Build It and Gild It!

Create an Outdoor Sculpture for a Classroom Exhibition

View examples below of outdoor sculpture in the National Gallery of Art's Sculpture Garden.
Artists from left to right: Mark di Suvero, Joel Shapiro, Tony Smith, and Lucas Samaras

Make your own Tony Smith-style sculpture by joining polyhedra together.

1. Select a partner. Plan your sculpture to be:
   - for a garden
   - large enough for a person to walk through
   - made of polyhedron shapes put together like Tony Smith's *Moondog (third from left above)*
   - covered with gold leaf

2. Make rough sketches that show the types and number of polyhedra you plan to use.

3. You will build the model, or maquette, rather than a life-size sculpture. Download and print several polyhedra patterns at http://www.korthalsaltes.com. You may decorate them before or after putting them together to make your abstract geometric sculpture.

4. To calculate the gold leaf needed to cover your work of art, you'll need the following tables and formulae:

   - Table for Calculating the Cost of Gold Leaf
   - How to Cover Your Model with Gold Leaf
   - Table for Evaluating the Surface Area of the Structure
   - Calculating Surface Area

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5. Use cardboard and other materials to create a mock, small-scale "outdoor" space for your finished sculpture. You can "site" it in a garden, city plaza, park, or playground.

6. Name your sculpture and write a label that includes a description and your math calculations.

7. Put it all together for a "Build and Gild" classroom exhibition.

   - Title
   - Name of Artist
   - Location (your school, city or town)
   - Materials used to decorate sculpture
   - Amount of gold leaf used (attach math to the back)
   - Date created
   - Write a short paragraph describing your work and referring to specific polyhedra included in it, what the art represents, why it is sited in a certain way, and any additional facts or commentary of interest to your audience.

Table for Calculating the Cost of Gold Leaf

Type of polyhedron	Number of solids of this type	Formula for one face	Apply formula for face	Number of faces	Surface area for each solid	Total surface area for all solids of this type	Cost of gold/unit	Surface area times cost/unit area
Tetrahedron								
Octahedron								
Icosahedron								
Dodecahedron								
Cube								
						Total surface area for all solids	**Total cost to cover structure with gold leaf**	
Hint: You will need to subtract the area of faces that are joined to another face.								

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How to Cover your Model with Gold Leaf

You'll actually cover your model with gold leaf—gold pounded into very thin sheets only 4-5 millionths on an inch thick! (Artists used gold leaf in paintings, sculpture, decorative objects, and architecture throughout history.)

One ounce of gold (which pounds down into approximately 200 ounces of gold leaf) will cover about 16 square meters.

Since the price of **gold** is $300 per ounce, the price of 200 ounces of **gold leaf** is also $300.

Solid	How many faces?	What is the sum of the areas of all faces?	How much gold?	What is the price?
Cube with edge= 2 meters	Six equal squares. The area of a square = s*s	The area of one face= 2*2 = 4 square meters. The total surface area = 6 * 4 = 24 meters	200 ounces will cover 16 sq meters. 300 ounces will cover 24 sq meter	The price = 300 * 300 = $90,000
Tetrahedron. each face is a triangle with base = 2 meters and height = 1.7 meters.	Four equal faces. Each one is a triangle. the area of a triangle = (base * height)/2	The area of one triangle = (2 * 1.7)/2 = 3.4/2 = 1.7 square meters. The total surface area = 4* 1.7 = 6.8 square meters	200 ounces will cover 16 sq meters. 136 ounces will cover 6.8 sq meters.	136*300 = $40,800
Octahedron with base = 2 meters and height 1.7 meters	Eight equal triangles. the area of a triangle = (base * height)/2	Eight equal triangles. the area of a triangle = (base * height)/2		
Dodecahedron with edge = 2 meters	Twelve equal pentagons. The area of each one = 5 *the area of a triangle =5* (base * height)/2 . (Divide each face into 5 triangles)	Twelve equal pentagons. The area of each one = 5 *the area of a triangle =5* (base * height)/2 . (Divide each face into 5 triangles)		
Icosahedron with edge = 2 meters	Icosahedron with edge = 2 meters	Icosahedron with edge = 2 meters		

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Table for Evaluating the Surface Area of the Structure

Type of polyhedron	Number of solids of this type	Formula for one face	Apply formula for face	Number of faces	Surface area for each solid	Total surface area for all solids of this type
Tetrahedron						
Octahedron						
Icosahedron						
Dodecahedron						
Cube						
						Total surface area for all solids

Calculating the Surface Area:

Using the cost of gold per ounce and the amount of surface area that each ounce of gold will cover, calculate the total cost of covering your structure with gold. First, count the numbers of each type of polyhedron you are using.

Second, for each type of polyhedron you have used, find the area of the polygon faces. To do this, measure the lengths of the sides of one polygon face, and use the area formulas to find the area. You can measure the sides more easily when a polygon is flat, before you have assembled it. Remember that while you only have your model to measure, you have to calculate the area for your proposed sculpture, which will be bigger than the model. To account for this, multiply each length measurement by the ratio between the model and the sculpture. For example, if your model was 1/8th scale, you would multiply all your length measurements by 8.

Once you have the area of a polygon face, multiply that value by the number of faces in a polygon. Next, multiply the result by the number of that type of polyhedron, that you use in the sculpture. Do this for all the different types of polyhedra you use.

Now you should have the total surface area of your sculpture. The sculpture will be made of thin sheets of gold, just like your model is made of thin sheets of paper. Assume that the sculpture will be made of gold sheets 0.1 cm thick. Multiply the total surface area of your model by the thickness of 0.1 cm to get the volume of gold needed. Then multiply the volume by the density of gold, which is 19.31 gm/cm3, to get the mass of gold used for your sculpture.

Bonus. When you make your model, sometimes you will attach the faces of two polyhedra together. When you do this, neither face can be seen. If faces can't be seen, you don't have to make them out of gold. You can subtract the area of any faces, that can't be seen from the total area of your sculpture.