

Math Instruction to the 3rd Dimension!

Participants:

Engaged Learning Activity

Calculating Area of Irregular Shapes using Google SketchUp & Excel (or Calculator)

Welcome to SketchUp for Math Teachers at UCET. I love to learn by doing, and I love technology. I think that many of your students are probably the same way. So, here is an engaged learning activity for you to use or modify. Hopefully you can gain some ideas on how you can use software that you might not currently be using in your instruction to enable your students explore and create new understanding relationships with a topic that they have seen before. The focus of the activity will center on a concept that our students have historically scored poorly in on the UBSTC: Calculating the Area of Irregular Shapes.

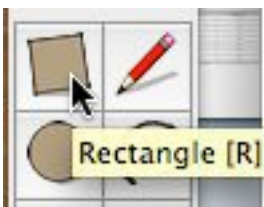
Discuss with your partner about the context that they usually use to present this technique to their classes. How could you present this skill to your students in a way that will make it meaningful to them? When would they or could they use this skill in their lives today?

Here's the approach I will take: Let's say you want to be the next Tiger Woods or Michelle Wie, who are famous (and rich!) golfers. To reach your potential, you want to construct a practice green in the back yard. Your parents have agreed to this only if they can closely estimate the area of your yard that will be used, how much sod or grass seed will be needed to cover this area, and how much it will cost to fertilize the area. Your parents also insist that the putting surface can only take up 25% of the 40' x 40' back yard. You want to design the coolest and largest green shape that you can and still keep your parents happy. How can you design your practice area, follow the guidelines and reach golf star status??? Follow along...

1. Once you are in your group of 2 people, make sure that one of the laptops in the group has Google SketchUp installed. If none of you do, please see one of your instructors for an installation disk. You should all have Microsoft Excel already.



2. First, we need to accurately represent the back yard. In SketchUp, grab the Rectangle tool from the toolbox or press R on your keyboard. Draw a square shape that is 40 feet square. The Dimensions information in the bottom right hand side of the window will tell you the dimensions of your square. You can easily get the precise size by typing the following **just after drawing** your square, 40',40' and pressing return (enter).



3. Calculate the area of the backyard. The formula is $a = l * w$. Enter in your calculated area here: _____ . Remember that your practice green has to be less than 25% of this number.

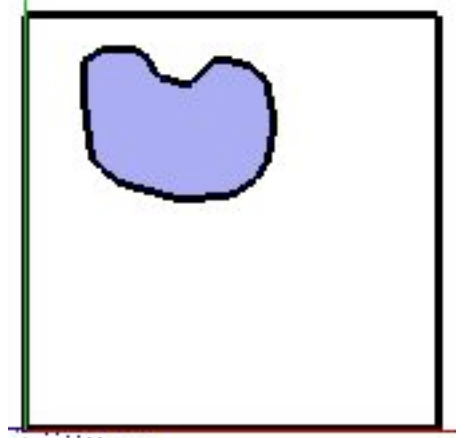
4. To make drawing the green easier, let's delete the blue "surface" of the shape that we just drew. Hit the space bar or click on the Select tool at



the top left of the toolbox. Click once on the blue part of the shape to select it, then press Delete (Backspace) on your keyboard. You should be left with an empty rectangle to represent the size of the backyard.

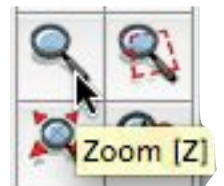


5. Now, let's get creative and draw an amazing putting green. Let's use the Freehand tool to do this - this tool will not constrain us to straight lines or perfect angles. Grab the tool and draw any roughly circular shape inside of your backyard. Remember to not make it too big or you may have to start over... Here is roughly what I made (image at right):



6. Let's stop and think for a minute... We need to make sure that our green shape will not be too big by estimating the area. If it were a boring perfect circle, we could measure the radius and calculate it precisely by using the formula $a = \pi r^2$. However, we have created a unique & irregular shape, so we need to use a different approach to finding the area. We must find an **average radius** for the shape, and then use that average in the area formula. How can we quickly and easily do this???

7. SketchUp has the tools that we need! First, let's zoom in so that the green takes up most of the screen. Use the Zoom tool for this.

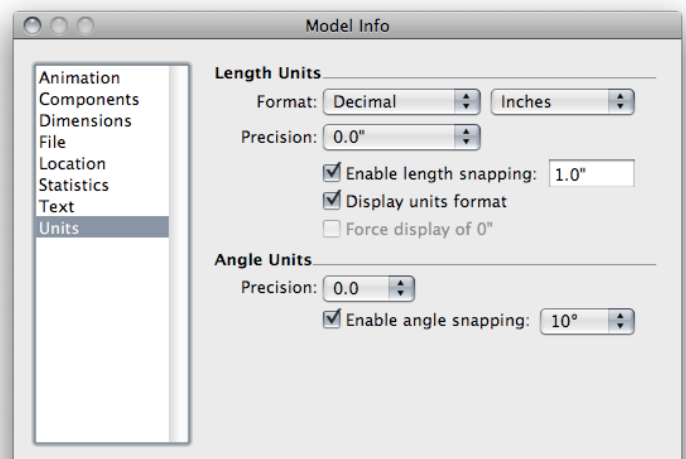


8. We need to pick a center for our shape to measure the radius from. It does not have to be perfectly in the middle of the shape - just somewhere close. Grab the Circle tool or press C on your keyboard to get it.



Single click in the center of your green shape, move your mouse away from that spot, and click again. Type 5 and then enter - this will resize the circle to a radius of 5" - just big enough so that you can see it. We don't need the shape, we need the center point that it created.

