Civil Engineering

Indoor Sportsplex Design Challenge

Grade Level(s): 7-8

Academic Content Areas: Mathematics; Science

Topics: Measurement; Geometry and Spatial Sense; Patterns, Functions, and Algebra; Scientific Ways of Knowing; Science and Society; Ethical Practices

Recommended area of co-teaching for an AFRL Engineer or Scientist.

Main Problem/Essential Question

In designing an indoor sportsplex, how can the space be maximized-including sports fields, spectator seating, and other facilities (restrooms, snack stands, etc.)?

Summary

Due to an increasing student population, along with student demand at City College, a multi-purpose sportsplex has been proposed. The school has set aside money and space (200,000 square feet) for development of a multi-function facility. Students will take on the role of civil engineers at an architectural firm and submit a design for this facility which makes the best possible use of the space available.

Big Idea(s) / Focus

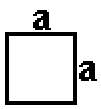
Students will design a sports complex for a local college with the idea that the compound be designed to maximize use of space. Students will also discuss how to reduce operating costs of the facility associated with heating, lighting and other building uses. Teachers may want to invite a facilities engineer from a local industry as a guest speaker since their jobs are to cut costs in lighting, heating, and other energy uses. The industry focus on civil engineering principles will give students insight into real world challenges and trade-offs that civil engineers must consider when designing such buildings.

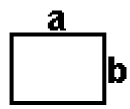
Students will develop problem solving skills as they redesign their sports complexes to accommodate given parameters by using geometry and measurement (i.e., the Pythagorean Theorem, area formulas). While math is the main focus of this lesson, standards from science and technology will also be used to enhance the learning process. Students will research energy efficient ways to light and heat the facility as well as build plumbing, and other things that would make the building go 'green'.

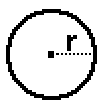
This lesson should be considered for use at the end of seventh or beginning of eighth grade. Middle school students routinely ask why they have to learn math concepts. Through inquiry and design, this lesson provides a real-life example to answer this question in an interesting and challenging manner.

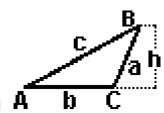
Prerequisite Knowledge

- The students should be familiar with performing conversions between metric units and standard units.
- The students should be able to understand and apply the concept of scale for proportional reasoning.
- The students must be able to determine perimeter of a given 2D figure.
- The students must be able to understand and apply the following area formulas (“math2.org” 2005):

Square: $A = a^2$ 

rectangle: $A = ab$ 

Circle: $A = \pi r^2$ 

triangle: $A = \frac{1}{2} b h$ 

Pythagorean Theorem formula: $a^2 + b^2 = c^2$

Standards Connections

Content Area: Math

Measurement Standard

Grade 7 – Benchmark B: Convert units of length, area, volume, mass and time within the same measurement system.	2. Convert units of area and volume within the same measurement system using proportional reasoning and a reference table when appropriate; e.g., square feet to square yards, cubic meters to cubic centimeters.
Grade 7– Benchmark C: Identify appropriate tools and apply appropriate techniques for measuring angles, perimeter or circumference and area of triangles, quadrilaterals, circles and composite shapes, and surface area and volume of prisms and cylinders.	7. Develop strategies to find the area of composite shapes using the areas of triangles, parallelograms, circles and sectors.
Grade 7 – Benchmark E: Use problem solving techniques and technology as needed to solve problems involving length, weight, perimeter, area, volume, time and	4. Solve problems involving proportional relationships and scale factors; e.g., scale models that require unit conversions within the same measurement system. 5. Analyze problem situations involving measurement concepts, select appropriate strategies, and use an organized

temperature.	approach to solve narrative and increasingly complex problems.
Grade 8 – Benchmark D: Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates.	2. Use proportional relationships and formulas to convert units from one measurement system to another; e.g., degrees Fahrenheit to degrees Celsius.

Geometry and Spatial Sense Standard

Grade 7 – Benchmark E: Use proportions to express relationships among corresponding parts of similar figures.	1. Use proportional reasoning to describe and express relationships between parts and attributes of similar and congruent figures.
Grade 7 – Benchmark G: Describe and use properties of triangles to solve problems involving angle measures and side lengths of right triangles.	3. Use and demonstrate understanding of the properties of triangles. For example: a. Use Pythagorean Theorem to solve problems involving right triangles.
Grade 7 – Benchmark J: Apply properties of equality and proportionality to solve problems involving congruent or similar figures; e.g., create a scale drawing.	6. Determine and use scale factors for similar figures to solve problems using proportional reasoning. 8. Perform translations, reflections, rotations and dilations of two- dimensional figures using a variety of methods (paper folding, tracing, graph paper).

Patterns, Functions, and Algebra Standard

Grade 7 – Benchmark D: Use symbolic algebra to represent and explain mathematical relationships.	8. Use formulas in problem-solving situations.

Mathematical Processes Standard

Grade 7 – Benchmark B: Apply mathematical knowledge and skills routinely in other content areas and practical situations.	
Grade 8 – Benchmark B: Apply and adapt problem-solving strategies to solve a variety of problems, including unfamiliar and non-routine problem situations.	
Grade 8 – Benchmark C: Use more than one strategy to solve a problem, and recognize there are advantages associated with various methods.	
Grade 8 – Benchmark J: Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.	

Preparation for activity

Day 1 Copy "Pre-test" (Appendix A)

Day 2 Copy "Field Dimensions Conversion" Worksheet (Appendix C)

Day 3 Copy "Sportsplex Design" Worksheet (Appendix E). Distribute blueprint paper. Implement plan for placing students in groups of 3-4.

Day 5 Copy "Sportsplex Redesign" Worksheet (Appendix F) and "Exit Slip" (Appendix G).

Day 6 Copy "Design Reflection Worksheet" (Appendix H)

Day 7 Copy "Design Presentation" Worksheet (Appendix I)

Day 8 Copy "Post-test" (Appendix A)

Critical Vocabulary

Area – The number of square units that cover a surface.

Blueprint – A two dimensional scale drawing of a three dimensional building. Also see scale drawing.

Diameter – A line passing through the center of the circle that connects two points on the circumference ("mathisfun.com" 2010)

Circumference – The distance around the edge of a circle (or any curvy shape). (“mathisfun.com” 2010)

Perimeter – The distance around a two dimensional shape (“mathisfun.com” 2010)

Pythagorean Theorem - A theorem stating that the square of the length of the hypotenuse of a right triangle is equal to the sum of the squares of the lengths of the other sides. It is mathematically stated as $c^2 = a^2 + b^2$, where c is the length of the hypotenuse and a and b the lengths of the other two sides. (“The Free Dictionary” 2011)

Radius – The distance from the center of the circle to the edge of the circle (“mathisfun.com” 2011)

Scale Drawing – A drawing that shows a real object with accurate sizes except they have all been reduced or enlarged by a certain amount (called the scale). (“mathisfun.com” 2010)

Timeframe

Day	***Time Allotment***	***Activities***
1	50 minutes	Pre-test KWL on Sportsplex, blueprints, and scale
2	50 minutes	Discuss unit conversions Assign Field Dimensions Conversion Worksheet
3	50 minutes	Give students Sportsplex Design Worksheet Begin blueprints of initial team design
4	50 minutes	Complete blueprints of initial team design
5	50 minutes	Give students Sportsplex Redesign Worksheet Begin new scale drawing given specific criteria Complete Exit Slip
6	50 minutes	Complete new scale drawing given specific criteria Begin Design Reflection Worksheet
7	50 minutes	Complete Design Reflection Worksheet Prepare Design Presentation

8	50 minutes	Design Presentations and Post Activity Discussion Post-test

Materials & Equipment

Digital Camera

Memory Card

USB Cable (to connect camera and computer)

Engineering Paper

Metric Rulers – 1 per student

Computers with Internet access or Microsoft office power point

Scissors

Calculators

Document Camera (optional)

Safety & Disposal

Students will be working in small cooperative groups. Groups will need to be monitored for on-task behavior throughout the lesson.

Pre-Activity Discussion

1. To introduce the lesson asking students what they know already about sports stadia and architecture. Suggested questions include:

Have you ever been to a professional sports stadium?

What did you think about this stadium?

What did you like about this design?

The stadium you saw was already being built—what has to happen first to get to this stage?

If you could design your own stadium, what would it include?

What do architects do when they are designing buildings?

2. Students should realize that in order to build something, it first has to be designed. In order to design a building, architects first make a 2-D scale model which is called a blueprint.

3. As a class, begin filling out a KWL chart (The chart will include sport stadiums, blueprints, and scale).

4. Ask the students what they know about blueprints and scale. Provide students with basic blueprints such as the one in Appendix J.

5. Ask questions about the scale of the print to the actual building. Also discuss the purpose for blueprints and how they are used in order to make a plan before the construction phase.

6. Ask questions about what scale means and how to interpret scale.

An engineer can lead the discussion and explain what role they play in building structures. They can discuss or elaborate on blueprints, how to the interpret them, how to apply them, and current computer software used to create them.

Teacher Instructions

Day 1

1. Students complete the pre-test (Appendix A).

2. Pre-Activity Discussion

    1. Have students complete a KWL regarding the following ideas:
        a. Sportsplexes
        b. Blueprints
        c. Scale

    2. Think-Pair-Share - After allowing the students to complete each of the three KWL, have them:
        a. Pair & Share
        b. Share with small group
        c. Share with class

    3. Then as a class, complete the "What Would You Like To Know" about each of the three topics.

Day 2

1. Students will complete a KWL regarding the following ideas:
    - Sportsplexes
    - Blueprints
    - Scale

2. Think-Pair-Share – Allow students to complete each of the three KWL and then have them:
    - Pair & Share
    - Share with small group
    - Share with class

3. As a class, complete the "What Would You Like To Know" about each of the three topics.

4. Briefly introduce that due to increasing student population, along with student demand at a

City College, a multi-purpose sportsplex has been proposed. Students have been hired, as civil engineers, to submit a design of the facility.

5. At this time, pass out the "Field Dimensions Conversion Worksheet" (Appendix B, task 1) to the students and discuss the directions. This worksheet becomes homework.

Day 3 Application of Surface area to Sportsplex (see Appendix B: task 1)

1. Review the "Field Dimensions Conversion Worksheet" to make sure the students have the correct answers.

2. Break the students up into teams of 3 to 4 students per team.

3. Inform the students that the committee has set forth certain stipulations as to how the total available space is to be used.

4. REMIND THEM THAT THESE ARE THE REQUIREMENTS SET FORTH BY THE COMMITTEE *AT THIS TIME*!

STIPULATIONS:

a. Building will have a footprint or surface area of 75, 625 square meters
b. Using either the given 5 sporting fields from yesterday's worksheet "Field Dimensions Conversion Worksheet," the Sportsplex committee is interested in seeing the maximum number of fields possible in the given footprint (75, 625 square meters).

