 	*Ethene* The simplest monomer, or building block of plastics, is ethene (also called ethylene). The chemical formula for ethylene is C_2H_4. Ethylene is the building block for three different types of plastics. The first type, polyethylene terephthalate (PETE or PET for short) is used to produce plastic bottles, food jars, microwaveable food trays, textiles (polyester), monofilament and carpet, among other products. The second type of plastic for which ethylene is the building block is high-density polyethylene (HDPE). This type of plastic is used to produce bottles (beverage, detergent, shampoo), bags, cereal box liners, and wire and cable covering, among other products. The third type of plastic for which ethylene is the building block is low-density polyethylene (LDPE). This type of plastic is used to produce bags (produce, dry cleaning and garbage), squeeze bottles, container lids, shrink wrap, toys, coatings for milk cartons and beverage cups and wire and cable coverings, among other products.
Vinyl Chloride 	*Vinyl chloride* If one of the hydrogen atoms from an ethene molecule is replaced with chlorine, then the molecule is called a vinyl chloride. The chemical formula for this is C_2H_3Cl. If many vinyl chloride molecules are linked together, the resulting plastic is called a polyvinyl chloride (PVC). This type of plastic is used to produce packaging, pipes, siding, window frames, fencing, flooring and medical products such as the bags and tubing used for intravenous therapy (IV).

Propene  	*Propene* If one of the hydrogen atoms from the original ethylene molecule is replaced with a methyl group, then a new molecule, another monomer, called propene (propylene) is created. The chemical formula for propylene is C_3H_6. If many propene (propylene) molecules are linked together, the resulting plastic is called polypropylene (PP). This type of plastic is used to produce yogurt and other food containers, medicine bottles, straws and more.
Butene  *cis*-2-butene  *trans*-2-butene	*Butene* A third type of monomer, in which yet another hydrogen atom is replaced with another methyl group, is butene. The chemical formula for butene is C_4H_8. Whether the replaced hydrogen atoms are on the same side of the molecule (cis-2-butene), or opposite sides of the molecule (trans-2-butene), determines the structure and alters the chemical properties such that the carbon atoms can subsequently react to form polymers. It is possible to form polybutene, but more commonly butene is combined with other monomers (such as ethylene) to form specialized plastic resins such as hot-melt adhesives.

Benzene   	*Benzene* If two propene molecules are put together, and the extra hydrogen atoms are removed so that once again double bonds between the carbon atoms can form, then a molecule called benzene is made. The formula for benzene is C_6H_6. Note that instead of the carbon and hydrogen forming a long chain (as in polypropylene), a benzene molecule takes on a hexagon structure. Benzene is not only used to produce plastics, but it is also found in detergents, drugs and pesticides. Besides synthetically produced benzene, benzene can be produced naturally by volcanoes and forest fires.
Styrene 	*Styrene* A fourth type of monomer is styrene. In styrene the original hydrogen group from an ethylene molecule is replaced with a molecule of benzene. The chemical formula for styrene is C_8H_8 or $C_6H_5CHCH_2$ Styrene when linked together forms polystyrene (PS). Polystyrene is found in two forms: extruded and expanded. These materials are used to produce CD cases, plates, bowls, building insulation, coat hangers, medical products, packing peanuts and egg cartons among other products.

Variation 2
5 Gyres, a non-profit organization that focuses on reducing plastics pollution by focusing on primary research, has an *Identifying Plastics* lesson for older students.

What to View When You Visit
Be sure to view a piece of artwork that can remind you of the monomers that serve as the building blocks of plastic. This artwork is Black Jack (2006) located in Gallery XVII. This piece of art combines two materials (metal and plastic) in one piece of sculpture. The tip of the piece is carbon fiber (or plastic).