9. To make the radius averaging easier, let's change how SketchUp measures from feet and inches, to decimal inches. To do this, click on the Window menu and select Model Info... Click on units, and enter in the settings shown here: Close the window.



10. The next tool we will use is the Dimension tool. This will precisely measure the length from one center- or end-point to another.

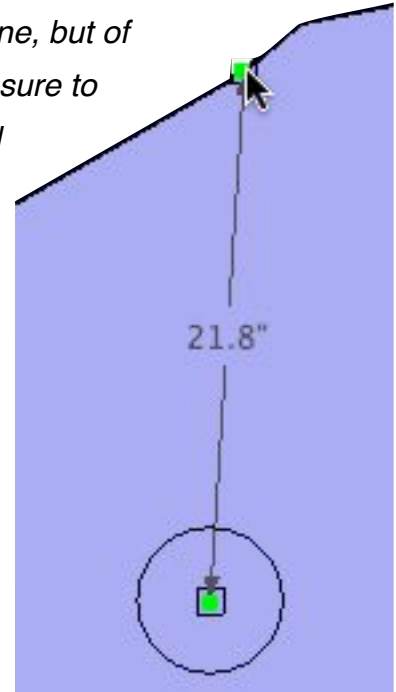


This is a 3-click tool - one click on the center mark (green square), the next click is on the end- or mid-point of the segments of our area shape, and the next click sets the line. The last two clicks of the mouse will be like a slow double-click - make sure not to move the mouse between these

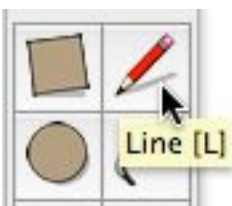
clicks, or the dimension tool will give you an unexpected result... If it does, just hit the Undo button (red left-pointing arrow in the top left of the window) or choose Undo from the Edit menu. You can also use the Escape key if things go weird.

11. *NOTE: The shape is constructed not of a smooth curving line, but of small short line segments. The Dimension tool will not measure to any point on these segments - just the endpoints, indicated by the green squares.*

12. Let's start at about 12 o'clock. With the Dimension tool selected, click once in the center (green square) of our reference circle. Now move your mouse (No click-and-drag!) to a segment endpoint of our shape - this will be shown by another green square and your tool should "snap" or jump to this spot. Do the slow double-click, and this radius length will be shown. You know that you have done it right when the green squares disappear! See the image at right to clarify:

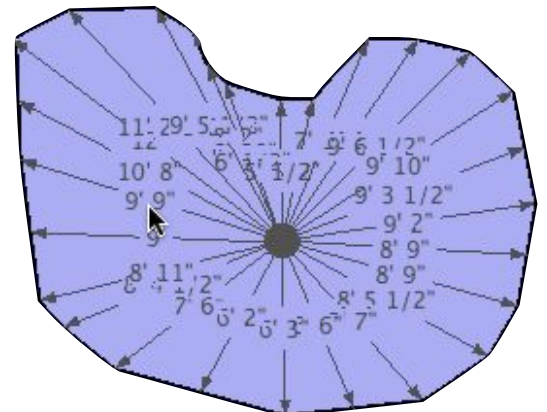


13. Now just repeat the last step, going around the "clock" for each segment endpoint. Make sure that each radii starts at the green square in the middle of the little circle. Ideally, each radii measurement will be about 10° apart. Repeat this until you have at least 20 radii measured all around the shape.



14. If you have long segments and can't get that 10° separation, you can create new endpoints to measure to by using the Line (pencil) tool. Once the Line tool is chosen, hover your mouse over the long line segment and look for it to snap to a light-blue midpoint square.

Single click on the midpoint, move the tool to the endpoint, and single click again. This has created a new end-point at the old mid-point that you can use the Dimension tool to measure to. You should have something similar to the image at right when complete:



15. Now we need to average our radii measurements from SketchUp (zoom in if you need to). You can use Microsoft Excel or a calculator - add them all up and divide by how many measurements you made. In Excel, type =AVERAGE(*range*) - where *range* is the series of radii measurements. Enter in your estimated area below.

• _____

16. Let's see how close our estimate actually came. We can use SketchUp to calculate the area of the shape for us. Why didn't we just do this first? This is great for planning and designing, but the estimating technique will work with any shape in the real world. To get the actual area, get the Select tool and single click on the blue area inside of your shape. Right click (control + click on the Mac) and select Area --> Selection. The actual area will appear! Please enter it below:

• _____

17. How close was your estimate??? Find the percentage difference by dividing whichever measurement was smaller by the larger area measurement/estimate, and multiply by 100. Hopefully you are above 95% accuracy. Enter this below:

• _____

18. Your area estimate is in square inches, where the backyard area is in square feet. Please convert your estimate from in² to ft² and enter it below.

• _____

19. Now, have we made the shape too big??? Find the percentage of the area of your super practice green to that of the entire backyard. Remember, you only have 25% of the yard to work with!

• _____

20. Great. Now we need to know some costs.

1. 3 Lb. of grass seed costs \$9.48/ each and covers 1,800 ft². How many bags or percent of one bag will you need? How much will it cost?
2. Fertilizer for New Grass Plants and Seedlings that covers 5,000 Sq. Ft. is \$15.88/ bag. What percentage of a bag will you use at each fertilizing? How much will that fertilizer cost?
3. Rolls of sod costs \$0.15 per square foot if you install it yourself. How much will it cost for this?
4. Professional installation of sod costs a little more - \$0.40 per square foot. How much would this cost you to do?