

Make a 3D Contour Model

Student Workbook

Student Name:

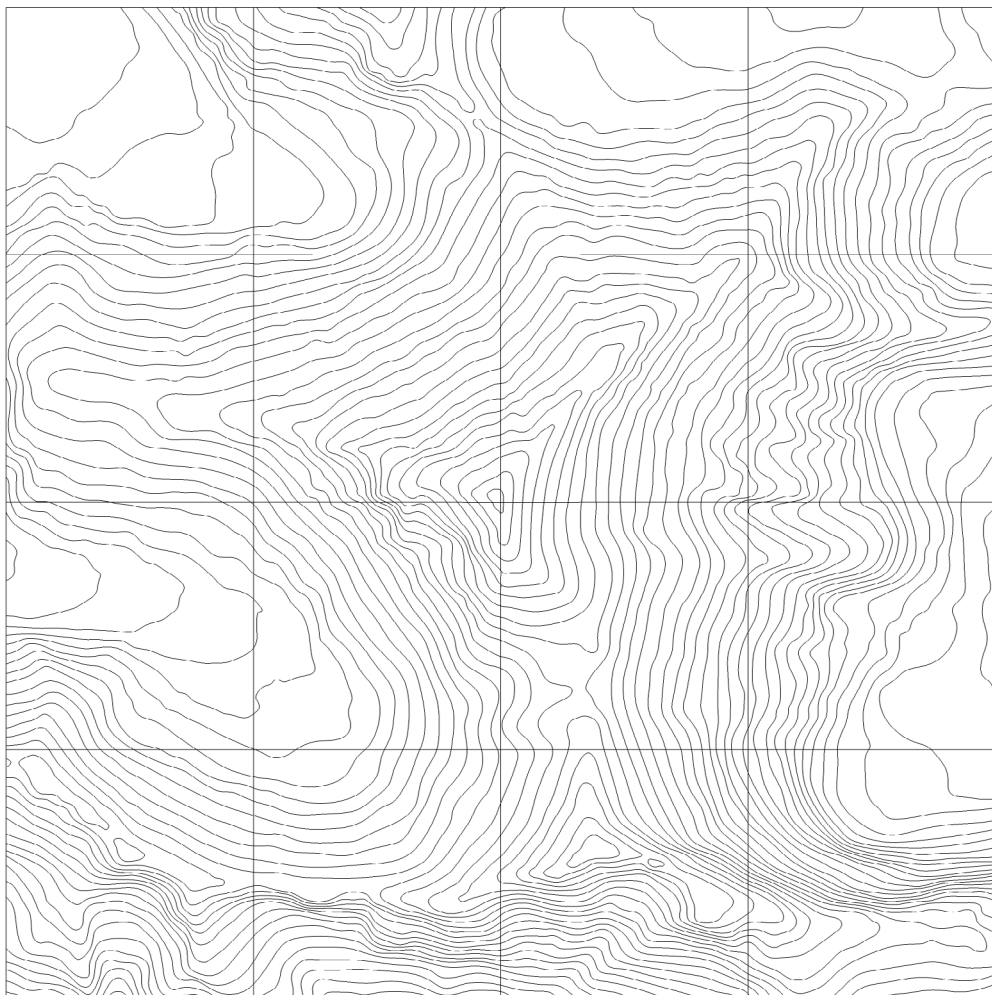


Introduction

The image below shows the contours of Mount Everest and its surroundings.

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You will notice that the image is split up into 16 squares and each student will design a different square. Throughout this workbook you will analyse the square allocated to you before using SketchUp software to design your section of the model.



1

Analyse your Grid

Take a look at the contour sheet given to you and see if you can work out the answers to the following questions.

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a. Using the scale stated on your contour sheet, a ruler and a calculator, work out the “real life” length of the square in metres. Hint: Measure the length of the square in mm, then multiply by the scale of the drawing. Finally, divide the answer by 1000 to convert to metres.

b. What is the difference in elevation between the lowest contour on your grid and the highest?