Inigo Manglano-Ovalle (American, b. Spain 1961). *Black Jack*, 2006. Carbon fiber and aluminum. 2009.4a-f On view: Gallery XVII

Plastic's Future

Concerns on the Horizon: Marine Debris

Background on Marine Debris
Marine debris is any man-made object discarded, disposed of, or abandoned that enters the coastal or marine environment. According to Victoria Gill,[8] possibly the first marine plastic litter found was collected via a metal sampling device known as a continuous plankton recorder (CPR). Since then, researchers and citizens alike have worked hard to understand the quantity and types of solid waste found within water bodies and other environments, but there is still much work to be done.
News outlets today continue to broadcast stories about the problem of plastic waste in the oceans. The "Great Pacific Garbage Patch" is a common phrase. The concept of a garbage patch implies a floating island of plastic trash. This is a misconception. It's true that there are places where higher concentrations of litter are found, but wind and wave action also disperse the litter throughout the water column. Additionally, much of the debris is actually small pieces of floating plastic that are not immediately evident to the naked eye. Thus, "it is possible to sail through 'garbage patch' areas in the Pacific and see very little or no debris on the water's surface" (NOAA, 2018). [9]

Marine debris is also a problem in the Great Lakes. It is also a potential problem for the waterways around Wisconsin, Dane County and all our backyards.

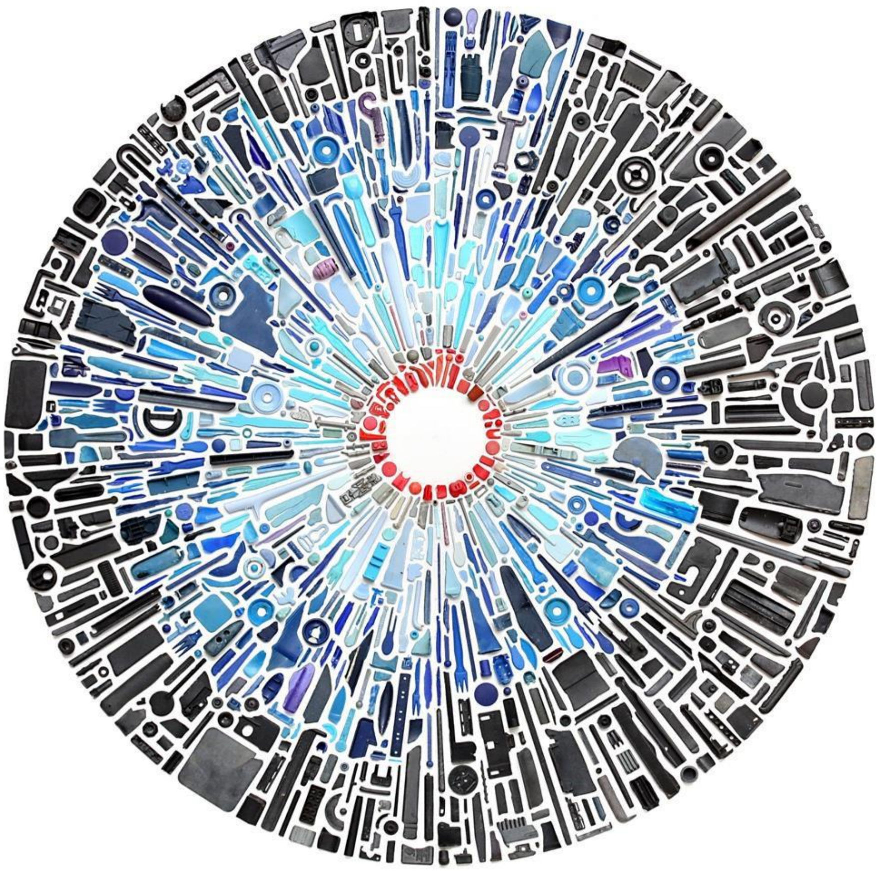
Two potential impacts of marine debris on aquatic life are ingestion and entanglement. If an organism ingests plastic, it passes through, or even remains within, the gut of the organism. Typically, the plastic is in the same form that it entered the body—unlike food the digestive processes do not break it down. "Plastic has been found in animals ranging from whales, fish, sea turtles, tiny crustaceans, birds, and even shellfish, for a total of about 700 species" (Smithsonian Ocean Portal Team, 2018).[10]

Researchers are actively examining the physical and chemical effects of ingesting plastics on organisms and how those chemicals may travel through the food web. It is unclear how humanity will be affected, but we know that we too are consuming plastic. Besides being ingested, organisms can become entangled in marine debris. "Ghost" nets — fishing lines that are no longer being tended by people but just floating on their own – are a significant problem. Not only can wildlife become entangled, but so can other boaters!

