

# Logical Thinking: Building Perspectives, in Google SketchUp

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**Teacher Note:** Most of our Math Forum projects have both a student and teacher version. This project, however, works best with just the teacher's computer and a projector, with the students shown only certain views of the model. So there is no separate student version.

For this project, it helps to have some basic knowledge of Google SketchUp (though detailed instructions are provided). In particular, it's important to know how to zoom, orbit, and pan the view. If you need more information on how to get started, and a description of some basic tools, please read 3DVinci's Getting Started Guide (PDF).

PC users: go to [http://www.3dvinci.net/SketchUp\\_Intro\\_PC.pdf](http://www.3dvinci.net/SketchUp_Intro_PC.pdf).

Mac users: go to [http://www.3dvinci.net/SketchUp\\_Intro\\_MAC.pdf](http://www.3dvinci.net/SketchUp_Intro_MAC.pdf).

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For more educational materials based on SketchUp, please go to <http://www.3dvinci.net>.

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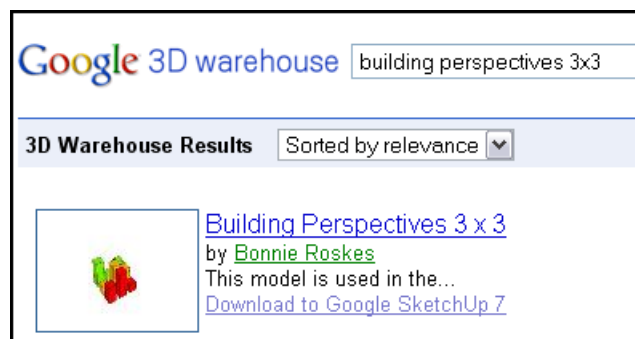
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“Building Perspectives” is a logic problem. We start with a model of buildings (really just tall boxes), and by seeing the model only in certain views, the students need to figure out which buildings have which height. As stated above, this project works best when the teacher shows the entire class only the necessary views of the model. (If the students could see the view below, the answers would be obvious.) The students can create their own solution grids using paper and pencil, and perhaps use some crayons to help them get oriented (the grid colors would correspond to the building colors.)

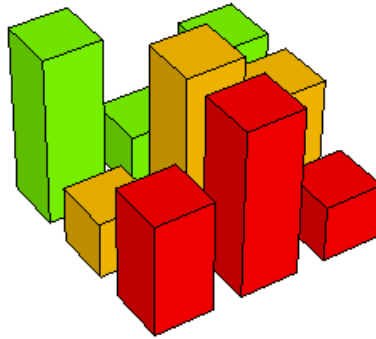
## 3 x 3 Grid

We'll start with an easy example.

1. To download the model used in this section, open the Google 3D Warehouse: <http://sketchup.google.com/3dwarehouse>. In the search field, enter “building perspectives 3x3.” (There are no spaces between the 3 and x.) For the model shown below, click the “Download to SketchUp” link.



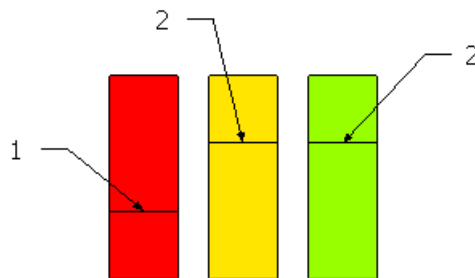
2. Open the model in Google SketchUp. There are 9 “buildings,” 3 each in red, yellow, and green. Each colored row has one building that’s 1 unit high, one that’s 2 units high, and one 3 units high.



3. By default, a SketchUp model appears in **Perspective** view, which means closer objects appear larger (this is, of course, how your eye actually sees objects in 3D). But for this project to work, we need true orthogonal, or projection, views. So from the main menu, choose **Camera / Parallel Projection**. The model view changes slightly; you might not even notice.
4. The remaining steps require you to frequently change the view (**Front, Right**, etc.), so it’s handy to have the **Views** toolbar displayed. PC users: choose **View / Toolbars / Views** from the main menu. On the Mac, choose **View / Customize Toolbar**, and drag the **Standard Views** toolbar onto the main toolbar.
5. Click the **Front** icon.



