Transformation 2013 Design Challenge Planning Form Guide

Design Challenge Title: Nano Corporate Logo

Teacher(s): Christina Holland

School: Akins H. S. (New Tech High Academy), Austin TX
Subject: Geometry

Abstract: Students will design a nano-scale logo for a nanotech corporation, as newly hired members of the design team. The logo must be of a scale to fit on the nanochips produced by the company, and must therefore be configured from Buckeyballs (rough spheres of carbon), prisms from graphite sheets, and carbon nanotubes. They will need to know the volume taken up by their logo, as well as the surface area (as a measure of cost in terms of the amount of carbon needed to produce the logo). Students must communicate their design persuasively and quantitatively through a written report, graphics, and a group presentation.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

Step 1: Begin with the End in Mind

- ***Does this design challenge meet the criteria for STEM student needs (21st century skills, TEKS, TAKS)?***

Section 1
Summarize the theme or "big ideas" for this design challenge.

Surface area and volume of solids both depend on the length scale of the object in question, but volume varies more rapidly with changes in length scale. If the scale is L, then surface area is proportional to L^2 (LxL) and volume is proportional to L^3 (LxLxL). Surface area and volume of prisms, cylinders, and spheres can be computed from specific formulas.

Section 2
Identify the TEKS/SEs that students will learn in the design challenge (two or three).

G.6(C) The student analyzes the relationship between three-dimensional geometric figures and related two-dimensional representations and uses these representations to solve problems (SE: use orthographic and isometric views of three-dimensional figures to represent and construct three-dimensional figures and solve problems.)

G.8(D) The student uses tools to determine measurements of geometric figures and extends measurement concepts to find perimeter, area, and volume in problem situations (SE: find surface areas and volumes of prisms, pyramids, spheres, cones, cylinders, and composites of these figures in problem situations).

Section 3
Identify key performance indicators students will develop in this design challenge.

Students will complete (in groups): a design plan, a schematic, a written report, and a presentation, plus individual work on in-class exercises. Students will gain confidence manipulating representations of 3-dimensional figures. Students will become proficient in computing surface area and volume for prisms, spheres, and cylinders at various scales (macro to nano).

Section 4
Identify the 21st century skills that students will practice in this design challenge (one or two).

Teamwork, collaboration, and communication.

Section 5
Identify STEM career connections and real world applications if content learned in this design challenge.

This project introduces students to the world of nanotechnology and some of its many applications.

Students will use math, science, engineering, and technology to solve a scientific problem, design a prototype of the design, and quantitatively assess the effectiveness of their design.

The Design Challenge

Congratulations on being hired to the design team of **Nanotech Transformative Hardware (NTH)**! We are very pleased to have you on board.

As you know, NTH is making its mark in the world of ultra-small electronic components. We've moved beyond the standard microchip. We're producing nanochips (squares 40 nanometers on a side), which will naturally revolutionize the computer industry.

We expect to roll out these nanochips onto market very soon. But, we need to put our corporate logo on the chip.

Your challenge is to design a logo for us that our engineers can build out of nanomaterials. It can be three-dimensional, but must be no more than 30 nm wide by 30 nm long by 15 nm high at its greatest extent. We want it to be clearly legible, with a microscope of course, and persuasive. We'll probably want to use other scales of your logo design as well, for tabletop art and to place on top of our corporate headquarters.

I'm including a graphic, to help you get a sense of the scales involved (see attached).

Please prepare: a design schematic or a prototype, a written description of your design, and a presentation for the board. We have enlisted other design teams as well, so you must be persuasive.

Step 3: Map the Design Challenge

Look at the *major* product for the design challenge and analyze the tasks necessary to produce a high-quality product. What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills.

Major products:

<u>Early in the Project:</u> Design Plan (text + basic sketch) Exemplary example shows (in sketch) and describes (in text) all component solids in the design, and describes in text how they will connect together.
<u>During the Project:</u> Design Schematic or Physical Model of logo (students' choice), properly labeled with scales indicated. Exemplary example shows the students' design in graphical or physical form. Several visual representations are provided, from a variety of angles and both three-dimensional and two-dimensional. If students choose to build a physical model, teacher will provide the use of a digital camera so that pictures of the design can be preserved. In the exemplary example, all parts have labels (on schematics or digital photos) indicating their scale in all dimensions.
<u>End of the Project:</u> Written Report: including design rationale, and calculations of surface area & volume, at nano and macro (tabletop) scale, plus thoughtful discussion – Exemplary example includes (1) a design rationale (why was this design chosen over other possible solutions), and calculations of surface area & volume at both nano and macro scale (for comparison, calculations should also be done for if the logo were big enough to fit on a table), plus thoughtful discussion – If the company wanted to reproduce this logo in large scale (to go on top of their building), what materials should they use, to make it strong and lightweight? (2) the design schematics or pictures of a physical model, (including any design changes made since first doing the schematic/model), complete with scale labels. These 2 and 3-dimensional representations should be used as a tool for calculating the surface area and volume. Presentation to class. Exemplary example (1) includes 5-10 powerpoint slides, including visual representation of the students' design, indications of scale, and the surface area and volume of the logo for two scales (nano and macro) (2) is clear and concise (3) lasts between 10 and 12 minutes (no more and no less)

Total project grading plan:

Individual Research		10%
Participation in all class activities, including group work on project		20%
In-class work, Labs, Homework		20%
Project Products		50%
Design Plan	10 pnts	
Design Schematic	10 pnts	
Written Report	15 pnts	
Presentation to Class	15 pnts	

A collaborative effort between Region XIII and Region 20 and their partners

Project Map

Product: Design Plan

KNOWLEDGE AND SKILLS NEEDED	**ALREADY HAVE LEARNED**	**TAUGHT BEFORE THE PROJECT**	**TAUGHT DURING THE PROJECT**	**HOW TAUGHT?**
1. writing	X			
2. technical writing			X	In-class exercises
3. computer illustration / 3-dimensional sketching			X	In-class exercises

What project tools will you use?

