ENGG1100 Introduction to Engineering Design

Engineering Faculty

The Chinese University of Hong Kong

Drawing Example - Dice

This material is designed to guide you (the students) to perform mechanical design in computer using SolidWorks. The details and basis on using the SolidWorks can be found in the tutorial notes. In this practice, you will have a review on how to design and build a part file, particularly drawing a dice, using various functions in SolidWorks;

Some students may have used other CAD software, but SolidWorks is adopted in this course. All students should design the components used in the course project using SolidWorks and submit their design files in the .stl format for fabrication with the rapid prototyping (RP) machine.

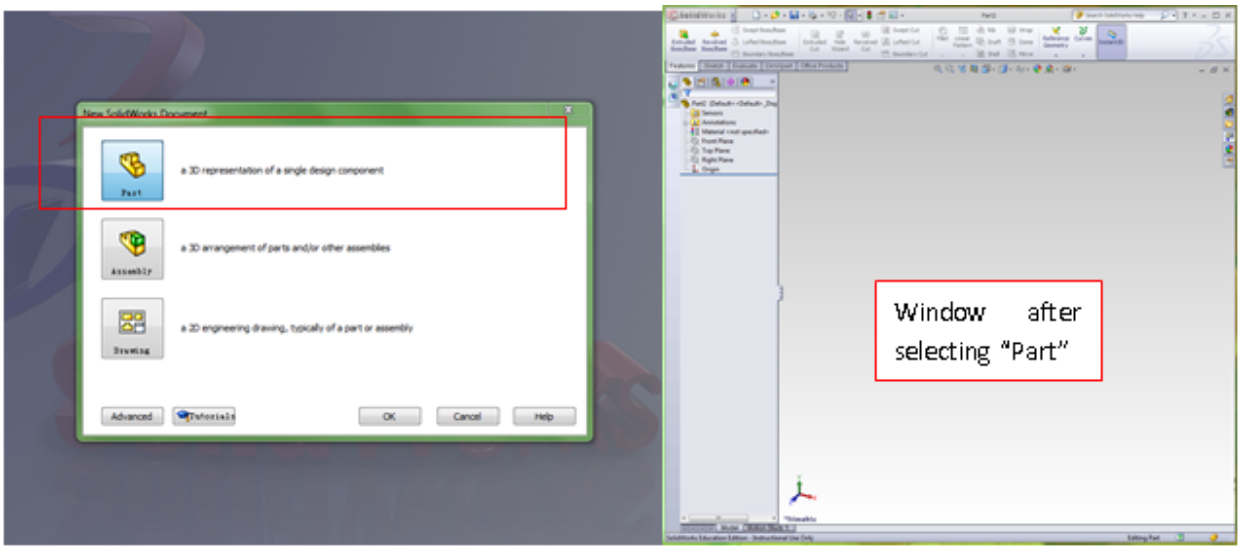
This laboratory practice is not an assignment. However, students are advised to go through these materials to ensure they understand how to use the basic functions in SolidWorks. Students will need this knowledge for the course homework and course project.

1. **Opening the program and select a part file:**

1.1. Click the SolidWorks icon (on desktop) to open the program;

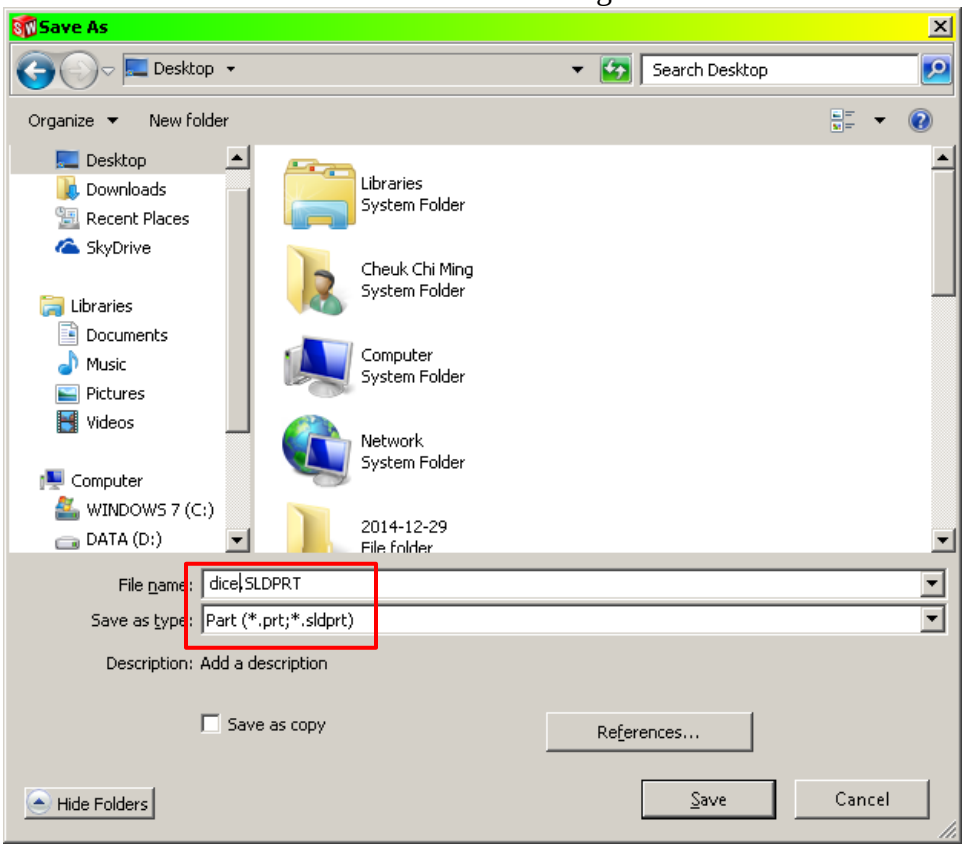
1.2. Open new document, with 

, select "Part" (icon at the top-left corner)



[Optional] If you are asked for selecting the "units and standards" after clicking "Part"-icon, select "MMGS" (millimeters-grams-second) and ISO standard, you can also change later if you skip this step. The unit can be set under "Tools/Options/Document Properties/Units".

1.3. Press "Ctrl + s" to save this part file first on desktop and name it as "dice.SLDPRT". You may open a new folder to store the file for better file management.

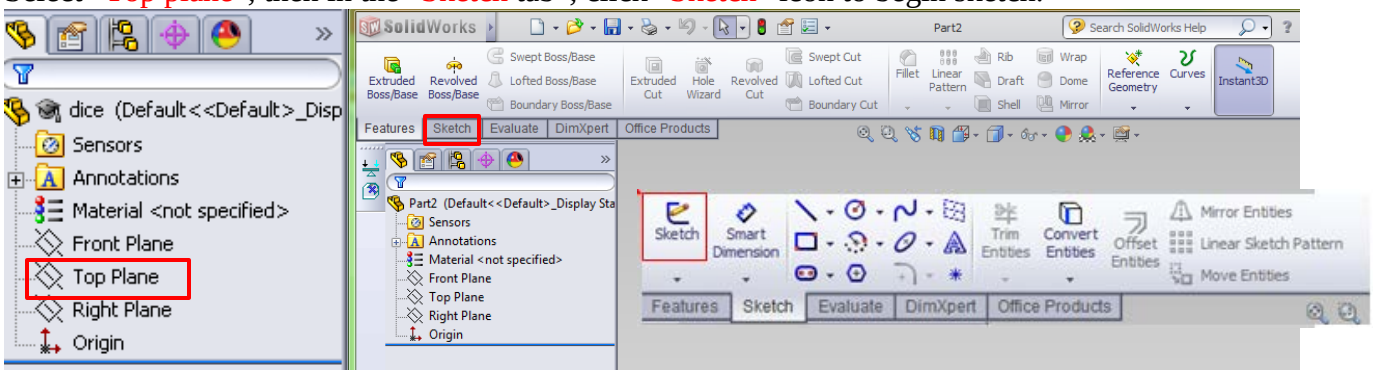


1.4. You have already opened a new part file and save it. Next, you are going to draw a dice.

2. Sketch in 2-D plane:

2.1. To start drawing you need to select a planer surface to draw. Initially there are 3 virtual planes you can draw on.

2.2. Select "Top plane", then in the "Sketch tab", click "Sketch" icon to begin sketch.

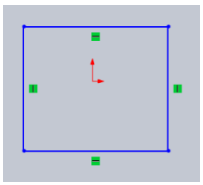


2.3. In the tool bar at the top, as you are doing 2D-drawing, keep it on the Sketch tab.

2.4. [Optional] You can select "line tool"  to draw straight lines. You can draw polygonal lines by successive mouse clicks. It will stop when you click on the start point to produce a closed-loop contour. After you complete the shape, exit this tool by pressing "Esc" button on the keyboard.