6. Now we’re looking directly at the front of the model. (If you were still in **Perspective** view, you would see a bit of the buildings “behind” the front row.) Here’s what we know: the front red building is 1 unit high, and the front yellow and green buildings are 2 units high.

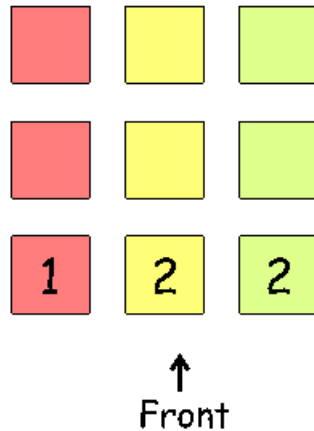



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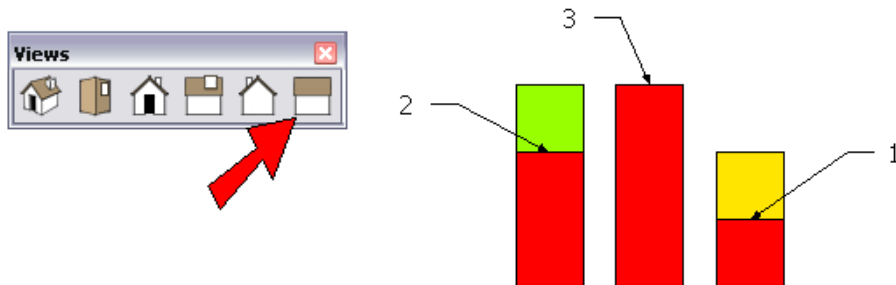
*In case you were wondering, the labels in the picture above were made using SketchUp’s **Text** tool.*

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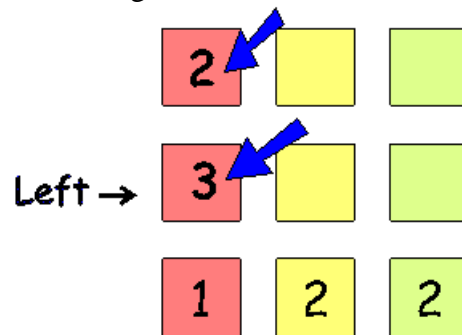
7. Here's where the paper, pencil, and maybe crayons are needed. Draw a grid representing the building layout, color the squares to match the buildings (if you have crayons), and start listing what we know: 1, 2, 2 in the front row.



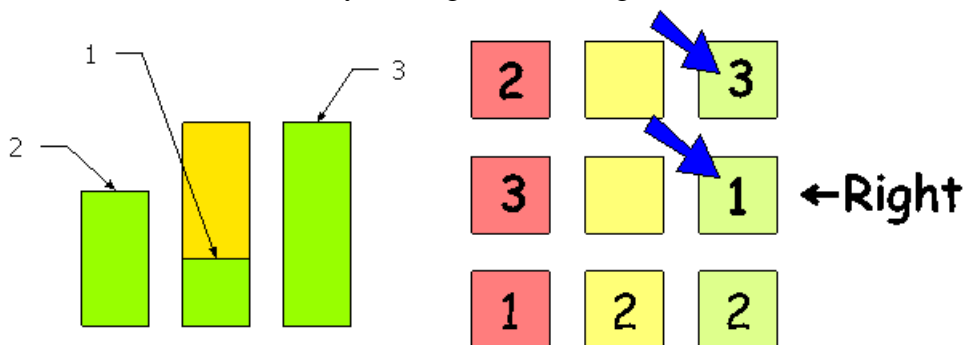
8. Now switch to **Left** view. Now the three red buildings appear in front, with the heights shown below (for the red building shown below on the right, we already knew it was 1 unit high).



