STEAM CONCEPTS

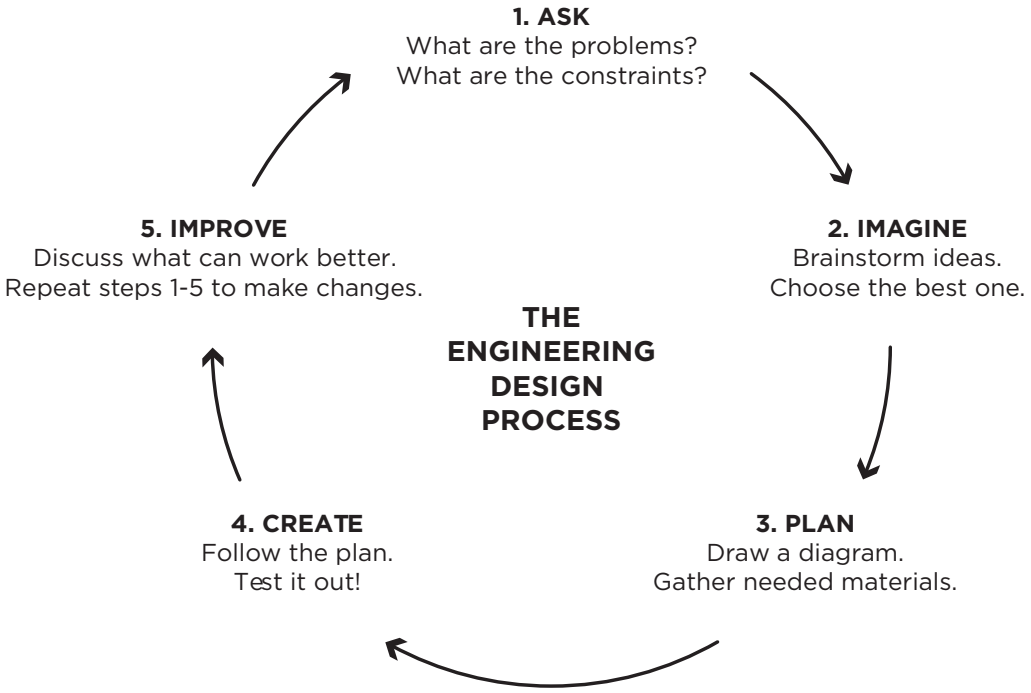
ENGINEERING
SEVEN MAGIC MOUNTAINS

OBJECTIVES

The construction of *Seven Magic Mountains* posed significant design and engineering challenges. Using this project as inspiration, students will explore the Engineering Design Process in order to design, construct and test student-built towers within the constraints of the defined problem and available materials. Students will synthesize this knowledge with their understanding of the design process as it applies to *Seven Magic Mountains.*

VOCABULARY

Engineering Design Process:



MATERIALS

Newspaper
Scrap Paper
Index Cards
Tape
Heavy Books

TIME

1-2 Class Periods (45-60 min)
Extra time for extensions

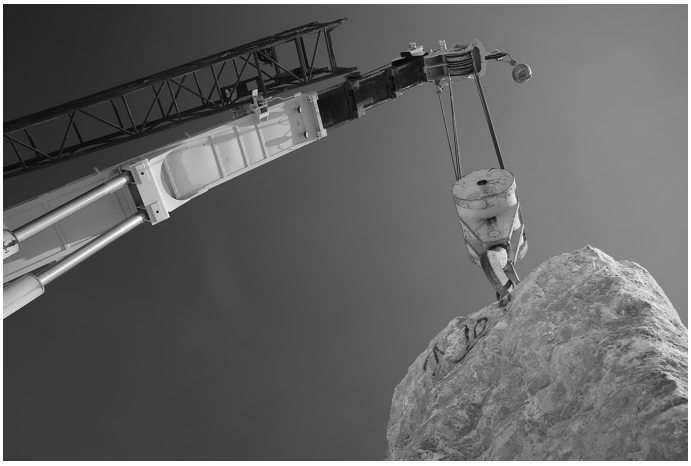
Questions? Contact Marisa L. Cooper, Charles N. Mathewson Director of Education at marisa.cooper@nevadaart.org or 775.398.7254

LESSON

Engagement: Show students an image of the fully completed art installation, *Seven Magic Mountains*. Ask students the following questions: How do you think these towers were constructed? What keeps these towers from falling over? What sort of challenges would the engineers have encountered while building these towers? Allow students ample time to process, draw and record their thoughts. Have students share and discuss their responses.

Exploration: Distribute materials to student groups. Tell students they have to build a tower. Do not provide any other guidance or explanation at this time. Give them roughly 5 -10 minutes, when every group has some sort of tower, have the students stop construction. Tell students that we must test their towers. Bring out a stack of heavy books and attempt to place a book or stack of books on top of each tower. Most of the students' towers will buckle and collapse under the weight of the books. This is good! After testing the towers, discuss this exploration with the students. Ask them WHY the towers collapsed (we didn't know about the heavy books). Ask the students how they would do this differently (plan ahead, have a better idea of what we're doing, etc.). Ask the students if this is how engineers work (no, this is not how engineers work). What if the *Seven Magic Mountains* engineers had worked this way?

Explanation: Introduce the Engineering Design Process to students (show students the process and discuss each step). There are several versions of this process and a variety of links included in this lesson. Pick the version that works best for your classroom. Explain that we are going to build towers again, but this time, we will use the Engineering Design Process. As a class, have students define the problem we are tackling (example: build a tower that can withstand the weight of one text book). As a class, discuss and define the constraints of the challenge (available materials and minimum height requirements are great constraints to use).



Elaboration: Have students work through the next three phases of the Engineering Design Process (Imagine, Plan, Create). In groups, have students brainstorm new designs for their tower, allow them time to discuss the pros and cons of each of the different designs and how they solve the problem while working within the constraints we defined earlier. Once they have settled on an idea, students should create a plan that includes a design or blueprint for their tower. Feel free to ask students to include a materials list or to use scale drawing in their blueprint. (Make sure you allow students ample time to create detailed plans. We are stressing the Engineering Design Process so it is important that students are able to experience this. Depending on the class time available, this might be a good stopping point for your students). When students have a complete and detailed plan that addresses the problem and the constraints, have students collect their materials and build their towers.

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Evaluation: Have students test out their towers according to the problem you defined (ex: build a tower that can withstand the weight of one text book). Have students evaluate the strength of their design and improve and retest as needed (and as time allows). Have students answer the following questions to help them analyze the experience and their understanding of the Engineering Design Process.

1. How similar was your design to the actual tower you built?
2. If you found you needed to make changes during the construction phase, describe why you decided to make revisions.
3. Describe the shape or construction of the tower that was the tallest. How was this tower different from yours? What changes made this tower stronger or taller?
4. If you had a chance to do this project again, what would you have done differently?
5. How did the Engineering Design Process impact how you built your tower?
6. How do you think the Engineering Design Process impacted the construction of *Seven Magic Mountains*?
7. Do you think that once a building is designed and approved for construction that many aspects are changed during the building process? Why or why not?

Extension: Watch the videos on the construction of *Seven Magic Mountains* and outline each step of the Engineering Design Process. Try to identify the design constraints of the project using the information we have on the artwork. For example, the rocks are composed of limestone (CaCO3) which has a density of 2.6Kg/cm3, how would this impact the potential height of the towers? How would the location of the installation impact the construction and material selection as it relates to wind and weather concerns?

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ART PRODUCTION FUND

NEVADA MUSEUM OF ART

STANDARDS

National Core Arts Standards

VISUAL ARTS: CONNECTING 10.1 (VA: CN10.1)
ENDURING UNDERSTANDING: Through art-making, people make meaning by investigating and developing awareness of perceptions, knowledge, and experiences.

Essential Question(s): How does engaging in art enrich people's lives? How does art attune people to their surroundings? How do people contribute to awareness and understanding of their lives and the lives of their communities through art-making?

NV Academic Content Standards for Science (NGSS)

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. 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.

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Helpful Links, Resources and Background Information

sevenmagicmountains.com/

eie.org/overview/engineering-design-process

sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml#theengineeringdesignprocess

teachengineering.org/engrdesignprocess.php

thorntontomasetti.com/wp-content/uploads/2012/02/Super_Tall_Design.pdf

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