Student Activity
There are numerous activities designed to teach about marine debris. The National Oceanographic and Atmospheric Association's Marine Debris Toolkit for Educators has an extensive list of activities, videos and supporting websites that is included in the post-visit educator's guide. From 5 Gyres, Plastic Pollution: It Can Be Deadly is a lesson on the deadly impacts of plastic on wildlife (for younger students). Plastics in the Water Column from the Monterey Aquarium illustrates where can you find plastic in the water column and how might it affect the animals that live there (for older students).

What to View When You Visit

The *Plastic Entanglements* exhibit displays a piece by British artist Steve McPherson. He has gathered plastic objects from the southern coast of Britain for more than two decades. "With its radial composition, *Wavelengths* (2012–13) speaks to the presence of circulating gyres of plastic trash in the world's five major oceans. According to McPherson, the distribution and gradated color spectrum of the assembled fragments chart the oceanic water column, now infiltrated with marine debris, from the sunlit surface to its impenetrable depths" (Plastic Entanglements Gallery Brochure, 2019).



Steve McPherson
British, b. 1972
Wavelengths, 2012–13
Unaltered marine
plastic objects found
on the UK coast
40 x 40 inches
Courtesy of Victori +
Mo Gallery

Canadian artist Kelly Jazvac collected a new type of stone consisting of a mix of plastic debris and beach sediment. These new stones, gathered from Kamilo Beach in Hawai'i, were inadvertently created by visitors through the heat of campfires. “The presence of these hybrid stones made of melted plastic and natural materials is a testament to the inordinate amount of plastic washing ashore from the Pacific garbage patches or gyres” (Plastic Entanglements Gallery Brochure, 2019).

Kelly Jazvac
Canadian, b. 1980
Plastiglomerate Sample [K1], 2013
Readymade objects (new hybrid stone made of melted plastic and natural materials)
7-1/8 x 7-1/8 x 3-3/4 inches
Courtesy of the artist

The Plastic Entanglements exhibit also features several photographs by Chris Jordan of Laysan Albatross found on Midway Island. These birds ingested plastic items that they were unable to digest. Additionally, Chris Jordan produced a video entitled *Camel Gastrolith* (2016) that illustrates the compacted contents of one camel's stomach, including more than 500 plastic bags. The image below is from that video.

Chris Jordan
American, b. 1963
Camel Gastrolith, 2016
Video projection with sound, 03:29 minutes
Dimensions variable
Courtesy of the artist

Concerns on the Horizon: Microplastics

Background - Microplastics

Although it takes years for plastic to degrade, plastics do break apart into smaller and smaller pieces, called "microplastics" (plastics < 5mm in size). There are three main types of microplastics. The first is called a "nurdle." Nurdles are resin pellets used to manufacture plastic items or as filler in soft products such as stuffed animals and pillows. Another type of microplastic is "microbeads." Microbeads have been added to personal care items (e.g., shampoo, soap, makeup) to serve as exfoliants and also to provide color/shine to the product. The third type of microplastic is called a "microfiber." Microfibers may enter the water from washing clothing made of synthetic materials, like polyester or nylon.

All over the world, scientists are investigating where microplastics are found and hypothesizing on how they got there.

Research is ongoing on microplastics – the plastic pollution that is the most prevalent in the fresh water systems in the upper Great Lakes. Research on the impacts of microplastics on wildlife and human health is a current area of focus. And regulation of microplastics is already in place. One microplastic – microbeads – has already been banned in personal care products in Wisconsin.

