

A balancing act

BY TODD HOOVER

This month's discrepant event helps students identify and develop an understanding of the simple relationships between various components of a system. Students will find that without each piece, the system does not work as a whole.

The discrepant event

The discrepant event aims to explain how placing three butter knives onto the mouths of three empty glass soda bottles can support something as heavy as a pickle jar (see Figure 1).

Materials

- Three butter knives with flat handles
- Three glass soda bottles with the lids removed
- A test item that can fall without breaking, such as a quart-sized take-out container
- A jar full of pickles or a plastic mayonnaise jar.

Students should work in pairs when carrying out the discrepant event. Crisscross and balance the knives on the mouths of the bottles (Figure 2). Note that the handle of each knife is placed over the open mouth of the bottle, and the blades provide support for each overlapping knife. Make certain that the knives are centered on the mouths of the bottles. The blades of the knives should create a triangle slightly smaller than the base of your test container and pickle jar, so that the container can be placed on top of the triangle without falling through the opening.

Safety notes

Because this discrepant event uses knives that must be placed correctly or a collapse is possible, carry it out on a surface with a lot of space and preferably with a raised edge, so that if something does fall, it does not continue to roll off the edge of a table and onto the floor. If the pickle jar began to fall, for instance, it could hurt a student's foot if it landed on it or shatter on the floor. Students should wear safety glasses

FIGURE 1: Butter knives support the weight of the pickle jar



when performing this experiment and immediately notify the teacher if the pickle jar breaks. Note: A plastic mayonnaise jar can also be used in place of the pickle jar to reduce the risk of breakage and possible cleanup.

Setting up bottles on a carpeted floor is another way to perform the discrepant event. Keep in mind that performing the event on the floor only lessens the chance of a

dangerous fall but does not prevent it, so extra care and precaution should still be taken.

Additionally, students should be trained on the safe handling of butter knives, which can cause injury if not handled properly. Any misuse or mishandling should not be tolerated.

How it works

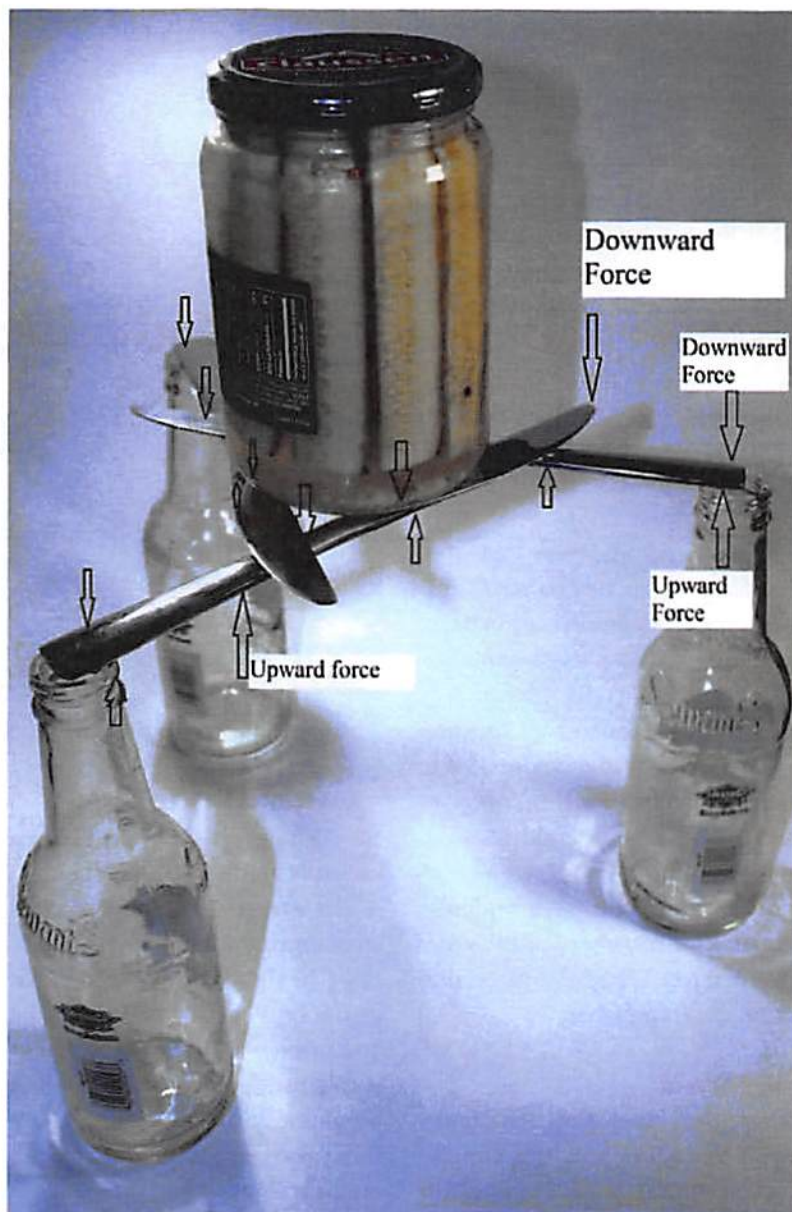
The placement of the knives creates a weave, where one knife is under another knife and on top of the third knife. When the heavy item is placed on the overlapping triangle in the center, it causes both upward and downward forces that create overall balanced forces (see Figure 2), allowing the pickle jar to be held, rather than collapse.

Engage

After arranging students in pairs and reviewing safety guidelines, give students all of the supplies, except for the full jar of pickles (see Materials). Challenge students by asking them: How can you use all of the items in front of you to get the empty container to sit on top of the knives, which must be balanced on the mouth of the bottles?

To promote higher-level, independent thinking, leave this question open-ended; do not tell students to weave the knives, or give any other hints as to how to make it work. You can tell them that the only requirement is that they use all the objects, and they must be used in the following or-

FIGURE 2: Balanced forces hold the pickle jar in place



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der: bottles at the base, knives in the middle, and container on top.

Explore

Give students 8–10 minutes to try to find a solution using trial and error. Have students record their trials in their science notebooks.

Explain

During a class discussion, ask students to share their achievements and failures and explain why they believe something did or did not work. Allow students to use their notes to assist in their explanations. If a document cam-

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era is available, they may project their notebook pages for the class to view as they explain.

Once groups have had a chance to share their data, set a timer for a “five-minute perfecting period” that allows students to refine their process, using what they learned from the class discussion. After the timer goes off, lead students in another class discussion where they describe their work in depth. At this time, redirect any group that has not used the weaved-knives pattern to build a model similar to the one in Figure 3.

Once students have set the knives in the correct pattern, and after another review of safety procedures, have them attempt to place the heavier object, the full pickle jar, on top of the triangle created in the center of the intersecting knives. If set up correctly, the knives should be able to easily hold the jar. If it does not work the first time, have students adjust it as necessary, until each group can successfully place the jar on the framework.

Elaborate

Bring the class together once again to discuss how this simple demonstration is an example of a system that works together to create the whole. Ask students to compare this to other systems in their lives with which they have some familiarity. Some of my students have compared this system

FIGURE 3: Butter knives in the shape of a triangle



to a group cheerleader pose, a house of cards, and a bridge.

For a fun extension, you could challenge students to see how close to the edge of the mouths of the bottles they can place the end of each knife handle without it collapsing. For this challenge, I would not permit students to use the pickle jar as the weight placed on the triangle. They should use a nonbreakable item for safety.

Evaluate

Have students draw a picture or diagram of this system, with the pickle jar on top, labeling it with

up-and-down arrows that show where various forces are being applied and how they balance one another out. Have students write a brief description telling you how, without the balanced forces, the system would not work. For example, if all the force was pushing down with no opposite force pushing up, the items would simply fall because the butter knives would not be able to hold any weight. Responses will vary by individual but should include basic concepts of balanced forces working together to create an overall balanced system. ●

Todd Hoover is an associate professor in the Department of Teaching and Learning at Bloomsburg University of Pennsylvania. Submit questions or ideas regarding discrepant events to Todd Hoover at todddhoover@comcast.net. Follow him on Twitter: @DrToddHoover.