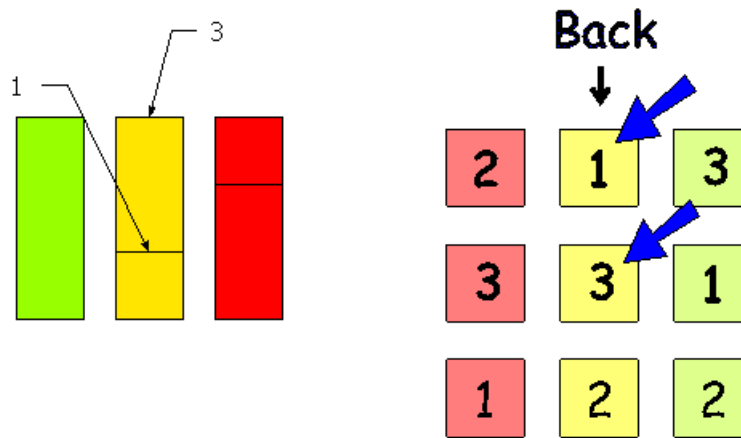
9. Now we can add two more numbers to our grid:



10. Switch to **Right** view, which looks directly at the green buildings. And add the new information to the grid.



- There are only two more numbers left to fill in; one must be a 1 and the other a 3. Switch to **Back** view, where you can see that the 1-unit high building appears in front.

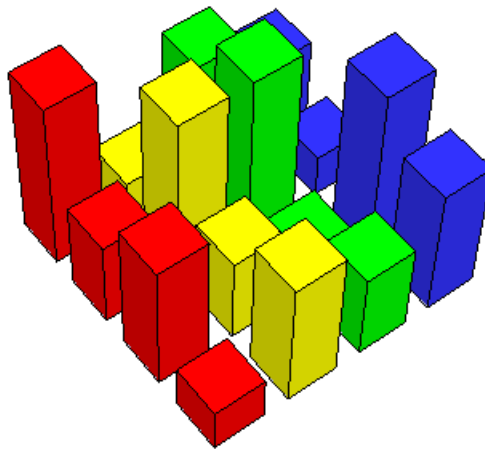


You could actually figure out all nine numbers just by looking at the **Front** and **Back** views, since we know there is one building of each height within each colored row.

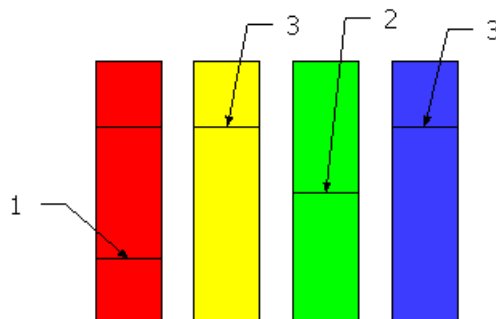
## 4 x 4 Grid

Now let's try one that's a bit harder, with 16 buildings. Again, each colored row has one building of each height (1 through 4 units).

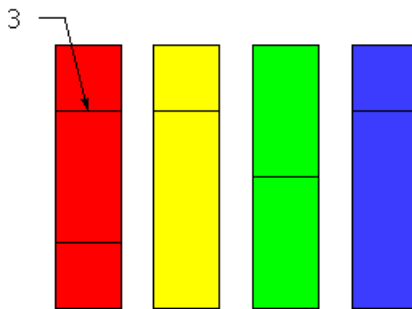
- Go back to the 3D Warehouse website and download the "Building Perspectives 4x4" model.



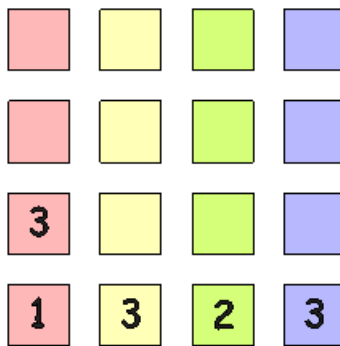
- Here's what can immediately figure out from **Front** view:



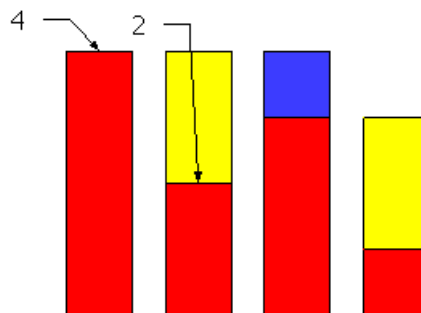
3. But with some logical thinking, we can figure out one more height in this view. Look at the red buildings. We know the “1” is in front, and there are three left. The “3” is clearly in front of the “4,” so the remaining three buildings can have the order 2,3,4 or 3,4,2 or 3,2,4. But if the order were 2,3,4, we would see the “2” in front of the “3,” so that option is out. That leaves the other two options, both of which have a “3” in front. So the building directly behind the “1” is the “3.”



