Marin County Civic Center
Post-Visit Lesson Plan: Science

Grades 3-5

This lesson builds on the students' visit to the Marin Civic Center, making connections to engineering concepts. The lesson is designed to meet the Next Generation Science Standards for Grades 3–5-ETS1 Engineering Design. The lesson also meets Common Core English/Language Arts Standards for Speaking and Listening for Grades 3-5.

This lesson will take approximately 50 minutes to complete, although more time may be useful with a large or enthusiastic class. Note that a real-world engineering project would allow plenty of time to discuss and draw up plans before construction begins. This activity can work as a quick "intro to engineering" experience, or it can be stretched out over a longer period of time to make it more analogous to the real world. If you did the pre-visit engineering activity with your students, consider adjusting this activity to reflect their previous experience. For example, if you did not require students to plan before their Engineering Challenge in the pre-visit, you may wish to build in class time to plan before this post-visit Engineering Challenge.

Standards

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (NGSS, 3-5-ETS1-1)
- Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. (NGSS, 3-5-ETS1-2)
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (3–5-ETS1-3)
- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3, 4, or 5* topics and texts, building on others' ideas and expressing their own clearly. (CCSS.ELA-LITERACY.SL.3.1, 4.1, 5.1)

Advance Preparation
• Students will work in groups of 4-5 for this lesson. Determine the groups in advance. If your students completed the Pre-Visit Science Lesson (building a tower), decide whether you will have students work together in those groups or form new groups.

- Each group will need a Builder's Kit (see Materials List). Prepare the Builder's Kits in advance and have them ready to distribute. If you did the Pre-Visit Science Lesson, you may be able to re-use elements of those Builder's Kits.
- Students will need a flat work surface to do their engineering experiments. Depending on the furniture in your classroom, you may wish to have students move their desks together, or you may wish to arrange to hold the lesson in a cafeteria, library, or other work room.
- Review the Engineering Challenge handout and determine the criteria which will be most appropriate for your class and the time you have available. For younger students or students with limited fine motor ability, a more restricted set of criteria may be appropriate. For older students or students with experience doing hands-on activities, more complex criteria would be appropriate. Revise the handout if needed, and then make copies (1 per student).

Materials List

- One Builder's Kit for every 4-5 students, containing:
  - 15-20 large marshmallows
  - 50 mini marshmallows
  - 50 pieces of dry spaghetti
  - 20 plastic straws
  - 1 box of toothpicks (at least 100 toothpicks)
  - 1 container of playdough (approximately 5 ounces)
- Multiple pairs of strong scissors (strong enough to cut through a plastic straw)
- A timer
- Copies of the Engineering Challenge handout, revised for your classroom (1 per student)
- A computer with a projector to show the PowerPoint presentation
- A ruler
- One (or more) small toy cars to roll under student-engineered arches as a test
- Optional: an electric fan (handheld or tabletop size)
- Optional: a protractor
- Optional: a ball of string or twine

Task Number	Task Description
1	**Discussion: Architecture, Engineering, and Shapes** Before class begins, prepare to display the Post-Visit Images PowerPoint. Also review the Engineering Challenge handout and revise it as needed to suit your students (see Advance Preparation). At the start of class, ask students about their visit to the Civic Center. What did they learn? What did they find interesting? Invite a few volunteers to share their thoughts. Then, narrow the focus of the conversation. Ask students:

	• What shapes did you see at the Civic Center? What shapes did Frank Lloyd Wright use as he designed the building? Students may immediately say "arches." If they do, display the Post-Visit Images and ask students to point out where they see arches. If you have a SmartBoard or similar technology, you may wish to circle, highlight, or otherwise mark the arch shapes on the provided photos. If they do not immediately think of arches, display the Post-Visit Images and ask students to name shapes they see in the images. The images are sequentially ordered so that by the final image, students should recognize the importance of the arch in Wright's design. Ask students: • What is an arch? Work together to define an arch as a class. Technically, an arch is a "curved, symmetrical opening." If students are confused, use the Post-Visit Images to point out specific examples of arches. Review concepts such as "curve" or "symmetry" as needed. If time permits, invite students to share why they think Wright used so many arches. Students may recall from the tour that Wright drew his inspiration from the hills on which the Center is built. Wright was imitating the shape of the hills with his arched design.
2	**Engineering Challenge: Build an Arch** Assign students to their groups and have them move to their work stations. Distribute copies of the handout (Engineering Challenge: Build an Arch), one per student. Review the handout with the class and answer any questions. Let students know that if they want to try having each group member design his or her own arch, that is acceptable, but they will have to work together to share their materials. You may wish to suggest that students take a minute or two to discuss and plan out their ideas before they begin constructing. As an alternative, you may choose not to advise them and allow them to learn from experience what happens if they choose not to plan. Pick the approach that best suits your students and your timeframe. If you wish to allow them time to plan, you may want to increase the amount of time they spend on the Engineering Challenge, and you may want to allow them to use paper and pencils to draw up their plans. Set a timer for 10 minutes and let students begin designing their arches. Circulate through the classroom to answer questions, but do not interfere unless absolutely necessary. Remind students to use the criteria on the handout to evaluate their own work. If students come up with a satisfactory design but still have time left, encourage them to work on a different design with their remaining materials. When the timer goes off, collect any unused materials and tell students to prepare their work stations so their arches can be tested.
3	**Engineering Challenge: Testing** Ask students:

	How can we evaluate these arches to be sure they meet the criteria? Take suggestions from the class. Supplement with your own suggestions as needed. Possibilities include: ✓ Using a ruler to evaluate how straight it is ✓ Using a curved shape (such as a protractor) to evaluate whether it is curved at the top ✓ Using a piece of string as a line of symmetry to evaluate whether it is symmetrical ✓ Rolling a small car through the arch to determine if it is sufficiently open ✓ Blowing on the arch with an electric fan to determine its stability At a minimum, arches should be evaluated using the ruler (to check if it is straight) and the car (to check if it is open underneath). All other criteria may be skipped or adjusted based on your students and the time available. If students wish to evaluate the "curve" of the arches, remind them that curves are difficult to achieve with straight objects such as toothpicks, so students should not expect a perfectly round curve. Once the class has settled on criteria, have students write down the tests on their Engineering Challenge handout. Then conduct the tests on each arch. If there are too many arches to test, consider having the groups conduct some tests on their own, while you circulate through the room. When the arches have been tested, ask students to return to their seats and complete the rest of the Engineering Challenge handout. If time permits, invite students to share what they would do differently the next time they try to build an arch. If students completed the Pre-Visit Lesson Plan, also invite them to share if they learned anything from their tower-building challenge that helped them as they designed their arches. If time permits, invite students to suggest other materials they think would work better to build an arch. You could choose to extend this activity by having students bring in their own materials and holding another Engineering Challenge with those materials.

Engineering Challenge: Build an Arch

Use your Builder's Kit to create an arch. You can work together or by yourself, but you must share your Builder's Kit with your whole group.

You will have **10 minutes** to build the best arch you can. Your arch must meet the following guidelines:

- ✓ It stands up straight and does not droop or sag.
- ✓ Its shape looks like a curve at the top.
- ✓ It is symmetrical (both sides look the same).
- ✓ It is open underneath (imagine a person walking under it or a car driving through it).

Testing Your Arch

As a class, decide how you will evaluate your arches to see which ones meet the guidelines. Write down the tests you will use here:

To test our arches, we will:_____

_____

_____

What You Learned from Testing

What did you learn from testing your arch? If you were going to build a new arch, what would you do differently?

I learned_____

_____

Next time I would_____

_____