Daily goal sheet

Project Map

Product: Design Schematic

KNOWLEDGE AND SKILLS NEEDED	ALREADY HAVE LEARNED	TAUGHT BEFORE THE PROJECT	TAUGHT DURING THE PROJECT	HOW TAUGHT?
1. thinking in 3 dimensions	X		X	In-class practice
2. computer illustration			X	In-class practice
3. labeling	X	X	X	Modeling and practice
4. measurement	X	X	X	Modeling and practice

What project tools will you use?

Daily goal sheet
Task lists

Project Map

Product: Written Report

KNOWLEDGE AND SKILLS NEEDED	ALREADY HAVE LEARNED	TAUGHT BEFORE THE PROJECT	TAUGHT DURING THE PROJECT	HOW TAUGHT?
1. word processing	X		X	In-class exercise
2. writing	X			In-class exercise
3. technical writing			X	Direct instruction, modeling and practice
4. surface area calculations			X	Direct instruction, modeling and practice
5. volume calculations			X	Modeling and practice
6. critical / creative thinking	X	X	X	In-class practice
7. computer illustration			X	

What project tools will you use?

Know/need to know lists
Daily goal sheet
Task lists

Project Map

Product: Presentation to Class

KNOWLEDGE AND SKILLS NEEDED	ALREADY HAVE LEARNED	TAUGHT BEFORE THE PROJECT	TAUGHT DURING THE PROJECT	HOW TAUGHT?
1. powerpoint	X	X	X	Modeling and practice
2. persuasive public speaking		X	X	In-class exercises, modeling and practice
3. computer illustration			X	In-class practice
4. surface area calculations			X	Direct instruction, modeling and practice
5. volume calculations			X	Direct instruction, modeling and practice

What project tools will you use?

Know/need to know lists
Daily goal sheet
Task lists

Step 4: Plan the Design Challenge 5E Lesson

Design Challenge Title: Assembling DNA with Nanobots

TEKS/TAKS objectives: (Geometry)

G.6(C) The student analyzes the relationship between three-dimensional geometric figures and related two-dimensional representations and uses these representations to solve problems (SE: use orthographic and isometric views of three-dimensional figures to represent and construct three-dimensional figures and solve problems.

G.8(D) The student uses tools to determine measurements of geometric figures and extends measurement concepts to find perimeter, area, and volume in problem situations (SE: find surface areas and volumes of prisms, pyramids, spheres, cones, cylinders, and composites of these figures in problem situations).

Engage Activity: Identify/focus on instructional task, connect between past & present learning experiences, lay groundwork for activities (ex. Ask a question, define a problem, show a surprising event, act out a problematic situation)

The particular subject area is introduced to the students with common examples that have meaning in their lives.

Activities:

1. Watch a short videos on " Video Journey into Nanotechnology" and "Carbon Nanotubes, What They Are and What Applications They May Bring in the Future":

http://www.azonano.com/nanotechnology-video-details.asp?VidID=39
http://www.youtube.com/watch?v=5jqQxuVncmc

2. Have a guest expert come in to talk about the geometry of scale. For example, one of the professors of Electronic and Advanced Technologies from Austin Community College, Riverside campus.

3. Each student will be given a letter to launch the project (see attached).

4. Groups are assigned.

5. Groups meet and brainstorm ideas.

Engage Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Product:

Design Plan (text + basic sketch)

[Next page: launch letter to students]

Dear new employees,

Congratulations on being hired to the design team of **Nanotech Transformative Hardware (NTH)**! We are very pleased to have you on board.

As you know, NTH is making its mark in the world of ultra-small electronic components. We've moved beyond the standard microchip. We're producing nanochips (squares 40 nanometers on a side), which will naturally revolutionize the computer industry.

We expect to roll out these nanochips onto market very soon. But, we need to put our corporate logo on the chip.

Your challenge is to design a logo for us that our engineers can build out of nanomaterials. It can be three-dimensional, but must be no more than 30 nm wide by 30 nm long by 15 nm high at its greatest extent. We want it to be clearly legible, with a microscope of course, and persuasive. We'll probably want to use other scales of your logo design as well, for tabletop art and to place on top of our corporate headquarters.

I'm including a graphic, to help you get a sense of the scales involved (see attached).

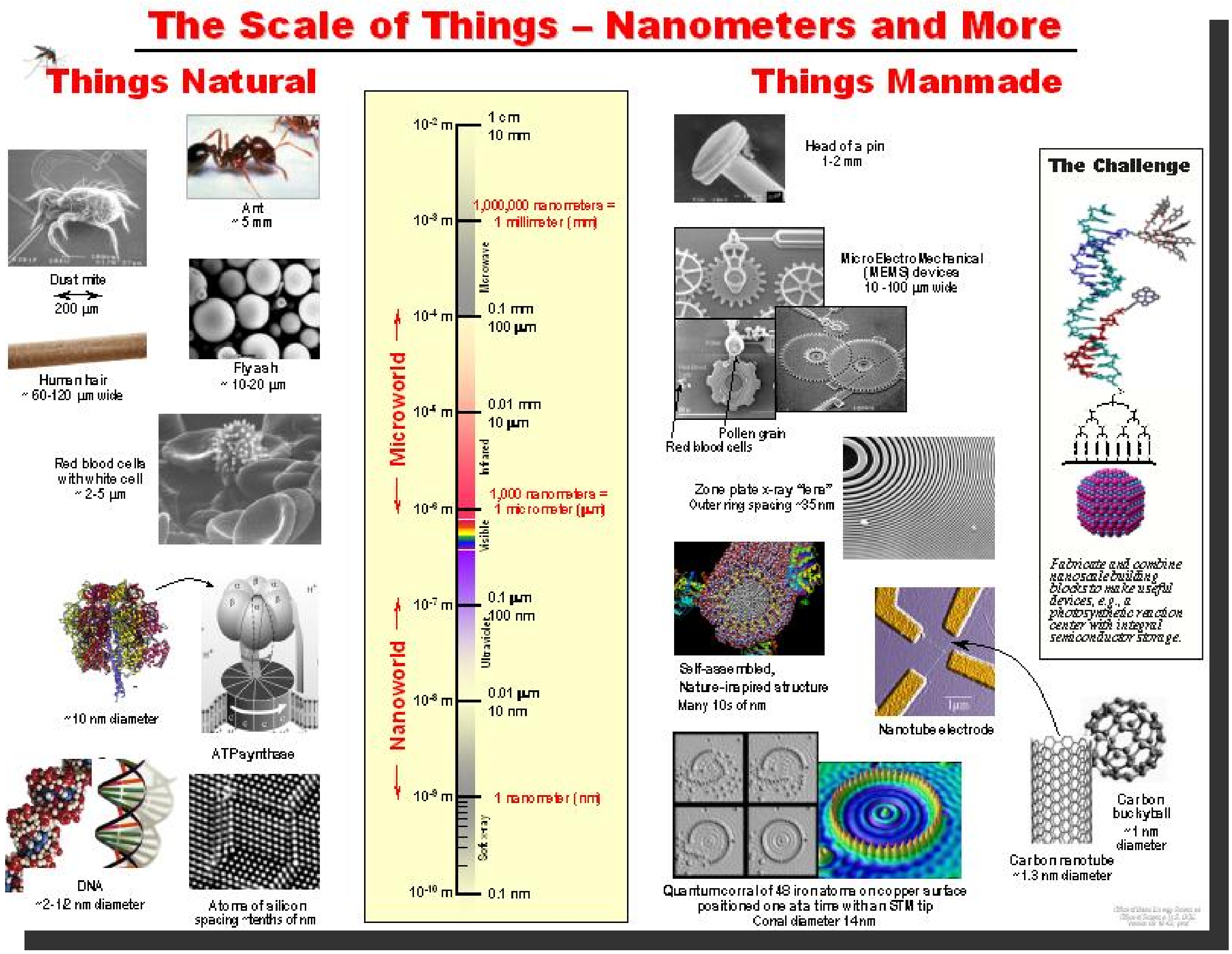
Please prepare: a design schematic or a prototype, a written description of your design, and a presentation for the board. We have enlisted other design teams as well, so you must be persuasive.

Again, welcome aboard.

Sincerely,

Robert Briggs, CEO

Nanotech Transformative Hardware, Inc.



(image from: http://www.sc.doe.gov/bes/Scale_of_Things_07OCT03.pdf)

Engage Activity Materials/Equipment

Computers (for preparing preliminary designs on Geometer's Sketchpad and Google Sketch-Up), LCD projector and teacher computer (for showing videos).

Engage Activity Resources

1. Geometer's Sketchpad and Google Sketch-Up
2. http://www.nanotechworkforce.com/curriculum/modules.php
3. http://en.wikipedia.org/wiki/Nanotechnology
4. http://www.nano.gov/
5. http://www.zyvex.com/nano/
6. http://www.nanowerk.com/nanotechnology/videos/videos.php
7. http://www.austincc.edu/nanotech/
8. Austin Community College (ACC) – Electronics and Advanced Technology program & professor(s)
9. http://www.azonano.com/nanotechnology-video-details.asp?VidID=39
   http://www.youtube.com/watch?v=5jqQxuVncmc

Explore Activity: Students get involved with phenomena and materials; students work in teams to explore through inquiry.

Directed laboratories are conducted so the students can experience the principles in a controlled manner. This experience is crucial to success in solving design challenges.

Students explore volumes of various solids (spheres, cylinders, prisms, pyramids, etc.) through displacement of water.

Each group is given a series of different small solids (must be denser than water, able to withstand getting wet, and small enough to fit in a graduated cylinder yet big enough to measure easily – 2 different sizes for each shape – such as marbles and ball bearings for spheres, dice of different sizes and shapes, and pennies and nickels for cylinders), a graduated cylinder, water, and a ruler on a fixed stand for measurements.

Students follow a basic procedure:
1. Measure the dimensions of the solid in centimeters (length, width, height, diameter, whatever that solid has).
2. Put water in the graduated cylinder and measure the volume of the water (V_{water})

in mL ($1mL = 1cm^3$)
3. Place solid into graduated cylinder and measure volume of water + solid ($V_{solid+water}$)
4. Infer volume of solid ($V_{solid}=V_{solid+water}-V_{water}$)
5. Repeat for other solids

Students can then discuss patterns they see within their group, and start to hypothesize about the relationships between the formula between the dimensions and the volume.

Discussion should then progress to the class as a whole (this becomes the Explain).

Explore Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Artifacts:

1. Lab sheet (see attached) with measurements of dimension, measurements of volume of water before and after adding each solid, and inferred volume of solids.
2. Brainstorming sheet (within group) about relationship between volume and dimensions.

Explore Activity Materials/Equipment

Water, graduated cylinders (1 per group, so 7-8), rulers (7-8 total), ruler stands (7-8 total), small solids for experiment (3-4 shapes, 2 sizzes each for each group), paper, pencils, calculators, paper towels.

Explore Activity Resources

N/A

Volume Lab Report

(to be completed in groups of 4)

Each group should collect the following materials (please designate one team member to get materials):

1 graduated cylinder
1 ruler
1 ruler stand
small solids: 1 large marble, 1 small marble, 1 each large and small 4, 6, and 8 sided dice, 1 penny, and one nickel.
4 calculators (one for each student)
scratch paper
paper towels
1 pitcher of water

Purpose: to explore volumes of various solids (spheres, cylinders, prisms, pyramids, etc.) through displacement of water.

Procedure:

1. Fill the graduated cylinder roughly halfway with water from the pitcher.
2. Note the water level and record in data collection table. (V_{water})
3. Measure the dimensions of one of the small solids (side length, diameter, height, as appropriate. Record all measurements.
4. Place the solid into the cylinder.
5. Record the new water level. ($V_{solid+water}$)
6. Compute the volume of water displaced by the solid and record it ($V_{solid}=V_{solid+water}-V_{water}$).
7. Pour the water back into the pitcher. Retrieve the solid and set it aside.
8. Repeat steps 1-7 for all solids provided.
9. Complete the reflection questions as a group. Be prepared to report back to the whole class.

Data Collection Table:

Solid	**Dimensions**	V_{water}	$V_{water+solid}$	V_{solid}
SMALL MARBLE	D =			
LARGE MARBLE	D =			
PENNY	D = H =			
NICKEL	D = H =			
SMALL 4 SIDED DIE	L =			
LARGE 4 SIDED DIE	L =			
SMALL 6 SIDED DIE	L =			
LARGE 6 SIDED DIE	L =			
SMALL 8 SIDED DIE	L =			
LARGE 8 SIDED DIE	L =			

(D = diameter, H = height, L = side length)

Reflection Questions:

1. What is the ratio of the volume of the large 6-sided die to the volume of the small 6-sided die?

2. What is the ratio of the side length of the large 6-sided die to the side length of the small 6-sided die?

3. What do your answers to questions 1 and 2 tell you about the relationship between side length of a cube and volume? ____
____
____

Explain Activity: Students discuss observations, ideas, questions and hypotheses with peers, facilitators, groups. Learners apply labels to their experiences – thus developing common language, clarification/explanation of key concepts

Delivery of the content begins with a discussion of the principles illustrated by the Hands-On examples. In this way, the participants' intuition is tapped to introduce terms and concepts that they may have heard. This approach leads naturally to an in-depth discussion of the science and mathematics concepts underlying the particular subject area.

Class comes together again to discuss results of explore activity. Students provide basic form of volume equations (e.g., $V_{sphere} \sim r^3$); teacher directs discussion as needed and provides constants of formulas where needed (e.g., $V_{sphere}=4\pi r^3$).

Discussion of increasing dimension: area is proportional to one dimension times the second dimension of a two-dimensional shape ($A = LW$ or ½ bH or πr^r); volume is proportional to one dimension times the second times the third dimension of a 3-dimensional solid ($A = LWD$ or $4\pi r^3$).

Formulas for common solids are provided (by teacher).

Sample problems are first modeled by teacher, then done as a class, then done by individual students (in class).

Explain Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Brief volume problem set. (see attached)

Explain Activity Materials/Equipment

laptop, powerpoint, LCD projector, paper, pencils, calculators

Explain Activity Resources

Geometry text, wikipedia

Volume Problem Set – show all work and draw diagrams as needed.

1. What is the volume of a sphere of diameter 10 meters?

2. What is the volume of a sphere of radius 2 inches?

3. What is the volume of a cube with sides measuring 11.34 cm?

4. An architect is designing a pyramid shaped house.
   a. If the house is an equilateral pyramid with sides measuring 20.5 feet, what is the height of the ceiling at its highest point?

   b. What is the volume of the house?

5. In art class, you need to make pyramids out of clay with a height of 10 cm and a square base of length 10 cm. You're given a 10cm cubic block of clay. How many pyramids can you made before you have to get more clay?

Explore Activity: Students get involved with phenomena and materials; students work in teams to explore through inquiry.

Directed laboratories are conducted so the students can experience the principles in a controlled manner. This experience is crucial to success in solving design challenges.

Students construct 3-dimensional solids (pyramids, prisms, cylinders) out of card-stock paper. They take careful measurements of all dimensions of their solid, calculate the area of each separate shape used to construct the solid, and infer the surface area of the whole.

Teacher will provide one pre-printed template for each shape, and groups will also construct their own (at least one)

Explore Activity Products and Artifacts:

3. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
4. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Artifacts:

1. constructed shapes
2. notes with surface area calculations.

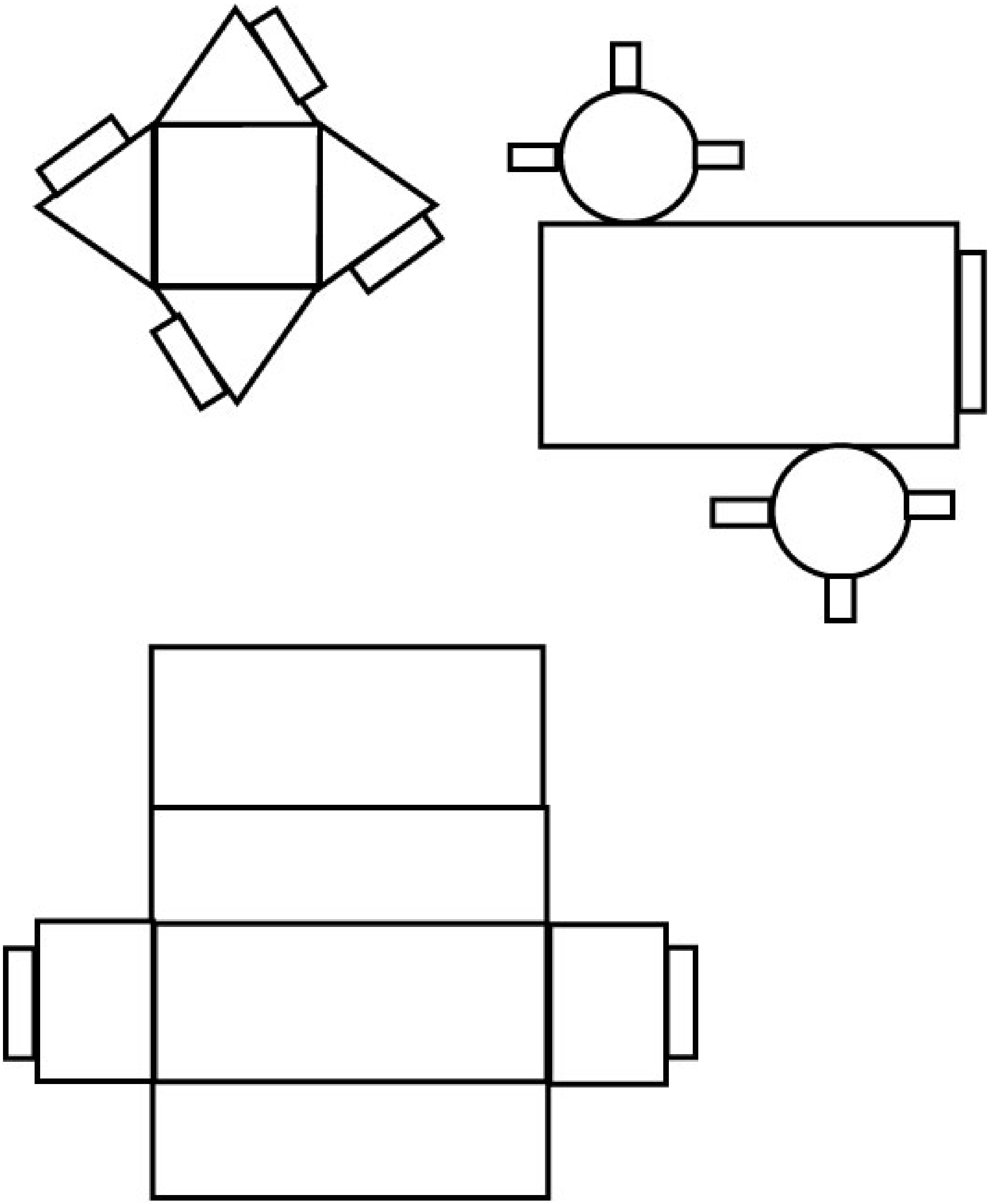
Explore Activity Materials/Equipment

card-stock, scissors, tape, rulers, paper, pencils, calculators

Explore Activity Resources

templates for constructing three-dimensional shapes (see attached)

Some sample templates:



(sample templates created by Christina Holland)

Explain Activity: Students discuss observations, ideas, questions and hypotheses with peers, facilitators, groups. Learners apply labels to their experiences – thus developing common language, clarification/explanation of key concepts

Delivery of the content begins with a discussion of the principles illustrated by the Hands-On examples. In this way, the participants' intuition is tapped to introduce terms and concepts that they may have heard. This approach leads naturally to an in-depth discussion of the science and mathematics concepts underlying the particular subject area.

Class comes together again to discuss results of explore activity. Students provide basic form of surface area equations (e.g., S.A. = sum of area of all faces); teacher directs discussion as needed and provides precise formulas where needed (e.g., $SA_{sphere}=4/3\ \pi r^2$, $SA_{cylinder}=2\pi rh + 2\pi r^2$).

Formulas for common solids are provided (by teacher).

Sample problems are first modeled by teacher, then done as a class, then done by individual students (in class).

Explain Activity Products and Artifacts:

3. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
4. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Brief surface area problem set. (see attached)

Explain Activity Materials/Equipment

laptop, powerpoint, LCD projector, paper, pencils, calculators

Explain Activity Resources

Geometry text, wikipedia

Surface Area Problem Set – Show all work and draw diagrams as needed:

1. What is the surface area of a cube measuring 10 cm on a side?

2. You are painting a room, 15 ft wide by 20 ft long by 10 feet high.
   a. How much paint is needed for the 4 walls?

   b. How much additional paint is needed to paint the floor and ceiling?

   c. What is the total surface area?

   d. There's a round pillar in the middle of the room, with a diameter of 1 foot. Now what is the total area to be painted? (Include walls, ceiling, floor, and pillar)

3. What is the surface area of the Earth? The radius is 6378 km.

Elaborate Activity: Expand on concepts learned, make connections to other related concepts, apply understandings to the world. (ex. Extend & apply knowledge).

At its heart, engineering is the application of science and mathematics to design solutions to problems for humanity. Thus, providing design opportunities to students is a key component of STEM education.
Opportunities to be creative in open-ended situations peak the interest of many students, providing an answer to the ubiquitous question: "Why do we need to know this?"

Students work in groups to design a nano-robot device to accomplish a specific task: designing a nano-scale logo to be placed on a 40 nm nanochip.

Students must "build" the logo out of carbon sheets (graphite, which would form prisms with more than one sheet), buckeyballs (approximately spheres), and carbon nanotubes (cylinders), which have very specific dimensions. They can use their imagination to design the device within those constraints. Their goal is to be as efficient with materials as possible while still designing a device that could work.

Since students won't have the facilities to actually build on the nano scale, they can design either on the computer (using Google Sketch-Up or The Geometer's Sketchpad), with paper and pencil, or by building a macro-scale model. All three methods will be modeled and taught.

In building macro-scale models, chicken-wire can be used to represent graphite (wire is in a hexagon pattern). The same material can be rolled into (macro) nanotubes, and modified (with wire cutters and spare wire to connect bits together) to form buckyball spheres. A digital camera should be made available for students to record visual representations of their model, which can then be labeled.

Elaborate Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Product:
Design Schematic or Physical Model of logo (students' choice), properly labeled with scales indicated.

Elaborate Activity Materials/Equipment

computers, paper, pencils, calculators, chicken wire, spooled wire, wire cutters, rulers, digital camera, media reader for camera, printer

Elaborate Activity Resources

Google Sketch-Up, The Geometer's Sketchpad, photo software

Evaluate Activity: Ongoing diagnostic process to determine if the learner has attained understanding of concepts & knowledge (ex. Rubrics, teacher observation with checklist, student interviews, portfolios, project products, problem-based learning products, assessments). Leads to opportunities for enrichment through further inquiry and investigation.

What is the culminating task?

Groups refine their nano-device design, calculate its total surface area and volume at the nano scale and if it were to be scaled up to the macro-scale, and communicate their design and ideas through a written report and a group presentation to the class.

Evaluate Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Products:

Written Report
Presentation to class.

Evaluate Activity Materials/Equipment

computers, LCD projector, digital camera, media reader for camera, printer, timer

Evaluate Activity Resources

MS Word, MS Powerpoint, Adobe Illustrator, The Geometer's Sketchpad, photo software, geometry text

Step 5: Plan the Assessment

Engage Product: Design Plan (text + basic sketch) Criteria: Exemplary example shows (in sketch) and describes (in text) all component solids in the logo, and describes in text how they are connected.
Explore Artifacts Volume lab sheet— Exemplary example has recorded measurements of all dimensions of each solid, a measurement of the water level in the graduated cylinder before and after the addition of each solid, and an inferred value for the volume of each solid. Volume brainstorming sheet— Exemplary example shows thought processes of students in group pertaining to calculations of volume, and some beginning of a relation between volume of a solid and its measured dimensions (i.e., as any dimension increases, the volume increases, or better: volume changes linearly with each dimension)
Explain Artifact: Volume problem set Exemplary example has all problems completed, with answer correct and all work shown, including formulas as applicable.

Explore Artifacts: Surface area constructed solids— Exemplary example is neatly constructed, with no missing or extra pieces. Surface area notes and calculations— Exemplary example has complete and accurate calculation of surface area for all constructed solids, with correct answers and all work shown.
Explain Artifact: Surface area problem set Exemplary example has all problems completed, with answer correct and all work shown, including formulas as applicable.

Elaborate Products:

Design Schematic or Physical Model of device (students' choice), properly labeled with scales indicated.

Criteria:
Exemplary example shows the students' design in graphical or physical form. Several visual representations are provided, from a variety of angles and both three-dimensional and two-dimensional. If students choose to build a physical model, teacher will provide the use of a digital camera so that pictures of the design can be preserved. In the exemplary example, all parts have labels (on schematics or digital photos) indicating their scale in all dimensions.