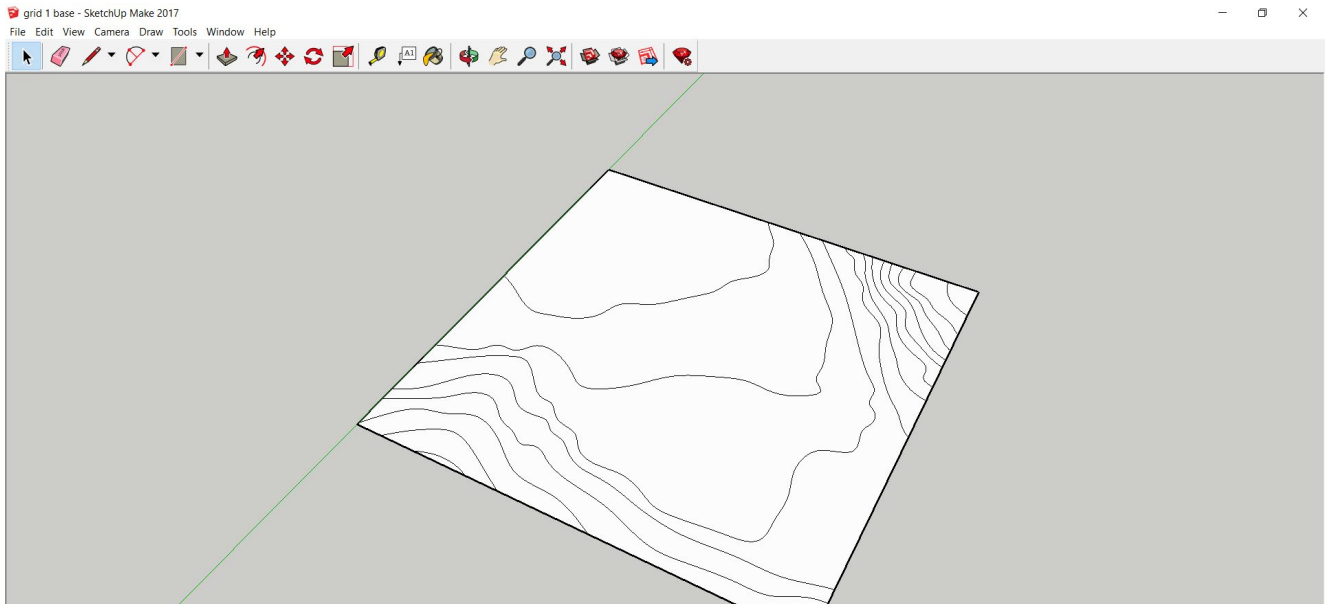
c. We are going to create a 3D contour model of your grid at the scale 1:50000. Can you work out the length your 3D contour model will be at 1:50000 in millimetres? Hint: The square on your contour sheet is 1:12500. A 1:50000 model will be 4 times smaller than a 1:12500 model.

d. Using a ruler and pencil, draw an outline of your 3D contour model at 1:50000. Mark on the dimensions that each side should be.

2

SketchUp - Basic Navigation

On your computer, open up the SketchUp file that matches the name of your contour sheet. Choose the template Architectural Design - Millimetres and click Start Using Sketchup.



Your screen should look something like this image. This is a 2D sketch of your contours and we are going to turn them into a 3D model. Here are some basic navigation tools, give them a try!

1. Zoom in by rolling the scroll wheel on your mouse upwards
2. Zoom out by rolling the scroll wheel on your mouse downwards
3. Hold down the scroll wheel and move your mouse around to orbit around the workspace
4. Hold down Shift and the scroll wheel whilst moving the mouse around to pan around
5. Click camera>standard views and select the different view modes to see what they do
6. Hover over the icons in the top toolbar. You will notice that a label appears as you hover over each one. Navigate to the zoom extents icon and click. This will zoom to the extents of the objects within your workspace.