Background activity

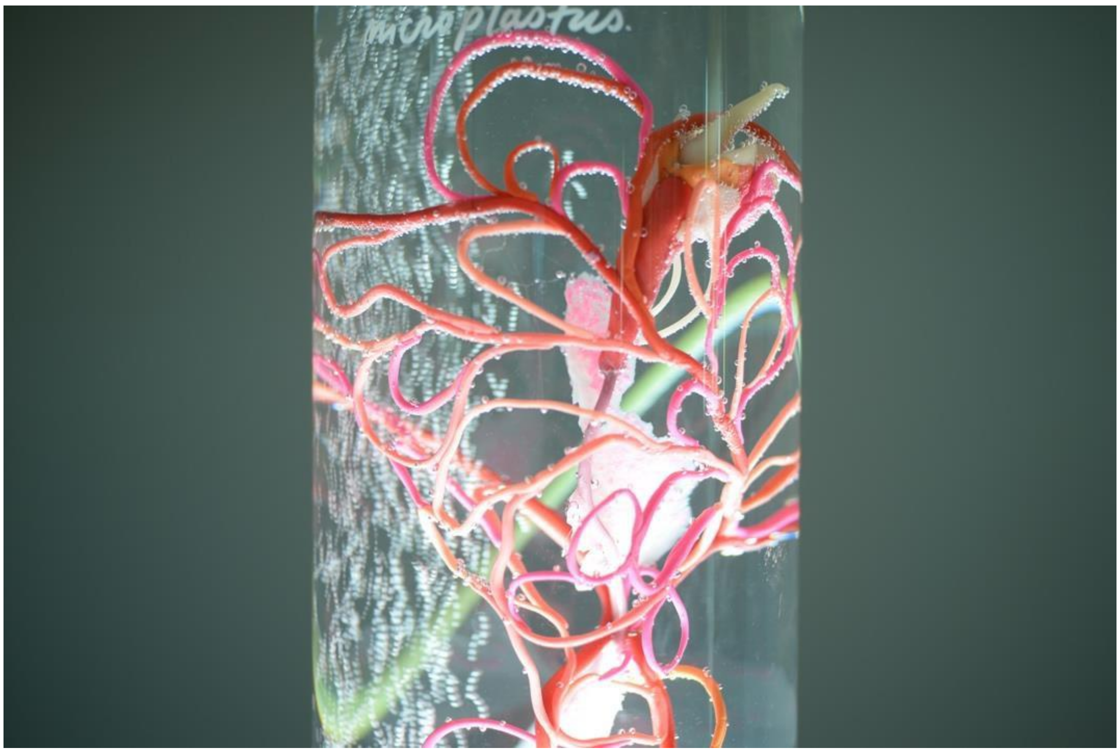
Students complete the Going with the Flow activity from Eastern Michigan University and University Corporation for Atmospheric Research (2008).[11] In this activity, students use a simple model to discover that air moving over water causes the surface of the water to move horizontally. Through writing and discussion, students relate this concept to surface currents in the ocean and the Great Lakes and the capacity for objects found within various levels of the water column to move from one location to another.

What to View When You Visit

"American artist Pamela Longobardi provides a figurative timeline of the accelerating rate of global plastic production and consumption in *Economies of Scale* (2013). Nearly twenty feet long, this sculpture draws the eye from a tiny *nurdle* (a preproduction plastic pellet) to a large fishing buoy (identified as Japanese tsunami drift) at the opposite end. …In some cases, the effect of long-term exposure to the elements disrupts our ability to identify the original plastic object. The beguiling shadows created by the installation also remind us that our dependence on ecologically unfriendly products and materials will cast a shadow on Earth long after we are gone." (Plastic Entanglements Gallery Brochure, 2019).

Pamela Longobardi
American, b. 1958
Economies of Scale, 2013
Microplastic, plastic, hydrocarbons and steel
24 x 208 x 30 inches
Courtesy of the artist and Hathaway Contemporary

In her ongoing project *Ecosystem of Excess (Organs for Sensing and Metabolizing Plastics)*, Turkish artist Pinar Yoldas poses a critical question: what kinds of creatures will evolve out of our oceans, where there are now, in some parts, six times more plastic than plankton? Drawing upon our current knowledge of biological systems and the kinds of chemicals and toxins found in plastic, Yoldas asks the viewer not simply to despair at our current state, but to imagine wild and prolific futures uniquely adapted to these petrochemical environments. Her intriguing "plasticeptors" suggest that evolution will continue and creatures will adapt to take advantage of the energy stored within plastics, even as they draw our attention to this overwhelming environmental problem (Plastic Entanglements Gallery Brochure, 2019)..



Pinar Yoldas
Turkish, b. 1979
Ecosystem of Excess (Organs for Sensing and Metabolizing Plastics): p-plasticeptor,2014/2017
Plastic clay, glass
40 x 6 x 6 inches
Courtesy of the artist

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