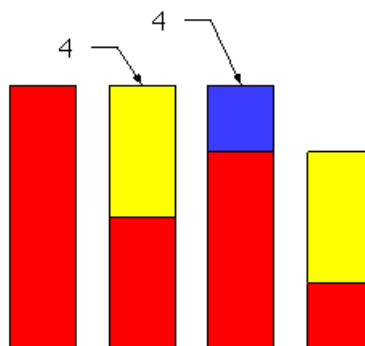
4. So already we can fill in five numbers in the grid.



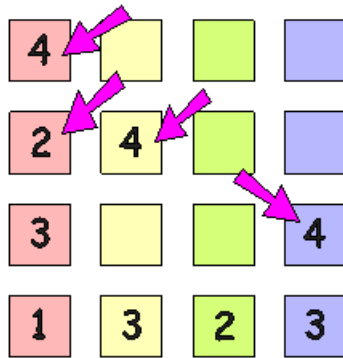
5. In **Left** view, we can fill in two more pieces of the puzzle:



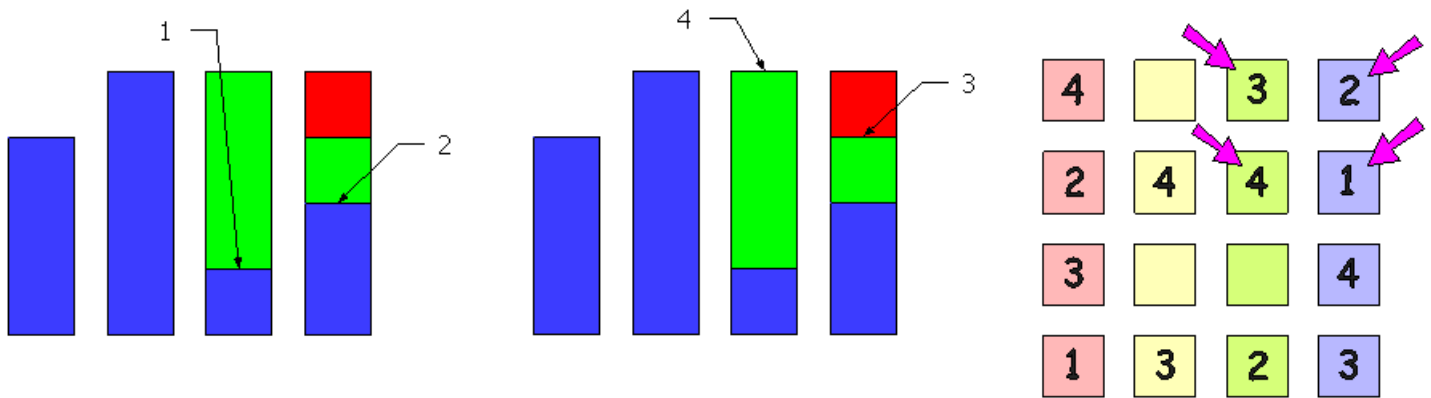
6. And because of the different colors, we know where two more “4” buildings are. . .



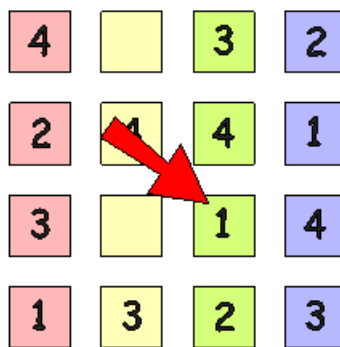
7. ... which gives us four more grid numbers.