Evaluate Products:

Written Report

Criteria:
Exemplary example includes
Written Report: including design rationale, and calculations of surface area & volume, at nano and macro (tabletop) scale, plus thoughtful discussion –
Exemplary example includes
(1) a design rationale (why was this design chosen over other possible solutions), and calculations of surface area & volume at both nano and macro scale (for comparison, calculations should also be done for if the logo were big enough to fit on a table), plus thoughtful discussion – If the company wanted to reproduce this logo in large scale (to go on top of their building), what materials should they use, to make it strong and lightweight?
(2) the design schematics or pictures of a physical model, (including any design changes made since first doing the schematic/model), complete with scale labels. These 2 and 3-dimensional representations should be used as a tool for calculating the surface area and volume.

Presentation to class.

Criteria:
Exemplary example includes 5-10 powerpoint slides, including visual representation of the students' design, indications of scale, and the surface area and volume of the device for two scales (nano and macro); is clear and concise; and lasts between 10 and 12 minutes (no more and no less)

Step 6: Create Rubrics

Develop rubrics for each artifact/product of the 5E learning cycle, using the criteria for exemplary performance as a foundation for the rubric.

Rubric: Design Plan

10 points possible.

	0 points	**1 point**	**3 points**	**5 points**
Sketch	Not present.	Shows some parts of device.	Shows ALL parts of device with function of some parts labeled.	Shows ALL parts of LOGO, with ALL individual parts clearly labeled.
Description (text)	Not present.	Describes some parts of device.	Describes ALL parts of device and the individual functions of some.	Describes ALL parts of LOGO and the purpose of EVERY part.

Rubric: Volume Lab Sheet: (one point for each checked item)

	Small marble	**Large marble**	**penny**	**nickel**	**Small 4-sided die**	**Large 4-sided die**	**Small 6-sided die**	**Large 6-sided die**	**Small 8-sided die**	**Large 8-sided die**
Measurement of all dimensions of solid										
Measurement of water volume before adding solid										
Measurement of total volume after adding solid										
Inference of volume of solid										

Rubric: Volume Brainstorming

0 points	5 points	10 points
Though processes of group not at all apparent	Shows some thinking about relationship between volume and dimension, but no formula approximated	Attempts to quantify relationship between dimensions of object and its volume, some type of formula attempted to explain this relationship.

Rubric: Volume Problem Set

For each problem, points are awarded as follows:

Not attempted:	0 points	
Attempted, work shown, but final answer is incorrect:	2 points	
Attempted, correct answer given but no work shown:	1 point!	← show your work!
All work shown, correct answer given:	3 points	

Rubric: Design Schematic

10 points possible.

	0 points	1 point	3 points	5 points
Visual representation (blueprints or physical model and photos, students' choice)	Not present.	1-2 distinct views provided.	3-4 distinct views provided, from different angles showing different aspects of device.	5+ DISTINCT VIEWS PROVIDED (DIFFERENT ANGLES) IN BOTH 2 AND 3 DIMENSIONAL REPRESENTATIONS.
Labels	Not present.	Some parts of logo labeled.	ALL parts of logo labeled.	ALL PARTS OF LOGO LABELED, WITH SCALE ON ALL.

Rubric: Constructed Solids

For each solid, points are awarded as follows:

Not attempted:	0 points
Attempted, object incomplete or has gaping seams:	1 point
Object is well constructed, with creases on edges and no gapes on seams:	2 points

Rubric: Surface Area Notes and Calculations

For each solid, points are awarded as follows:

Surface area not computed:	0 points
Area of some faces correctly computed:	1 point
Correct surface area given, no work shown:	1 point
Correct areas for all faces of solid given, work shown, and correct total surface area given:	2 points

Rubric: Surface Area Problem Set

For each problem, points are awarded as follows:

Not attempted:	0 points	
Attempted, work shown, but final answer is incorrect:	2 points	
Attempted, correct answer given but no work shown:	1 point!	← show your work!
All work shown, correct answer given:	3 points	

Rubric: Written Report: 15 points possible.

	0 points	1 point	2 points	3 points
Formatting	No text.	Less than 3 or greater than 5 pages (text only) when formatted properly.	Not 12 point Times / New Roman font, double spaced, but would be 3-5 pages if it were correctly formatted.	3-5 PAGES (NOT INCLUDING IMAGES) OF 12 POINT TIMES / NEW ROMAN FONT, DOUBLE SPACED.
Design rationale	Not present.	Briefly explains why this device was chosen.	CLEARLY EXPLAINS WHY THIS DESIGN WAS CHOSEN, AND DESCRIBES AT LEAST TWO OTHER VARIATIONS THAT WERE CONSIDERED AND REJECTED.	(2 point max)
Surface area calculations	Not present.	Effort made, but calculations incomplete or incorrect, or work not shown.	CALCULATIONS COMPLETE AND CORRECT, AND WORK SHOWN, FOR BOTH NANO AND MACRO SCALES.	(2 point max)
Volume calculations	Not present.	Effort made, but calculations incomplete or incorrect, or work not shown.	CALCULATIONS COMPLETE AND CORRECT, AND WORK SHOWN, FOR BOTH NANO AND MACRO SCALES.	(2 point max)
Discussion of nano-scale logo	Not present.	Briefly describes logo.	CLEARLY DESCRIBES HOW THE LOGO IS CONSTRUCTED, AND WHAT SHAPES COMBINE IN WHAT WAYS.	(2 point max)
Extrapolation to macro-scale	Not present.	Briefly describes whether device would function if scaled up to set on a table.	CLEARLY DESCRIBES WHETHER AND HOW LOGO WOULD WORK IF SCALED UP TO THE TOP OF A BUILDING, AND SUGGESTS 1-2 MODIFICATIONS THAT MIGHT BE NEEDED TO IMPROVE DESIGN FOR THAT SCALE.	(2 point max)
Schematic	Not present.	1-2 distinct views, with some parts labeled with scale and function.	3+ DISTINCT VIEWS (DIFFERENT ANGLES, SHOWING DIFFERENT ASPECTS OF LOGO), IN 2 AND 3-DIMENSIONAL REPRESENTATIONS, WITH ALL PARTS LABELED WITH SCALE AND FUNCTION. UP TO DATE WITH ALL CHANGES MADE TO DEVICE.	(2 point max)

Presentation to Class Rubric: 15 points possible.

	0 points	1 point	2 points	3 points
Length	Less than 4 minutes	1-2 slides, 4-5 minutes	3-4 slides or 11+ slides, 6-9 minutes or 13+ minutes	5-10 POWERPOINT SLIDES, 10-12 MINUTES.
Graphics	Not present.	Some visual representation of logo.	At least two views of logo.	3+ DISTINCT VIEWS OF LOGO, WITH DETAILS CLEARLY VIEWABLE FROM BACK OF ROOM.
Surface area and volume results	Not present.	Calculations incorrect or incomplete.	Results correctly shown for one scale (nano or macro).	RESULTS CORRECTLY SHOWN FOR BOTH NANO AND MACRO SCALES OF LOGO.
Sales pitch	No effort	Audience was left without clear idea of how logo is constructed.	Audience was left understanding how logo is constructed, but unconvinced that they should invest money in your project.	AUDIENCE UNDERSTOOD HOW THE LOGO WOULD BE CONSTRUCTED, AND IS TOTALLY SOLD ON THE IDEA!
Context	Not present.	Shows similarity of logo to one similar real-world corporate logo.	Shows similarity of logo to and differences of logo from multiple real-world examples.	SHOWS SIMILARITY OF LOGO TO EXISTING CORPORATE LOGOS AT BOTH NANO (OR MICRO) AND MACRO SCALES, AND DEMONSTRATES SOME KNOWLEDGE OF DIFFERENCES IN HOW THINGS WORK IN THE TWO SCALES.

Storyboard

Time line, major activities, and important milestones.

(7 class meetings over 2 ½ - 3 weeks, meeting every other day for 90 minutes each)

Day 1	Day 2	Day 3
1. Launch: intro to geometry at nanoscales 2. Assign working groups 3. Issue challenge 4. Groups meet and brainstorm	1. Calculating volume: instruction, modeling, and practice 2. Modeling of brief technical writing / communication 3. Groups brainstorm and design	1. * Design plans DUE * 2. Calculating surface area: instruction, modeling, and practice 3. Exercises in 3-dimensional illustration 4. Groups work on logo model or schematic

Day 4	Day 5
1. Review & jeopardy game 2. Elaboration – surface area and volume change with scale 3. Groups work on schematics & report	1. * Schematic DUE * 2. Exercises in technical writing 3. Practice with surface area and volume 4. Groups work on written report

Day 6	Day 7
1. * Report DUE * 2. Exercises in persuasive communication 3. Groups work on presentations	1. * Group presentations * 2. Class discussion and student evaluations of project

What challenges or problems might arise in this project? 1. time! 2. teamwork and communication, 3. technical skills in Word, Powerpoint, The Geometer’s Sketchpad, etc.

Manage the Process

Describe how you will share the goals and context of the project with the students. 1. letter to students at beginning of project, 2. videos (launch), 3. outside expert
Describe method for assessing checkpoints and milestones. 1. Products due at beginning, middle and end of project, 2. checking in individually with students and groups throughout, 3. in-class exercises throughout project.
How will you and your students reflect on and evaluate the project? Class discussion Individual evaluations – students will evaluate themselves, their group, and the overall project.
Describe how you plan to celebrate success of the project. 1. Special treats on presentation / class discussion day 2. Displaying student designs in classroom after project

List preparations necessary to address needs for differentiated instruction for ESL students, special-needs students, or students with diverse learning styles. 1. Group work – Depending on the needs of individual students, I will work with groups to allocate the work among group members. 2. Learning the concepts – Material will be taught through direct verbal instruction, visual representation, handouts, and manipulatives (and measurement tools) to aid students with different learning styles. 3. Making schematics – Students can choose to use software to do illustrations, to make hand sketches, or to build a physical model and take digital photographs of it. 4. In-class calculations and problems – All students will have access to graphing calculators. As appropriate some students will be given fewer problems, more time, or a distraction-free work-space. 5. ESL students – Vocabulary will be clearly defined verbally and in writing. Additional help will be available as needed for writing and presentation tasks.