5. Pass out the engineering paper and allow the teams to work on maximizing the given area.

Dimensions of some "Playing surfaces." Students may use the dimensions found from day 1 homework as well.

Football field (390ft x 190ft)

Basketball (94ft x 60ft)

Baseball field (150ft down the line, right and left, 1/2 circle with a 212 ft diameter)

L-shaped pool (164 ft x 82 ft, with attached 84 ft x 84 ft warm-up section)

Soccer Field (360 ft x164 ft)

An engineer can lead the class or aid teams of the implementation of these mathematical concepts in their design. This individual can stress the importance of accurate measurements, calculations, and applications of formulas. This individual can help spark creativity in the student designs.

Day 4

1. Complete initial design

Day 5

1. Allow students to share their initial designs. Question why they chose to design their building as they did and how they used the given area.

2. After discussing their rationale, introduce students to the new stipulations regarding the complex requested by Sportsplex Committee.

   New Stipulations:

   Complex must be able to house three sporting events at a given time. Students need to choose any combination of three sporting events from the 5 fields given in the Field Dimensions Worksheet (Appendix C).

3. Students complete Exit Slip questions for a quick formative assessment to check for understanding (see Appendix G).

An engineer can lead the class or aid teams of the implementation of these mathematical concepts in their design. This individual can stress the importance of accurate measurements, calculations, and applications of formulas. This individual can help spark creativity in the student designs.

Day 6

1. Complete finishing touches to blueprints.
2. Begin Design Reflection Worksheet (Appendix H)
3. Allow teams to discuss and compare designs.

Day 7

1. Begin Design Reflection Worksheet (Allow teams to discuss and compare designs).
2. Prepare Design Presentation (Appendix H). Students will need internet access or Microsoft Office Power Point

Day 8

1. Design Presentations
2. Post-test (Appendix A)
3. Use the Project Rubric (Appendix K) to assess student mastery

Background Information

In order to produce structures that are functional and interesting, engineers as well as architects must apply various principles of mathematics and geometry. Scale drawings or blueprints are used as patterns during the construction of buildings. Proper ratios and proportions relate each feature of a design to each other and to the real life construction of a building. This project addresses basic mathematical principles used in architecture and engineering. Students must apply these mathematical principles to their design of a sports complex and discuss the concepts of measurement, scale drawings, ratios and geometry in small groups.

Scaling is a proportion used to determine the dimensional relationship of a representation to that which it represents ("The Free Dictionary" 2011). Common scales can include 1:10, 1:100, 1:24000, etc. Each means that one unit on a blueprint represents 10, 100, or 24000 of the same unit in real life. The unit of measurement is commonly centimeters or inches. If a person wanted to represent 1 cm = 1m on a blueprint, the scale would be 1:100.

Blueprints are commonly used by civil engineers and architects when they are planning the design of a building. They are simply a detailed plan or model that is drawn to scale of a building or land layout. In this project, students will be required to draw a scaled blueprint of a sports complex that holds various sporting fields.

It will be important for students to understand the concepts of area and they should know how to calculate it before beginning this project. Some important formulas can be found in the Prerequisite Knowledge section of this document.

Assignment of Student Roles and Responsibilities:

Students will all assume the different roles: (example provided)

Role Name	*Brief Description*
Drafter	Responsible for ensuring that all team members complete a scale drawing, measurement their cut-outs correctly, and use accuracy in calculations
Note Taker	Responsible for taking notes during brain storming and keeping track of any changes made to the original design.
Presenter	Responsible for preparing materials for final presentation
Project Manager	Responsible for accuracy and aesthetics

Student Instructions

Appendix C, E, F, G, H, I

Formative Assessments

Use the Exit Slip questions during the Day 5 lesson, after new stipulations/parameters have been determined and given to the students. This will be a quick assessment to check for understanding. (Appendix G)

Post-Activity Discussion

The following questions could be used as classroom discussion questions or has a handout for individual reflection in advance of post-test. (Appendix H)

- Look over your final blueprint design. Do you see any space that is "left-over"? If so, how can you utilize this space? You are not restricted to just adding more seating for spectators etc. If you can think of a novel way to use the space, by all means do so. The only restriction is that it must in some way correlate with the idea of serving a sports complex.

  Answers will vary.

- Compare your final blueprint design of the sports complex with other groups in your class. Was your design more or less efficient than the other groups? Give a detailed explanation of how you reached your conclusion.

  Answers will vary.

- Is the complex that you designed, fully functional as it stands? Is it missing any vital components? If so, what are they?

  A place to house water heaters, heating and cooling equipment, janitorial services etc. In other words - facilities management.

- Do you have any space to accommodate these necessities or do you have to redesign your complex?

  Any left-over space could possibly house at least some of these services. Otherwise, students will have to redesign their plan. This question is posed to simply make students aware that there are a lot of issues to consider while designing such complexes.

- You were provided a list of spectator sports that the complex could accommodate. If you were asked to come up with the original list of sports out of which three had to be chosen, how would your list differ?

  Answers will vary. Hopefully the list will be creative.

- What if any of the sports "field" or "arena" was irregularly shaped? How would you compute its area? Explain.

  Students will have to make a scale drawing on graph paper and either section the drawing into regular shapes and find the area of the regular shapes and then count/estimate the left-over squares and find the total area or count/estimate squares for the entire drawing.

Pre-Test / Post-Test
(Appendix A)

Pre-Test / Post-Test Answer Key
(Appendix B)

Technology Connection
Use the **ADISC** Model created by ITEL to plan the use of technology.
(Reference your handbook for more information as to the ADISC model.)

Integration Model	***Application Description***
Technology that supports students and teachers in **adjusting, adapting, or augmenting** teaching and learning to meet the needs of individual learners or groups of learners	Calculators: Used to accurately find area, perimeter, and volume
Technology that supports students and teachers in **dealing effectively with data**, including data management, manipulation, and display	Engineering Paper Calculators Computers Rulers Internet
Technology that supports students and teachers in conducting **inquiry**, including the effective use of Internet research methods	Calculators Camera Computers Rulers Internet Google Sketch-up Draft Sight Crayola.com
Technology that supports students and teachers in **communicating and collaborating** including the effective use of multimedia tools and online collaboration	Camera Computers Internet Google Docs Microsoft Office Power Point

Interdisciplinary Connection

Teachers can incorporate English standards through documentation and research requirements. For example students could research different sports facilities and their design.

Home Connection

Students can access Auto CAD, Google Sketch-up, DraftSight, Crayola.com, and for the less tech-savvy, there is a lesson plan called, "Design Your Dream Stadium". This activity makes use of common 3D materials such as construction paper, glue, scissors, and assorted Crayola coloring products to design and build a hands-on, 3D model of a stadium. The instructions encourage students to ask important questions to be considered in the process of designing and constructing a stadium.

A more challenging and high-tech approach however, is "Google Sketchup". It can be accessed for free via the Google.com website. This software can be used for designing 3D models of anything from furniture, to buildings, to cities. The website includes a tutorial for beginners.

The next time the family is watching a sports competition on T.V., or in person, the student might start a discussion on the science, technology, engineering and math considerations that go into the design and construction of the facility that houses that competition.
Students can ask their parents how they go about deciding how much paint to use when painting a room, how much flooring used to cover an area, and how they plan the layout of a garden.

Parents that work in any type of design or construction field could be guest speakers. Coaches and facility managers can also be included.

Differentiated Instruction

Process: Teacher may place students with partners, in small groups, or they may work by themselves. This can be adjusted on a day to day assessment of student progress using formative assessment and teacher observation.

Product: Templates that can be manipulated on graph paper may be provided for students who need adjustment in the lesson based on ability.

Teacher may adjust 'stipulations' by adding more—for example, students may be asked to consider adding more snack/concession stand(s) for spectators. Students may be given dimensions of this area or may be asked to design and justify their own.

Content: Students who need adjustments while completing the Field Dimensions Conversions Worksheet (Appendix C) may be given the specific formulas for each problem or may be given the conversions to the problems at the teachers' discretion when considering student ability.

Extension

1. Have students estimate how many gallons of paint it would take to paint the interior bathroom walls, given the bathrooms' dimensions.
2. Have students estimate how many square feet of tile needed to cover the interior dimensions of the swimming pool given that it has a depth of 3 meters.
3. Have students created a 3-D version of their field design using DraftSight or Google Sketch-up.

Career Connection

Architect

Architects design buildings and other structures. In addition to considering the way these buildings and structures look, they also make sure they are functional, safe, and economical as well as suit the needs of the people who use them. (About.com 2011)

Civil Engineer

Civil engineers plan, design, and direct projects including: city infrastructure (roads, bridges, power lines, buildings, etc.), irrigation systems, landfills, pipelines, and much more. They are responsible for presenting and analyzing reports, maps, blueprints, geologic data, topography, etc.

Construction Worker

Construction workers are required to follow plans of civil engineers and architects in order to build structures according to a given criteria. They are responsible for purchasing materials and ensuring that these materials meet the specifications that are provided to them.

Human Factors Engineer

Human Factors Engineers are concerned with applying human capabilities to processes, systems and work environments. They would be responsible for ensuring that there is enough room for average and handicap people to move around the complex (walkways, restrooms, etc.) and for seating (regular areas, wheelchair accessible areas, etc.)

Additional Resources

Purpose and Application:	***Resource:***
This site has great teaching ideas for area for a variety of geometric shapes.	http://www.regentsprep.org/Regents/math/ALGEBRA/AS1/indexAS1.htm
For information and teaching tips on surface area, use the following link.	http://www.regentsprep.org/Regents/math/ALGEBRA/AS2/indexAS2.htm
This link has some teaching tips to help with unit conversions and understanding different systems of measurement.	http://www.regentsprep.org/Regents/math/ALGEBRA/AM2/indexAM2.htm
This link that has shapes and sizes (including diagrams) for a variety of sports arenas.	http://pioneerathletics.com/store-category-LAY

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Teacher Reflections

- Were students focused and on task throughout the lesson? *Insert answer here.*
- If not, what improvements could be made the next time this lesson is used? *Insert answer here.*

- Were the students led too much in the lesson or did they need more guidance? *Insert answer here.*
- Did the students learn what they were supposed to learn? *Insert answer here.*
- How do you know? *Insert answer here.*
- How did students demonstrate that they were actively learning? *Insert answer here.*
- Did you find it necessary to make any adjustments during the lesson? *Insert answer here.*
- What were they? *Insert answer here.*
- Did the materials that the students were using affect classroom behavior or management? *Insert answer here.*
- What were some of the problems students encountered when using the …? *Insert answer here.*
- Are there better items that can be used next time? *Insert answer here.*
- Which ones worked particularly well? *Insert answer here.*

Additional Comments

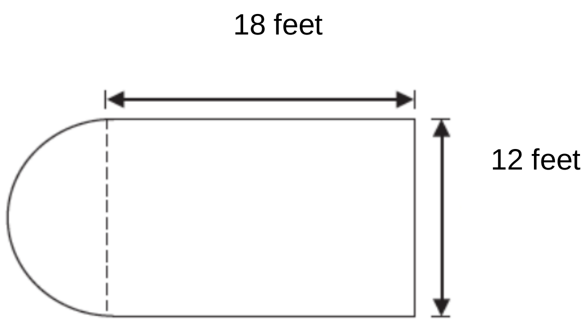
Appendix A: Multipurpose Sportsplex Pre/Post Test

Name ________________________________

Period _____ Date ____________

Solve each problem. You must show your work in order to receive full credit for your answer.

1. The following figure represents part of the basketball court:

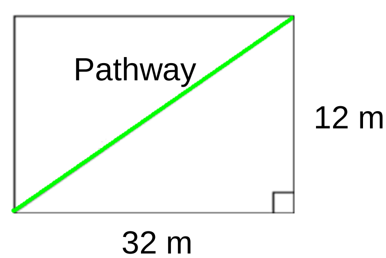


What is the approximate area of this figure—rectangle and half circle? (Use 3.14 for π)

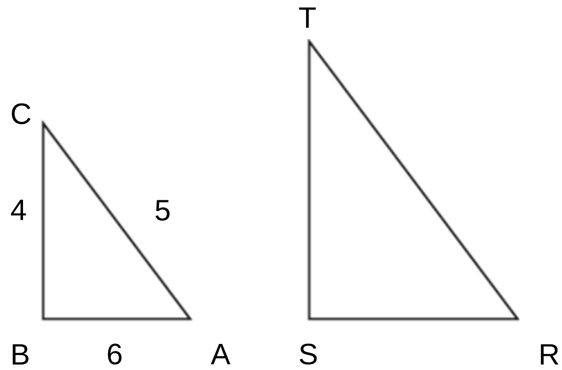
A. 216 square ft
B. 329 square ft
C. 273 square ft
D. 442 square ft

2. A local park is shaped like the figure below. A pathway cuts diagonally through it. What is the length of the pathway? If needed round your answer to the nearest meter.

A. 44m
B. 34m
C. 44ft
D. 34ft



3. Triangle ABC is similar to triangle RST.



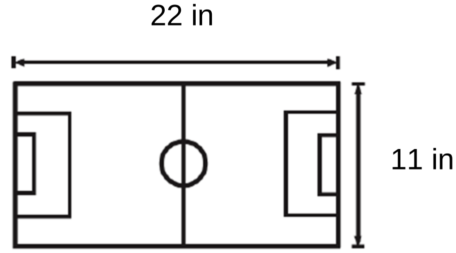
The scale factor of triangle ABC to triangle RST is 2:3. What is the length of RS?

A. 6 units
B. 12 units
C. 7 units
D. 9 units

4. Mitch is making a 1/16 scale model of a 10 story building. Each floor of the building has 8 ft ceilings with an additional 1.5 ft for air ducts, joints, electrical wiring and other building materials. How tall will Mitch's model be?

A. 5.9 ft
B. 5 ft
C. 15.2 ft
D. 12.8 ft

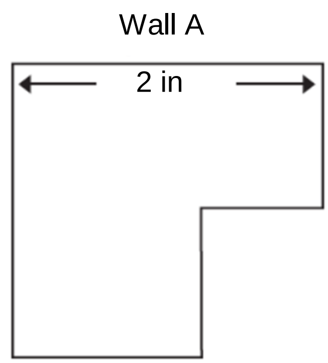
5. The diagram below is used by Alli to put the lines on the indoor soccer field when the season begins.



Alli knows that the width of the indoor field is 85 ft, but the scale is missing. What should the scale say?

A. 1 in. = 5 ft
B. 1 in. = 7.7 ft
C. 1 in. = 12.2 ft
D. 1 in. = 14 ft

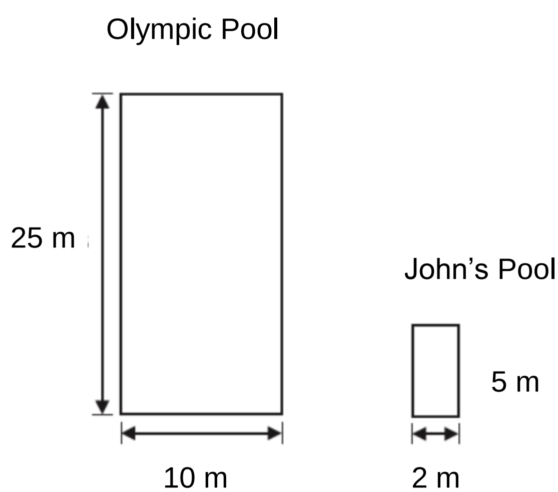
3. Adrienne is designing a living area. She drew a scale drawing of the space below.



The perimeter of the scale drawing is 18 inches. The actual length of wall A is 9 feet. What will the perimeter of the living space be?

A. 62 ft
B. 73 ft
C. 81 ft
D. 90 ft

4. An indoor pool is shown below.



John built a pool that is proportional to the indoor pool. What is the scale factor John used to build his pool?

A. 1/2
B. 1/3
C. 1/4
D. 1/5

Appendix B: Pre/Post Test Answer Key

1. *C 273 square ft*
2. *B 34 m*
3. *D 9 units*
4. *A 5.9 ft*
5. *B 1 in. = 7.7 ft*
6. *C 81 ft*
7. *D 1/5*

Appendix C: Field Dimensions Conversions Worksheet

Name ______________________________

Period _____ Date ____________

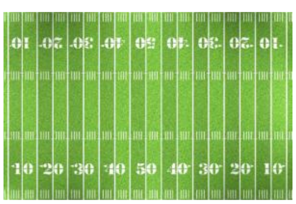
Field Dimensions Conversions

Due to increasing student population, along with student demand at City College, a multi-purpose sportsplex has been proposed. The school has set aside money and space, 75,625 square meters, to develop this multi-function facility. You have been hired to submit a design for this facility. Your job will be to make the best use of the space available.

To prepare for this job, you have been given some dimensions for the sports fields, court, and pool that you may include in your design. Convert all of the units to meters, calculate the area of each field, court and pool, and round your answer to the nearest tenth.

Area Formulas		Conversion
Rectangle	$A = L \cdot W$	1 foot = .3048 meter
Triangle	$A = \frac{1}{2} \cdot B \cdot H$	
Circle	$A = \pi r^2$	Pythagorean Theorem
		$c^2 = a^2 + b^2$

190 ft



390 ft

Football Field

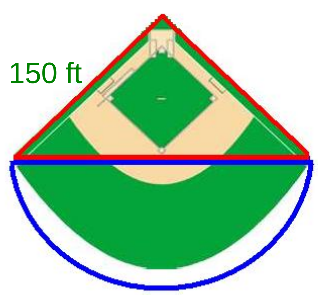
Dimensions: ___ m x ___ m

Area = _________ m^2

Basketball Court

Dimensions: _____ m x _____ m

Area = ______ m^2



Baseball Field

Triangle Dimensions: ___ m x ___ m x ___ m

Triangle Area = _______ m^2

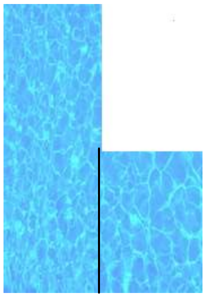
½ circle with a 212 feet diameter

½ Circle Radius: ___ m

½ Circle Area = _______ m^2

Total Area = Triangle Area + ½ circle area = ___m^2

82 ft



164 ft

82 ft

82 ft

Pool & Smaller Warm-up Section

Pool Dimensions:

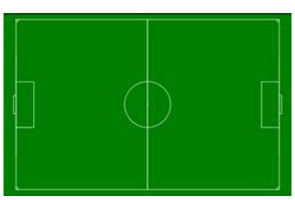
Pool Area = ______ m^2

Warm-up Dimensions: ____ m x ____ m

Warm-up Area= ____ m^2

Total Area = Pool Area + Warm-up Area =__m^2

164 ft



360 ft

Soccer Field

Dimensions: ___ m x ___ m

Area = ______ m^2

Appendix D: Field Dimensions Conversions Worksheet Answer Key

Football Field

Dimensions: 118.9 m x 57.9 m

Area: 6,884.3 m^2

Basketball Court

Dimensions: 28.7 m x 18.3 m

Area: 523.9 m^2

Baseball Field

Triangle Dimensions: 64.6 m x 45.7 m x 45.7 m

Triangle Area: 1,044.2 m^2

½ Circle Radius: 32.3 m

½ Circle Area: 3,296.2 m^2

Total Area: 3,340.4 m^2

Pool & Smaller Warm-up Section

Pool Dimensions: 50.0 m x 25.0 m

Pool Area: 1250 m^2

Warm-up Section Dimensions: 25.0 m x 25.0 m

Warm-up Section Area: 625.0 m^2

Total Area: 1,875.0 m^2

Soccer Field

Dimensions: 109.7m x 48.7 m

Area: 5, 351.2 m^2

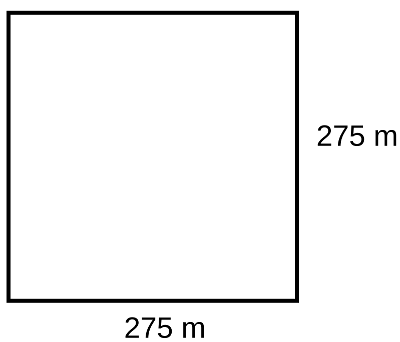
Appendix E: Sportsplex Design Worksheet

Name ______________________________

Period _____ Date ____________

Sportsplex Design!

Your team has been given 75,625 square meters to design the multi-purpose sportsplex. The area is in the shape of a square with side lengths of 275 meters. Your job is to design the facility with as many fields as possible in the given area. Your blueprints must be drawn using an appropriate scale. Once your team has decided on a scale, use the color key below and draw each of the fields, court and pool on a piece of paper, label each one and cut them out. Each person must cut out at least one field, court, or pool. You may choose to include any of the fields from the first task. Allow at least 2 meters for hallway space.



Color Key

Fields, Courts, Pool – Green

Appendix F: Sportsplex Redesign Worksheet

Name ______________________________

Period _____ Date ____________

Sportsplex Redesign!

The school has come back and asked your team to re-design your sportsplex. You still have 75,625 square meters, but you must now include at least 3 to 5 of the sports listed in the first task. If you choose basketball as 1 of your sports you must include 2 courts. For each sport designs must also include 2 locker rooms, seating for 12,000 spectators, 4 sets of restrooms (2 male and 2 female) and 2 concession stands. Again, your blueprints must be drawn and the cut out using an appropriate scale. See the color key below and please justify the placement of your locker rooms, seating, restrooms and concession stands. Include a key and scale in your blueprint.

Dimensions

Locker Room: 12.2 m x 20.8 m

One Seat: 0.51 m x 0.99 m

Restroom: 6.1 m x 10.4 m

Concession Stand: 4.6 m x 4.0 m

Color Key
Fields, Courts, Pool – Green
Spectator seating – Red
Restrooms, Locker Rooms, Concession Stands - Blue

Appendix G: Exit Slip

Name ______________________________

Period _____ Date ____________

Exit Slip

Directions: Write complete sentences and use correct grammar, punctuation, and capitalization to answer the following:

1. Do you think the new stipulations (number of fields, seating, locker rooms, restrooms, concession stands) that you were given today are more confining or that they allow for more creativity in how the sportsplex is designed?

    ____

    ____

    ____

    ____

    ____

2. Why do you suppose that civil engineers redesign buildings they are working on? (Give at least two reasons).

    ____

    ____

    ____

    ____

    ____

Appendix H: Reflection

Name ______________________________

Period _____ Date ____________

Design Reflection

Directions: Answer the following questions.

1. Look over your final blueprint design. Do you see any space that is “left-over”? If so, how can you utilize this space? You are not restricted to just adding more seating for spectators etc. If you can think of a novel way to use the space, by all means do so. The only restriction is that it must in some way correlate with the idea of serving a sports complex.

2. Compare your final blueprint design of the sports complex with other groups in your class. Was your design more or less efficient than the other groups? Give a detailed explanation of how you reached your conclusion.

3. Is the complex that you designed, fully functional as it stands? Is it missing any vital components? If so, what are they?

4. Do you have any space to accommodate the necessities you mentioned in number three or do you have to redesign your complex?

5. You were provided a list of spectator sports that the complex could accommodate. If you were asked to come up with the original list of sports out of which three had to be chosen, how would your list differ?

6. What if any of the sports “field” or “arena” was irregularly shaped? How would you compute its area? Explain.

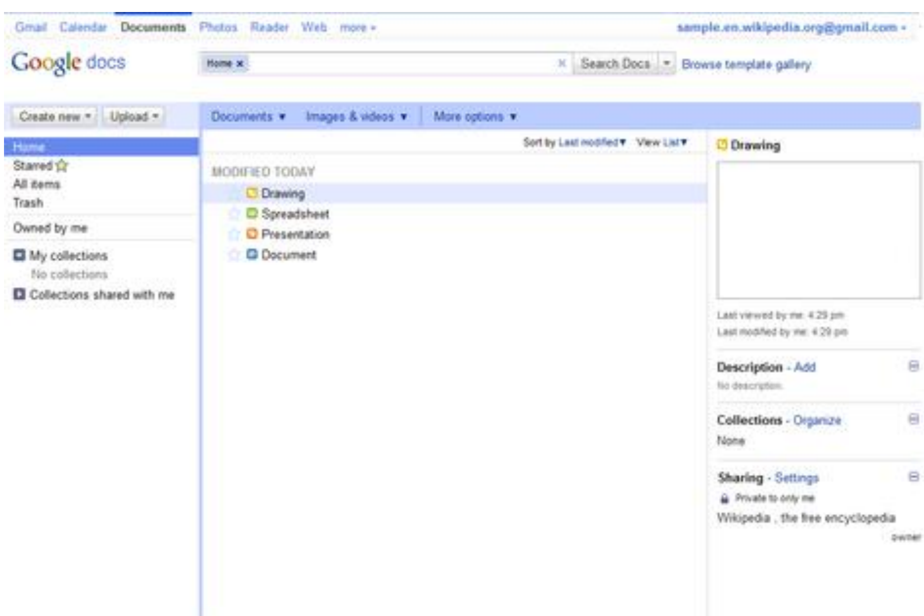
Appendix I: Sportsplex Design Presentation Guide

Name ______________________________

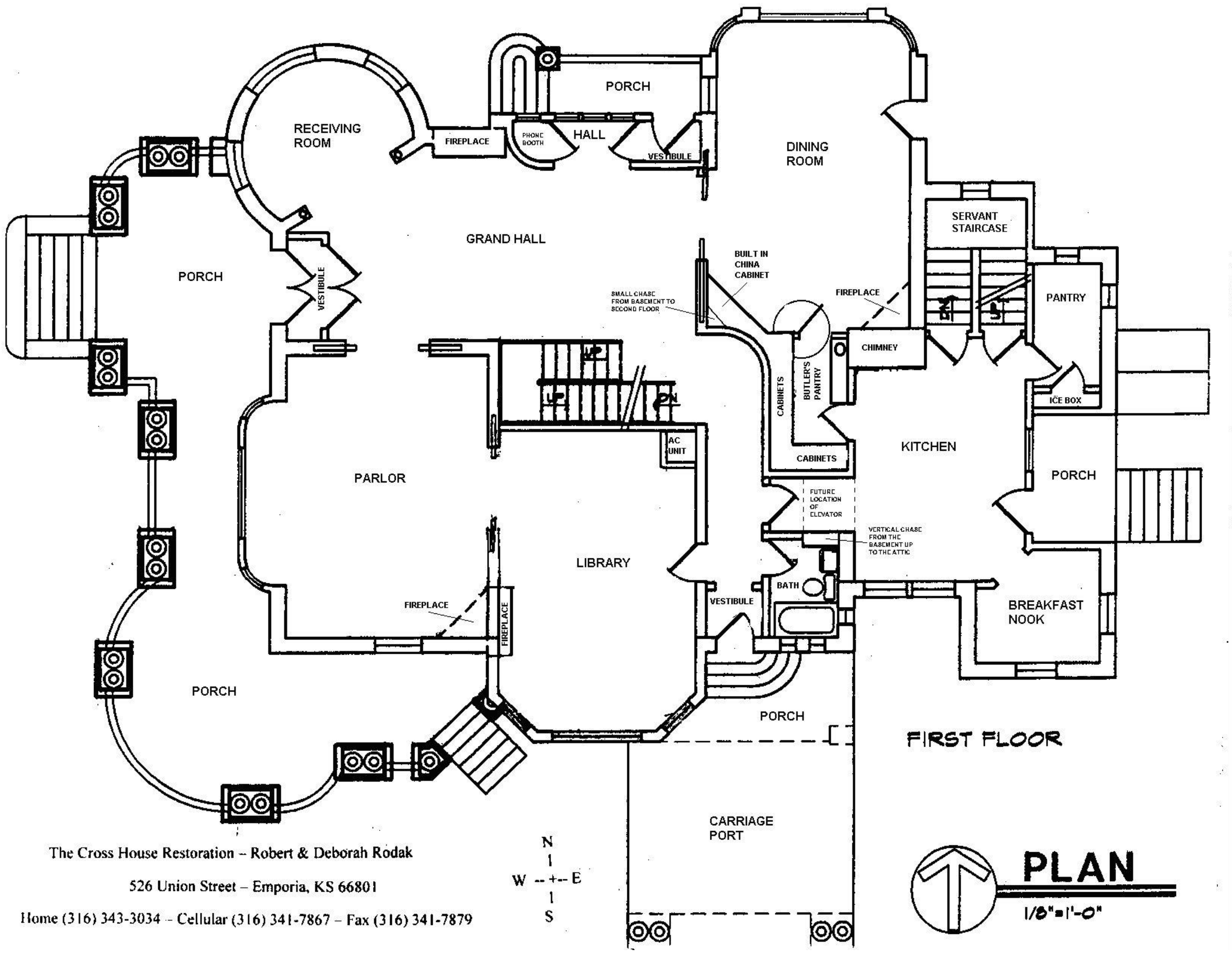
Period _____ Date ____________

Design Presentation!

You must now present your proposal to the College Board. Using Google Presentation tools on Googledocs.com or Microsoft Office Power Point, prepare three slides explaining your design and reasoning for choices you have made. Include a picture of your blueprint. Remember, you are trying to "sell" your design to the Board. Why is it the best design? Why should they choose you as the design firm?



Appendix J: Sample Blueprint



Retrieved from http://www.thecrosshouse.org/Page%208%20-%20Blue%20Prints.html

Appendix K: Project Rubric

CATEGORY	*4*	*3*	*2*	*1*
Mathematical Concepts	Explanation of area and perimeter of regular & irregular shapes are 95% or more accurate. .	Explanation of area and perimeter of regular & irregular shapes are 94-85% accurate.	Explanation of area and perimeter of regular & irregular shapes are 84-75% accurate.	Explanation of area and perimeter of regular & irregular shapes are 75% or less accurate.
2-D Drawings	Exhibits: 3 athletic fields Seating Concession stands Restrooms Locker Rooms	Exhibits 5 of the following: 3 athletic fields Seating Concession stands Restrooms Locker Rooms	Exhibits 3 of the following: 3 athletic fields Seating Concession stands Restrooms Locker Rooms	Exhibits 1 of the following: 3 athletic fields Bleachers Concession stands Restrooms
Drawing--General	Lines are clear and not smudged. There are almost no erasures or stray marks on the paper. Color is used carefully to enhance the drawing. Stippling is used instead of shading. Overall, the quality of the drawing is excellent.	There are a few erasures, smudged lines or stray marks on the paper, but they do not greatly detract from the drawing. Color is used carefully to enhance the drawing. Overall, the drawing is good.	There are a few erasures, smudged lines or stray marks on the paper, which detract from the drawing OR color is not used carefully. Overall, the quality of the drawing is fair.	There are several erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is poor.
Accuracy	95% or more of the assigned structures are drawn accurately and are recognizable. All assigned structures are labeled accurately.	94-85% of the assigned structures are drawn accurately and are recognizable. All assigned structures are labeled accurately.	84-75% of the assigned structures are drawn accurately and are recognizable. 94-85% of the assigned structures are labeled accurately.	Less than 75% of the assigned structures are drawn AND/OR labeled accurately.
Scale	All features on the plan are drawn to scale and the scale used is clearly indicated on the plan	All but 2 features on the plan are drawn to scale and the scale used is clearly indicated on the plan	3 to 5 features on the plan are NOT drawn to scale even though a scale is clearly indicated on the plan	6 or more features on the plan are NOT drawn to scale AND/OR there is no scale indicated on the plan.
Legend/Key	Legend is easy-to-find and contains a complete set of symbols, including a scale. At least 90% of the items are labeled and located correctly.	Legend contains a complete set of symbols, including a scale. 80-89% of the items are labeled and located correctly.	Legend contains an almost complete set of symbols, including a scale. 70-79% of the items are labeled and located correctly.	Legend is absent or lacks symbols AND/OR scale. Less than 70% of the items are labeled and located correctly.