3

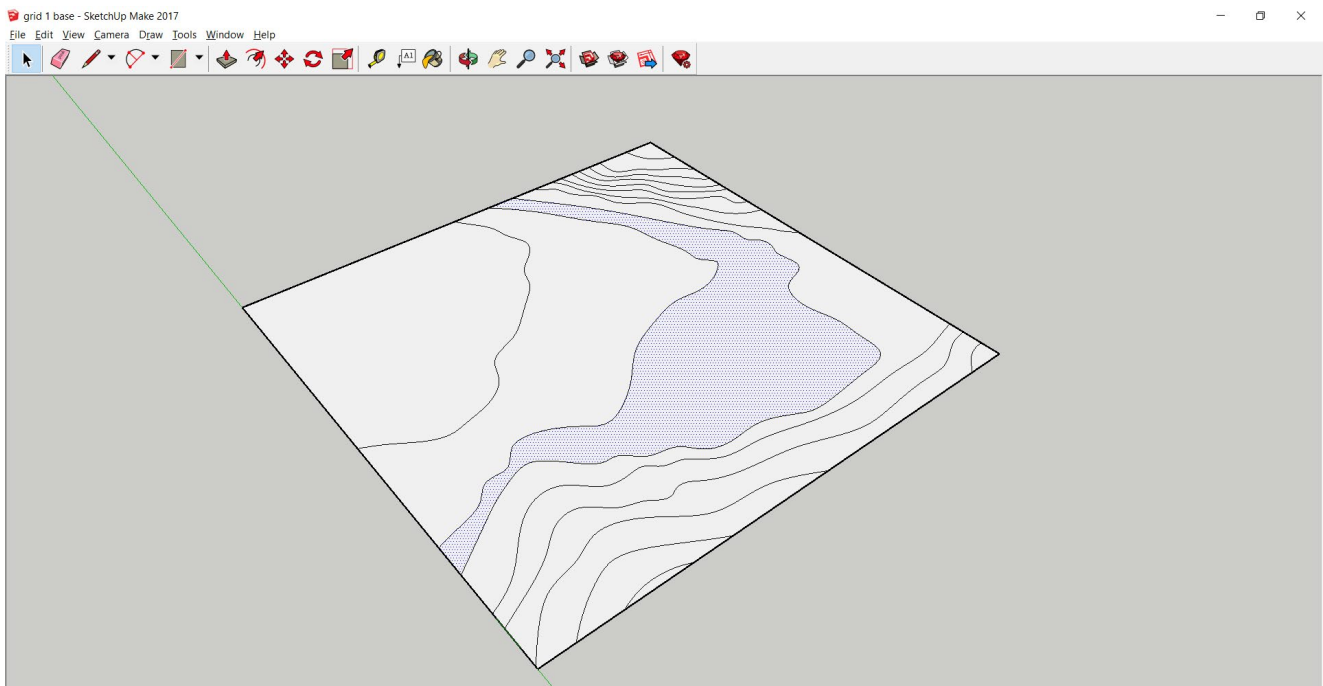
Analyse your Sketch

Let's take a closer look at the sketch. Go through the following steps

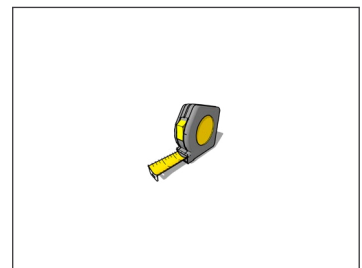
a. Navigate to the select tool in the top toolbar. Click the icon then click on different areas of your sketch. You will notice that when you click on a surface, it is highlighted like the below image.



We'll be "extruding" these surfaces different distances to create our 3D contour model.



b. Select the tape measure from the top toolbar. Hover over a corner of your image - you will notice that the cursor snaps to the corner point with a coloured circle. Click on the snap point and move your cursor along the line until it reaches another corner, then click again. The length value will appear in the bottom right hand corner of the screen.



The length value you see should match the value you entered in step 1c.

4 Elevation Calculations

We are now going to work out the distances we need to extrude our surfaces.

a. Remember your model is part of a larger model that will be assembled together. In order to fit everyones contours into the model, the base of the model will represent 5400m above sea level. Using your contour grid sheet, write down the elevation of each of your contours in the table below and calculate the distances you need to extrude your surfaces by.

Hint: Once you do a few calculations for contours that are next to each other, you will begin to see a trend in the distances you need to extrude. This means you can follow the pattern and you may not need to do long calculations for every contour. If you have multiple contours with the same elevation, you do not need to replicate them in the table below.

Contour Elevation	Elevation of model base	Difference in elevation between contour and base elevation	Difference in elevation at 1:50000 (distance you need to extrude)
<u>example</u>			
5500m	5400m	100m	2mm 100m = 100000mm. 100000/50000 = 2mm
	5400m		
	5400m		
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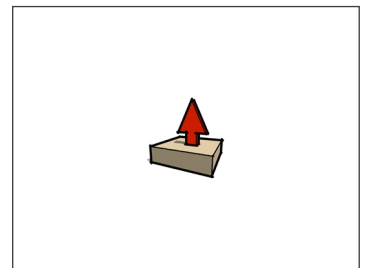
5

Extrude your Model

Now it's time to turn our drawing into three dimensions by extruding our surfaces.

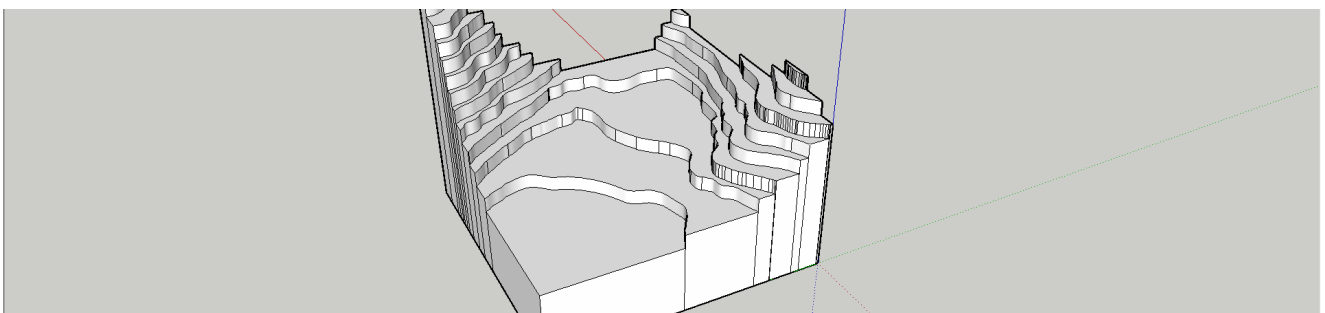
a. Find the contour with the highest elevation. You will see there is a surface on either side of this contour. For this model we are going to assume that the elevation represents to surface that is lower in elevation (this is very important so remember this as you go through these steps)

b. Click the push/pull tool and hover over the surface that represents your contour. Click the surface and move your cursor up. You will see that it starts to extrude the surface. At this point, type in the distance that you need to extrude (you worked this out in the previous step), then hit enter on your keyboard.



c. Repeat steps 7a and 7b for the rest of your contours using the table you filled in as a reference. If you are extruding a surface higher than an adjoining surface, SketchUp may limit the distance you can extrude. To get around this extrude the surface to match the adjoining one by selecting the push/pull tool, then click the surface you want to extrude and click the surface of the adjoining contour. Work out what the difference in height between your contours should be then extrude again to this same distance.

c. You may notice that at the end you have one or two surfaces that have not yet been extruded. This is because the contour they relate to are on another student's grid. In this case, look at the way you contours are sloping and extrude it accordingly.



d. Orbit around so you can see the bottom of your model. If it is not solid, simply use the rectangle tool and draw a rectangle from one corner to the opposite corner. Congratulations your 3D model is now complete!

6 Export your Model

The final step is to turn our model into a 3D printable object by making it one solid object and exporting it as an STL file.

a. An STL is the standard file type for 3D printing and in order to create one suitable for 3D printing, our model needs to be watertight (one solid object with no gaps). Make sure your model has no gaps and white faces. If some are blue, use the reverse faces command as you did previously.

b. Click the select tool and drag a box from right to left over your whole model. Once everything is highlighted, right click on your model and click group.



c. Now click tools > solid inspector 2 and if there are any errors click fix all. To check if your model is now solid, right click on your model and click entity info. In the entity info window you should see the words “solid group”.

d. Now click file > export stl and choose “binary” for the file format. Click export, choose a file destination and name your STL the same title as your contour grid sheet then click save.

e. In addition to saving an STL file for 3D printing, we also want to save our SketchUp file. This will allow us to make any amendments to our model in the future. Click file > save as and select type SKP. You can save it as the same name as your contour grid sheet and STL file.

Well done - you have completed the student workbook and your teacher will now demonstrate the 3D printing process!

If you complete your workbook before other students, see if you can use the drawing tools in SketchUp to design features for your 3D contour model. For example you could design some 3D text or a scale bar that can be 3D printed and attached to the classroom model.