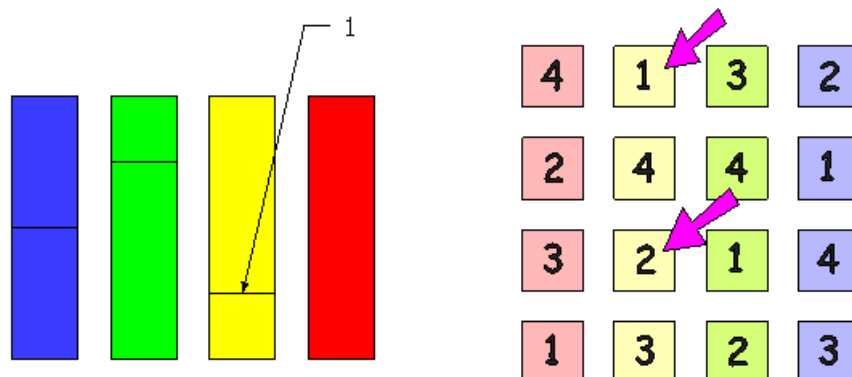
8. Here's what we can figure out in **Right** view:



9. Now we can fill in the missing "1" in the green row. That leaves just a "1" and "2" in the yellow row.

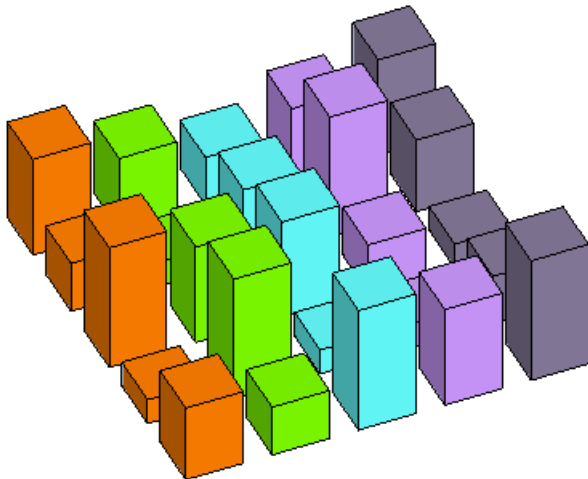


10. So we can get our final clue in **Back** view.



## Try This: 5 x 5

Download “Building Perspectives 5x5” from the 3D Warehouse and get to work! It’ll take a few spins around the model (you’ll need to look at some views more than once). The solution is shown below.

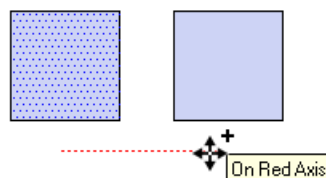


4	3	2	3	4
2	1	3	5	3
5	4	4	2	1
1	5	1	1	2
3	2	5	4	5

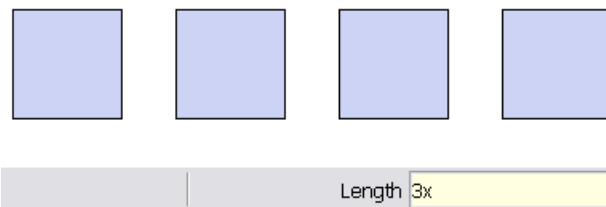
## Make Your Own

If you want to make your own building grids, you should first plot out on paper the heights of each building. Then you can easily building the model in SketchUp.

1. In **Top** view, use the **Rectangle** tool to draw a square.
2. Activate the **Select** tool and click the rectangle to select it.
3. To make the first copy, activate the **Move** tool. Then press once (don’t hold) the Ctrl key (PC) or Option (Mac). Click two move points to draw out a copy to the right or left (in the red direction).

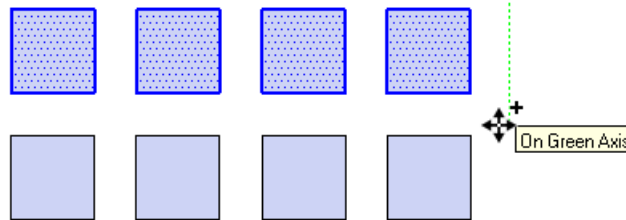


4. If your grid is 4x4, you need three total copies in the first row. So type 3x, which appears in the **Length** field. (You never have to click inside this field, just start typing). Press Enter, and the three copies are made.

