Lesson Title: Ge-*ART*-metry	**<u>Big Idea & Learning Objectives</u>** 1. Students will understand geometric concepts to be an integral part of everyday life. 2. Students will conclude that art plays an important role in developing a clearer understanding of mathematical concepts. 3. Students will understand and differentiate between surface area, lateral area, and volume. 4. Students will calculate surface area, lateral area, and volume of 3-dimensional shapes. 5. Students will construct a visual artifact (using a net) to demonstrate the understanding of a mathematical concept.
Content Area & Arts Discipline: Math and Visual Arts	**<u>Overview of the Lesson</u>** The students will work cooperatively to create three-dimensional figures that could be used at one of the entrance way to the Metropolitan Museum of Art in New York City. The students will take their individual shapes and will create a sculpture within their groups after viewing sculptures by David Smith. While creating these, students will be required to determine the surface area needed to be covered in paint and the amount of concrete needed to fully form the sculpture (volume).
Grade Level: Grades 6, 7, & 8	**<u>Procedures</u>** **Engaging Students ("The Hook"):** Have a picture of the Louvre Pyramid on the screen during the first part of the opening. When discussing the Metropolitan Museum of Art, show the museum followed by an areal view of Central Park. *"The Louvre Pyramid in Paris, France has been a popular tourist attraction since its completion in 1989. It forms an entrance to the Louvre Museum and hosts around 7 million visitors each year. Hoping to replicate that popularity, the Metropolitan Museum of Art in New York City has decided to construct a similar tourist attraction in the portion of Central Part that is adjacent to the Museum. Not wanting to appear to merely copy the Louvre, the Museum has decided to commission a group of artists/engineers to create a series of three-dimensional forms to serve as entry points from the gardens to the lower levels of the Museum."*

Proposed Time Frame: < 3 hours (3 class periods)	**Building Knowledge:** *Architects and engineers use mathematical information all the time when designing and building any kind of structure.* (Allow students to discuss the type of mathematical information that may be needed.) *Even doing something as simple as painting a room, you need to understand the concept of surface area, more importantly, the concept of lateral area. What is the difference? Why would you need lateral area and not surface area?* *But, even after completing a building or structure, the designers want it to be aesthetically pleasing -- that it is something that is good to look at or is interesting and unusual.* (Allow students to discuss why aesthetics are important.) **The teacher may want to discuss and use Frank Lloyd Wright (the designer of the Guggenheim in New York) as an additional reference of knowledge building. He was known as the "Father of the Arts & Crafts Movement" and also designed a home that is located in Florence, Alabama. This may provide a more familiar name and will give them a location that they may be familiar with.
Date Lesson Created: April 21, 2014	**Modeling the Experience:** The teacher may want to have net manipulatives to demonstrate how nets fold to create a 3-D solid. The teacher will show how the edges are measured so that surface area and volume can be found. The teacher can refer back to some of the images used of unusual designs so that students can determine the geometric shapes (specifically solids) within these buildings.
Lesson Author: Shasta Long -classroom teacher Dr. Miriam Wahl -art resident Randy Jolly -art resident	**Guided Practice:** The students will work to create a three-dimensional solid. The teacher will need to be monitoring students so that they cut and fold correctly. The students will need to devise a plan to calculate surface area and volume. The teacher will need to monitor students and ask them guiding questions to develop their plan. The students will need to calculate surface area and volume of their solids. The teacher will need to monitor formula substitutions and calculations.

	Applying Understanding: Students will use nets to construct a three-dimensional shape. Students will devise a way to determine the surface area of the shape (whether use of a formula or decomposing the net). Students will work in groups to combine their shapes to create a sculpture and will work to determine how much concrete would be needed to build the sculpture (volume).
Room Requirements & Arrangement: classroom -groups of 4	**Opportunities for Reflection (Closing):** Students will discuss the use of unusual sculptures and architecture found in the world. Students will continue to discuss how knowledge of these unusual works can help in the understanding of mathematics. Students will discuss why architects, engineers, and builders may need to understand different mathematical concepts like surface area, volume, and measurement.
Material Equipment: •smart board •nets of 3-D shapes •card stock •pencils •colored pencils •crayons •markers •rulers •scissors •decorative supplies (glitter, sequins, pom-poms, pipe cleaners, etc.)	**Assessing the Learning:** •The teacher will observe students as they work to manipulate nets and design and build a sculpture. •The students will be graded on their sculpture based on given criteria and a teacher-made rubric. •The students will be graded on their calculations of surface area and/or volume of their sculptures.

Resources:	**Standards & Principles**
•sculpture grading rubric •calculation worksheet •task card	**Common Core State Standards:** **6.G.4 Geometry** Standard: Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems. **7.G.6 Geometry** Standard: Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilateral, polygons, cubes, and right prisms. **8.G.9 Geometry** Standard: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems. **Arts Standards:** **Visual Arts: Middle Level III** **1 - Use advanced techniques appropriate to the unique qualities of various media to reach an original and artistic solution. (CP)** **b.** Demonstrate safe and competent use of art materials and tools including storage and clean up. **c.** Demonstrate originality in solving artistic problems. **10 - Know that multiple factors affect how people respect, value, and derive meaning from art. (A)** **b.** Understand the role of compromise in group decision making. **11 - Know that the integration of visual arts concepts and skills with knowledge in other subject areas provides essential tools for everyday life. (C)** **a.** Demonstrate the use of mathematical concepts to create space and form in works of art. **c.** Recognize the importance of planning a project involving the arts and a variety of other disciplines.

Vocabulary (math): •edge •face •net •surface area •three-dimensional figure •vertex •volume **Vocabulary (visual art):** •abstract •geometric •organic •three-dimensional form	**Principles of Universal Design for Learning**: I. Provide Multiple Means of Representation 1: Provide options for perception 1.1 Offer ways of customizing the display of information 2: Provide options for language, mathematical expressions, and symbols 2.1 Clarify vocabulary and symbols 3: Provide options for comprehension 3.1 Activate or supply background knowledge 3.3 Guide information processing, visualization, and manipulation 3.4 Maximize transfer and generalization II. Provide Multiple Means of Action and Expression 5: Provide options for expression and communication 5.2 Use multiple tools for construction and composition III. Provide Multiple means of engagement 7: Provide options for recruiting interest 7.1 Optimize individual choice and autonomy 8: Provide options for sustaining effort and persistence 8.3 Foster collaboration and community 9: Provide for self-regulation 9.1 Promote expectations and beliefs that optimize motivation

Appendix

Extended Learning Activities:

•For 6th grade, have the students convert between measurements for further practice and review (6.RP.3.d).

•For 7th grade, have the students create a scale for their models to calculate the actual measurements of their models (7.RP.1; 7.G.1).

•For 8th grade, have the students justify the similarity of their models to the actual building (8.G.4).

TIPS/FAQs:

•The teacher may choose to have dimensions of the shapes already written on the board to assist students that struggle with measurements.

•There is a spray paint at Wal-Mart that looks like stone when it dries. You may choose to let students spray paint the final sculptures.

References:

•David Smith: http://www.moma.org/collection/artist.php?artist_id=5480

•Louvre Pyramid: http://www.greatbuildings.com/buildings/Pyramide_du_Louvre.html

•Louvre Pyramid: http://en.wikipedia.org/wiki/Louvre_Pyramid

•Central Park (areal view): http://www.airpano.com/Photogallery-Photo.php?author=5&photo=261

•Unusual architecture: http://unusual-architecture.com/

Task Card:

The Louvre Pyramid in Paris, France has been a popular tourist attraction since its completion in 1989. It forms an entrance to the Louvre Museum and hosts around 7 million visitors each year. Hoping to replicate that popularity, the Metropolitan Museum of Art in New York City has decided to construct a similar tourist attraction in the portion of Central Park that is adjacent to the Museum. Not wanting to appear to merely copy the Louvre, the Museum has decided to commission a group of artists/engineers to create a series of three dimensional forms to serve as entry points from the gardens to the lower levels of the Museum.

Create a structure using a three dimensional form to place in Central Park and used as an underground entry way to the Metropolitan Museum of Art in New York City. Study the map provided to determine the best placement for your design. Calculate how much material is needed to cover the lateral surface area of the form. Use the various materials on hand to finish the forms so that they are creative and will serve as a visual invitation to enter the Museum. Creativity, craftsmanship, and attention to detail are an integral parst of this project.

Surface Area Rubric

Student Name _____ **Project Title** _____

CATEGORY	4	3	2	1
Mathematical Concepts	Explanation shows complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Mathematical Reasoning	Uses complex and refined mathematical reasoning.	Uses effective mathematical reasoning	Some evidence of mathematical reasoning.	Little evidence of mathematical reasoning.
Use of Manipulatives	Student always listens and follows directions and only uses manipulatives as instructed.	Student typically listens and follows directions and uses manipulatives as instructed most of the time.	Student sometimes listens and follows directions and uses manipulatives appropriately when reminded.	Student rarely listens and often "plays" with the manipulatives instead of using them as instructed.
Planning and Explanation	Student can describe in detail at any point during the process how s/he envisions the final product and how they intend to reach their goal. Very focused and goal-oriented.	Student can somewhat describe how s/he envisions the final product and can describe some of the steps s/he will use to reach the goal. Focused with some planning.	Student can describe how s/he envisions the final product but finds it difficult to describe how s/he will reach that goal. Has set a goal, but lets things evolve in somewhat random manner.	Student has thought very little about the project. Is present but is not invested in the product.
Neatness and Organization	The work is presented in a neat, clear, organized fashion that is easy to understand.	The work is presented in a neat and organized fashion that is usually easy to understand.	The work is presented in an organized fashion but may be hard to understand at times.	The work appears sloppy and unorganized. It is hard to know what information goes together.
Design/Composition *Design Principles: Unity, contrast, balance, movement, direction, emphasis, center of interest* Elements of Design: *Color, texture, shape, value, space, line*	Student applies design principles and elements with great skill.	Student applies design principles and elements with fair skill.	Student tries to apply design principles and elements but the overall result is not pleasing.	The student does not appear to be able to apply most design principles and elements to his/her own work.
Time/Effort	Class time was used wisely. Much time and effort went into the planning and design of the product.	Class time was used wisely most of the time.	Class time was not always used wisely.	Class time was not used wisely and the student put in no additional effort.

On the back of this sheet please answer in **complete sentences**:

1. What was the most difficult part of this project?
2. What was the most interesting part of this project?
3. Write a brief description of your work and explain why you chose this design to solve the problem.

Calculation Worksheet

Student Name _____ **Teacher/Class Period** _____

Surface/Lateral Area

Steps	Work
1. Name of the object	1.
2. Formula	2
3. Plug in the dimensions	3
4. Show your work	
5. Answer with appropriate units	

Volume

Steps	Work
1. Name of the object	1.
2. Formula	2
3. Plug in the dimensions	3
4. Show your work	
5. Answer with appropriate units	