SURFACE AREA AND VOLUME OF PRISMS, pyramids, and cylinders are challenging topics for middle school students. For the past five or six years, at the end of a unit covering these topics, I have reinforced this material by doing a project that involves the construction of a “creature” by each student. The creature had to be made out of a pyramid and a prism. Later, I added a cylinder as another choice to use in making the project. I provide the students with materials (see fig. 1), a scoring rubric, and class time to work on the project.

Unleashing Students’ Creativity

THE FIRST TWO YEARS THAT I DID THIS PROJECT, I held a contest in which staff in the building voted for the best creature in various categories, such as prettiest, scariest, most original, weirdest, and so on. One of the funniest designs I remember from that time was “Super-Cockroach,” an insect-like creature whose body and head were made of triangular prisms. The addition of a black cape made of felt, antennae and appendages made of pipe cleaners, movable plastic eyes, and coloring done with markers completed the design.

The project is still evolving, and I make changes every year. For example, this year, students were told

Materials List

If you do not have the money for supplies in your budget, consider applying for a grant to get enough materials to do the project for two years in a row. The art teacher may be helpful in finding a catalog with the kinds of materials you need.

Required:
- lightweight cardboard (large white pieces and smaller card stock in a variety of colors)
- markers
- tape (Buying inexpensive dispensers and tape rolls is more cost-effective over time because the dispensers are reusable.)
- glue sticks
- plastic eyes
- scissors, calculators, rulers, protractors, compasses

Optional:
- pipe cleaners
- feathers
- fabric scraps, yarn

Note on feathers: Students tend to use feathers whether or not they make sense in their design. Discuss this with them ahead of time. Sometimes the feathers take away from the design. Encourage them to use markers and paper to enhance their project.

Fig. 1  Materials for the Candy Box Project
that as artists for a graphic design firm, they had to submit ideas for candy containers (which replaced the creatures) that would appeal to children (see fig. 2). Students had to make three-dimensional candy containers, prepare detail sheets for the construction of the solids used in their designs, and write business letters explaining why their designs should be selected. They were given a rubric (see fig. 3) outlining how each part of the project would be scored.

Students had their choice of using two out of three kinds of solids—cylinders, pyramids, or prisms—in their designs. For example, a student could use a cylinder and a pyramid, a prism and a cylinder, or a pyramid and a prism. Students could use many three-dimensional cylinders, pyramids, or prisms to make the containers and add any design elements they chose, but they had to fill in only two detail sheets (see figs. 4, 5, and 6).

The detail sheets required students to measure the dimensions of the pyramid, cylinder, or prism and determine the surface area and volume. For the pyramids and prisms, they also had to determine the number of edges, faces, and vertexes. We had worked on finding surface area and volume in the unit preceding the project, but this assignment required students to apply what they had learned. For example, the cylinder detail sheet required that students measure or compute the radius, diameter, circumference, and area of the base and record their
findings. They also had to find the height of the side, the volume, and the surface area of the cylinder.

Students could use centimeters or inches to measure the dimensions of the solids and compute the surface area and volume. Work on the project reinforced measuring skills. The previous year, a student had made a teddy bear using octagonal prisms for the head and body and small pyramids for the ears. Inspired by that project, many students used more complicated hexagonal, pentagonal, and octagonal prisms than other students had used in previous years. To make the regular polygons for the bases, students had to determine and carefully construct the interior angle measurements.

For the business letter, I asked the language arts teacher to review persuasive letters and the format for business letters with the students before we began the project. The time spent on this part of the assignment in English class saved mathematics class time. Also, the assignment reinforced instruction in the English classroom by giving the students an opportunity to practice skills taught there.

Assessing Students’ Abilities and Managing the Activity

STUDENTS COULD GET HELP FROM ME AS needed in any part of the project. Some students did well on the creative activities but needed help on the detail sheets. Others needed help in determining how to create more difficult prisms, such as an octagonal prism. One student even created an octagonal pyramid for the top of her design, a circus tent. The project helped reinforce vocabulary, measuring skills, spatial visualization, and mathematical communication. As the teacher, I could informally assess how well students had learned to find the surface area and volume of various solids and provide remediation to individual students during class time.

The project offers interesting insights into abilities that some students have that are not always apparent in less creative activities. One student showed me a complicated design of a lizard-dragon
creature. I could not imagine how he could possibly build it. He worked on it steadily and held true to his vision, and the result was awesome! Another student, who often struggled with mathematics, quickly created her candy-box design in less than one class period. She was artistically talented and demonstrated great spatial visualization. A few students labored for days on the simplest of designs.

Of course, having an entire class working with a variety of materials, including tape, glue, lightweight cardboard, scissors, calculators, feathers, pipe cleaners, plastic eyes, and so on, requires good classroom management procedures and patience from the teacher. One student made a huge rectangular-prism flag with a thin cylinder for the flagpole. She started and stopped on a few versions. I thought that her project was too large. She decorted the flag with red, white, and blue feathers, which often found their way to the floor. When the flag was finished, however, it was impressive, especially in the display case.

I believe that teachers should allow some flexibility in the project. For example, I had two students this year who created backgrounds for their designs. One girl's design was a stop sign made of an octagonal prism and a cylinder. The girl also made a backdrop showing a road and a tree and attached the stop sign to it. Another student, who may have been inspired by the first project with a backdrop, made a sick cow and placed it next to a road in a pastoral scene of green grass, a fence, fluffy clouds, and a blue sky. He then placed a label that read “Mad Cow Disease” in the sky area.

Displaying the Results and Evaluating the Project

WHEN WE WERE FINISHED WITH THE PROJECTS and they were graded, I put the candy boxes in a display case in the main part of the building. Some of these boxes were rather large and would have held lots of candy! The display was wonderful (see fig. 7). Because one student had made a character from a popular children's television show, other students would burst into the theme song when they walked by the case.

The students were absorbed in working on the project. One student, who wanted to do a project involving baseball and his favorite team, asked whether he could work on his candy box over the weekend. He reported that he spent about six to seven hours on it at home. The result was a model of the Boston Red Sox Stadium gate.

This year, we worked on the projects after state testing, a time when many teachers reported that the students were unmotivated, but this assignment kept their interest. I offered some help and allowed students to discuss the projects among themselves and to help one another. However, because students had to create their own candy containers, and their designs used different shapes and sizes, they had to work hard to do the required mathematics and complete the projects on their own.

This activity gave me the opportunity to help students who were struggling with the concepts of surface area and volume, to correct students’ misconceptions, and to reinforce a variety of skills. Each year, I evaluate how I can change and improve the project and try to determine whether I need to include more practice in the preceding unit on a particular skill. The project is still evolving, and ideas from other teachers are welcome. □