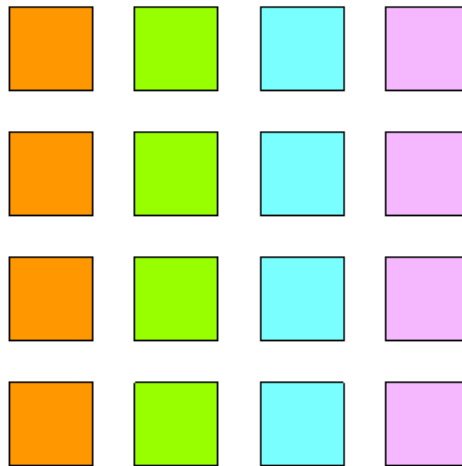


*Right after the copies are made, you can still change your mind. For example, if you have four total squares but need five instead, just type 4x and press Enter.*

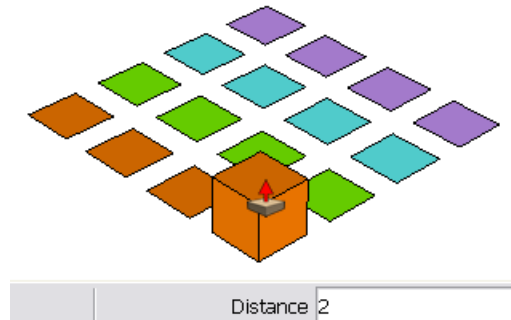
5. Now we'll make copies of the first row. You can select everything by pressing Ctrl+A or Cmd+A, or activate **Select** and drag a selection rectangle around all of the rectangles. Then activate **Move**, press Ctrl / Option, and place the first copy in the green direction.



6. Type 3x (or whatever number you need) and press Enter to complete your grid. To paint each row a different color, click the **Paint Bucket** tool, find a collection of colors you like, and paint.



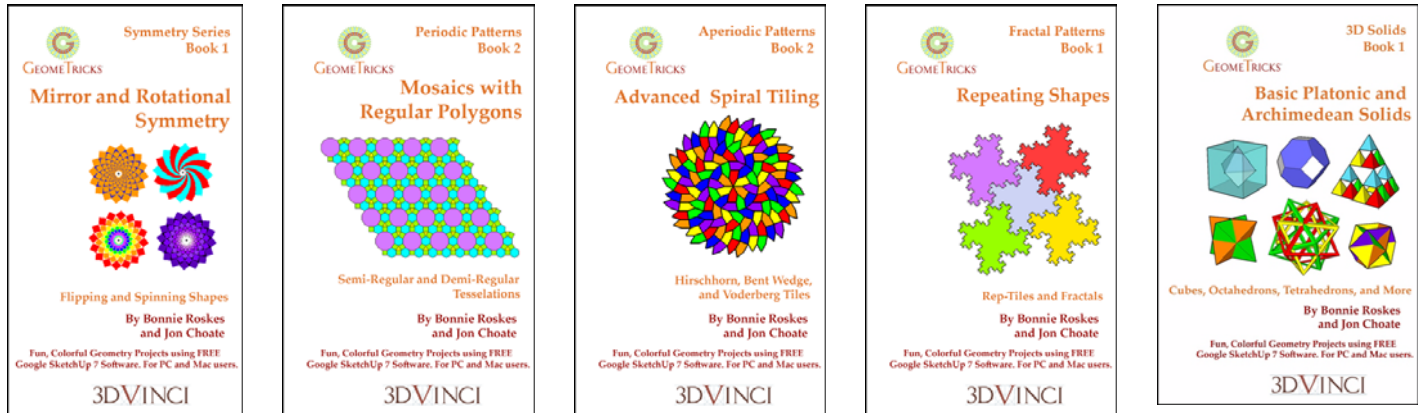
7. To give the buildings their heights, activate the **Push/Pull** tool. Then click on a rectangle and start to pull it up. Type the height you want, and press Enter. If the first building turns out too low or too high, adjust your heights (for example, if a height of 1 is too small, try 10 or 100.)



8. Keep going until each building has its assigned height. Then turn on **Parallel Projection** view, show your students the various views, and let them figure it all out!

**Want More?**

If you like geometry projects in Google SketchUp, you'll love 3DVinci's [GeomeTricks series!](#) These are just some of the books in this series:



All books are available in print and as printable PDF. For details on GeomeTricks, go to <http://www.3dvinci.net/ccp0-catshow/GM.html>.

You can also sign up for our [SketchUp Project of the Month](#) subscription. Each month you will receive **THREE FUN PROJECTS** (one in math, two in 3D design) that can be used in K-12 classes. Details at <http://www.3dvinci.net/ccp0-prodshow/POM.html>.

The subscription's math project for December 2009 is about measuring length and area in 2D and 3D:

