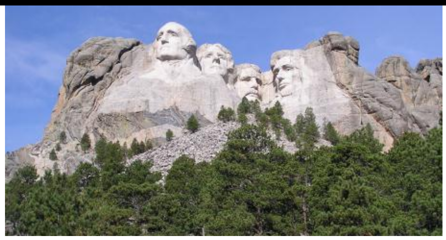
Mount Rushmore

National Park Service
U.S. Department of the Interior

Mount Rushmore
National Memorial



Mount Rushmore Education Program
Planning Worksheet

Instructor Name:___________________

Title of Program:
Complex Geometry of Mount Rushmore

Grade level: 9-12 **Subject area:** Geometry, Algebra, Measurement and Data

Content Standard: Geometry, Algebra, Measurement and Data for 9th through 12th grades

-Standards: Common Core Curriculum Standards (http://www.corestandards.org/the-standards/mathematics)

-List Standards:

- G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*
- G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

  a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

  b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
- G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.
- G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.*
- G-GMD.4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
- G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

Lesson objectives: "The learner will be able to . . .

Calculate the weight of Mount Rushmore. Start by calculating the volume using cross sections of the model. Use density of stone to finally arrive at a rough estimate of the weight. Finally, calculate when two cracks on the surface of the sculpture would intersect over time.

Introduction: What is the hook, the attention grabber, the interesting beginning?

Begin with a discussion of what a heritage site is. Introduce students to Mount Rushmore as an American heritage site and discuss how the sculptor, Gutzon Borglum, decided to carve the heads of the four Presidents. Show two pictures of Mount Rushmore: before and after carving. The students should be able to have a discussion about the significance of human design and how we shape the world around us. With Mount Rushmore, what we have as a result is a monumental sculpture that took a great amount of human and material resources. Brainstorm on reasons why documenting and understanding our heritage sites is so important. How do we make sure that we're taking care of an important heritage site like Mount Rushmore when there are forces like deterioration and destruction at play? To illustrate deterioration, use provided sample photos of deteriorating structures. For destructions, use example of Bamiyan Buddhas that were destroyed by the Taliban in 2002. Use the PDF entitled "Caring for a Monumental Sculpture" to introduce the students to the specific preservation concerns at Mount Rushmore. In order to come up with a plan to conserve a site, we would need to have an accurate record of it as our starting point. Use provided introductory videos to learn about digitally documenting heritage sites and the specific process used at Mount Rushmore. For more information, explore the CyArk website.

Content: Body of lesson, sequence of learning activities.
(Keep them busy, keep them active, keep them thinking, keep them involved)

After completing the introduction activity, discuss the history of the carving of the Mountain, including the Hall of Records. One important benefit of having an accurate record of the mountain is knowing the exact shape of it so that you can keep track of whether that shape changes over time. Begin looking closer at the sculpture by using the provided Measurable 3D PDF of the model, or the 3D viewer on the CyArk website. In both the 3D PDF and online 3D Viewer, the teacher can cut sections through the model to give a better understanding of the Mountain's contours.

How do you keep track of changes within the mountain? You can create new 3D models of it over time by laser scanning it again and doing a new volume calculation. If appropriate, teacher can introduce students to how volume formulas were first arrived at. Use simplified proofs to demonstrate a series of formulas that get progressively more complex (start with the circumference of a circle, then the area of a circle, then the volume of a sphere).

Hands-on activity 1: Introduce students to the activity of calculating the volume of Mount Rushmore. This activity will use the provided PDF of cross-sectional layers of the Mountain Sculpture to calculate volume. Use the instruction video to understand how these layers are meant to come together to form the mountain before proceeding. Students should be able to use the Measurable 3D PDF to figure out the scale of the cross-sectional layer PDF drawing. Determining the scale factor of the layers will allow the students to arrive at a real-life volume measurement.

Hands-on activity 2: Research the rock types found in Mount Rushmore, the estimated percentage that they make up within the mountain, and their respective densities to calculate the sculpture's mass.

Hands-on activity 3: Use the provided "vertical" section drawings of the Presidents' heads to calculate when two surface cracks would intersect. If these cracks are to form deeper into the stone, and eventually intersect, they could cause a large portion of the sculpture to "come loose." Suppose the location of two cracks along the surface of the sculpture and have students calculate how long it would take for them to intersect if they formed perfectly perpendicular to the surface at the spot of the crack. Rate of expansion of the cracks can be assigned by teacher as well.

Materials needed: (equipment, handouts, graphic organizer, worksheets, props, papers)

-Computer for introduction presentation and any necessary research
-List of area and volume formulas for geometric shapes (to be provided by teacher)
-Photos of Mount Rushmore, before and after carving (provided)
-PDF document entitled: Caring for a Monumental Sculpture (provided)
-Illustrative images of deterioration and destruction (provided)
-Mount Rushmore introduction video (provided—if the entire video is too lengthy, the segment between 6:25 and 11:50 provides a sufficient introduction to how the mountain was carved)
-Digital Preservation introduction videos (provided)
-PDF of layers of 3D model (can be overlaid with a scaled grid to calculate area)
-Instructional video showing how layers come together (provided)
-Measurable 3D PDF of the mountain (provided—Teacher should spend some time becoming familiar with this file's use ahead of time)
-Sectional drawings of the Presidents' heads (provided)
-Rulers
-Protractors
-Writing/drawing utensils

Summary and conclusion of lesson: What helps set a course of action or leaves them thinking?

Summarize concepts covered through activities. Discuss the importance of scale drawings and models as a way to keep accurate records of a structure/sculpture.

Theme statement: (The "big picture", the final result, the "so what?!)

Why is documenting and understanding our heritage so important? For buildings/sculptures that are really important to us, we can't take for granted that they'll be around forever. Based on example of Bamiyan Buddhas, show other examples of important heritage sites deteriorating or suffering destruction.

Evaluation method: How will we see the success of your program?
Example: completed worksheets, class discussion, drawings

Evaluate student involvement and results of in-class activities.