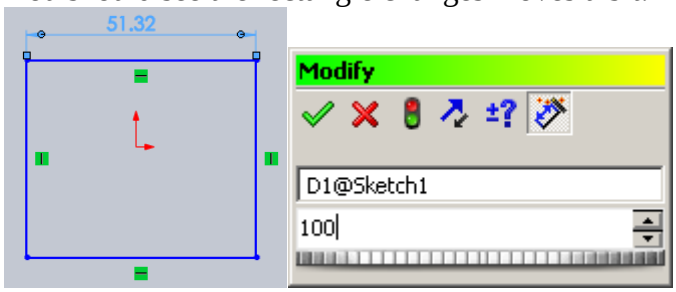
2.5. [Optional] To change the shape of the polygon that you have drawn, you can pull any line by clicking the straight line, or by clicking on any vertices, and move it. (Note: You need to first exit the "line tool", or other shape sketch tools, to edit a shape.) To delete line(s), you can click any line and then press "Delete" button on keyboard. Multiple selections can be made via holding down "Ctrl" button on keyboard and clicking the lines successively.

2.6. To draw a dice, we can first click the tool  . Click one of the corners of the desired rectangle first and then click the opposite diagonal corner.

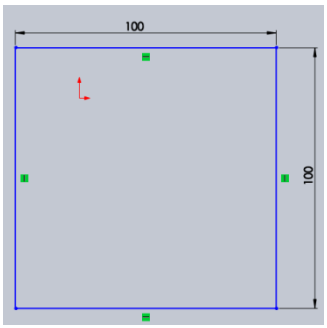


2.7. Now you can adjust the length of the rectangle by a tool called "Smart Dimension"

2.8. To define the length of the rectangle, after you have selected the "Smart Dimension" tool, click the top edge of the rectangle. A dimension is displayed. Place it a bit above the top edge. Then a small editing window is shown. You can type "100" or "100mm" inside the window and hit "Enter" on keyboard. You should see the rectangle changes moves a bit.

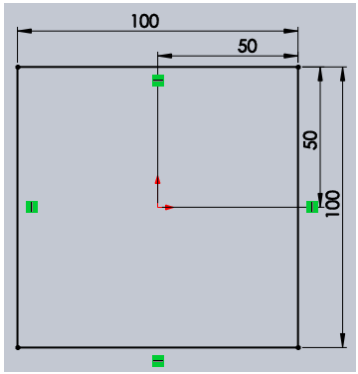


2.9. [Optional] After the rectangle has changed shape, it may be difficult to view to select other edges. You can spin the mouse wheel to zoom, or press down the mouse wheel (it has a button inside) and move the mouse to rotate the viewing angle. To move in linear direction, hold down Ctrl button on the keyboard, press the mouse wheel and then move the mouse to move.



2.10. Repeat the above dimensioning for the right edge and also set it to 100mm to make it a square.

2.11. You will notice that the lines of the rectangle are all in blue color. It means that all the blue edges are not yet "fully-defined" (i.e. fixed with respect to the environment). You may verify it by moving any lines or corners of the rectangle. The positions of the rectangle is NOT yet fixed w.r.t. the origin.



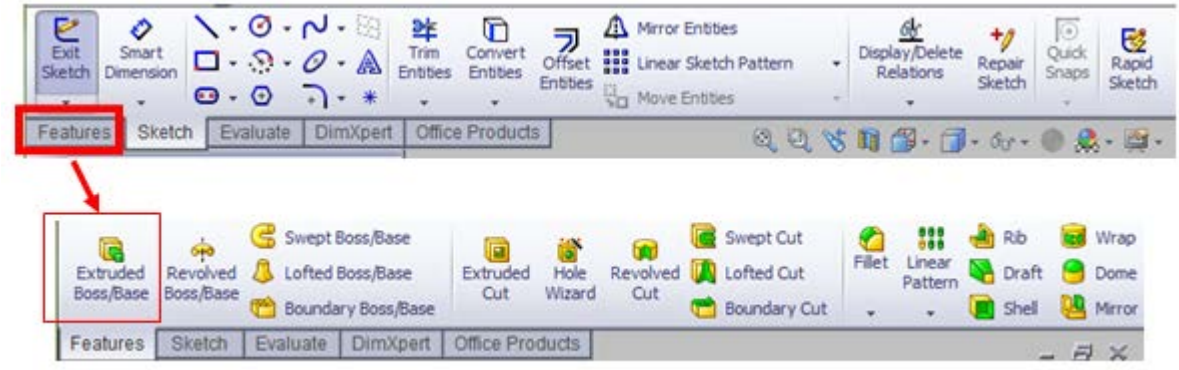
2.12. Now we will fix the position of the rectangle by defining the distance between the edges and the origin. Select the "Smart Dimension" tool. First click on the top edge, but DO NOT place anywhere. Then do the 2nd click on the origin. You will see the dimension direction has changed. Place the dimension near the right-edge-length for consistence and set it to "50mm".

2.13. Repeat it for the distance between the right edge and the origin, and also keep it at "50mm".

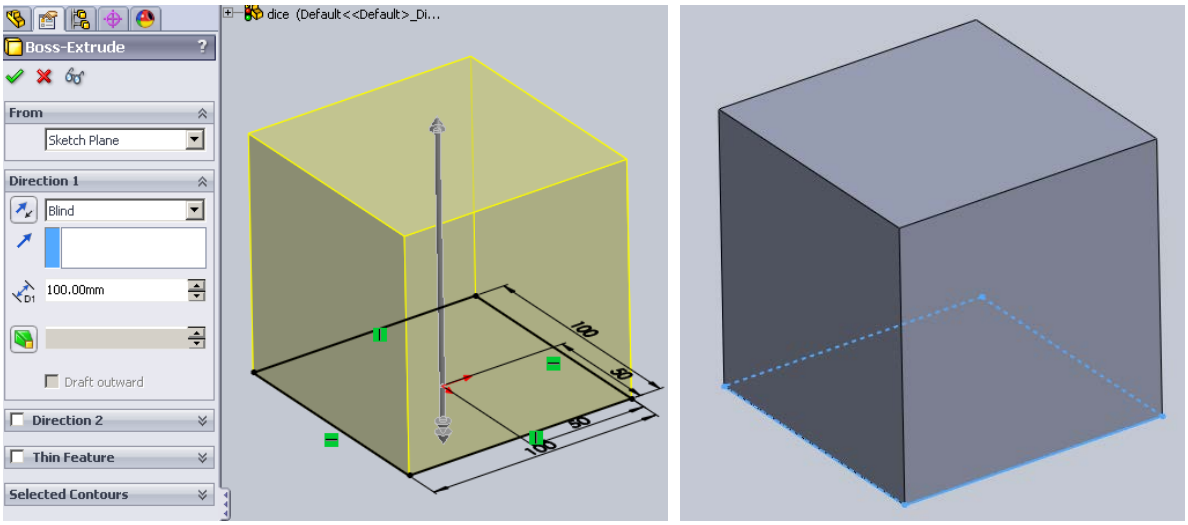
2.14. To finish/confirm sketch, you can click the transparent icon at top-right hand corner.  (Note: DO NOT click the nearby red cross,  which is the exit-and-discard button.) However, you can skip this step to directly proceed to building-3D-feature. If you don't select the confirm button, the software assumes you are building additional features for the current sketch. Please note that one "sketch" may contain drawings of several shapes. But they should be ON THE SAME SURFACE.

3. Creating a 3D feature:

3.1. Continuing from the last sketch of a square without confirming a sketch, go to the "feature tab", and select "Extruded Boss/Base". This is the function to create a prism from a 2D closed-loop contours.



3.2. Type 100mm in the field, keep the option as "Blind", then click the top Green tick icon to confirm.

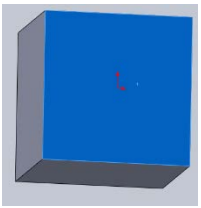


4. Draw more features on the 6 sides:

4.1. Draw an ONE:

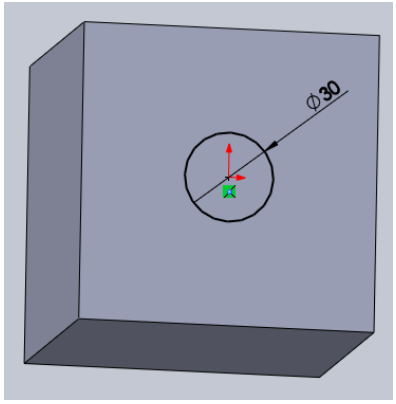
4.1.1. You can further sketch on one planer surface by first clicking on the surface and then selecting the "sketch" button  in the "Sketch" tab (like what you did before). Alternatively, you can select the small "sketch" button shown in a small shortcut window after you have selected the surface.

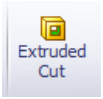
4.1.2. Let's select the surface with the origin to sketch. After entering the sketch, make sure the origin is at the middle of the square. If the origin exists on one of the edges (meaning the origin is actually on the other surface that shares that edge with the current surface), exit that sketch by pressing the transparent "Red cross" button at the top-right corner and then select another surface



4.1.3. Now in the sketch tab, click the "circle"  to draw a circle. The first click should be at the center of the circle and the 2nd click should be on the circumference. Draw the circle centered at the origin (middle of the square) and then place the 2nd point anywhere you like. Again, press "Esc" when you finish drawing a shape.

4.1.4. Dimension the radius/diameter using "smart dimension". Single-click on the circumference and place the diameter label anywhere you like, change the diameter to 30mm. The special sign before the "30" value indicates that it is the diameter.



4.1.5. Go to Features tab and select “Extrude Cut” 

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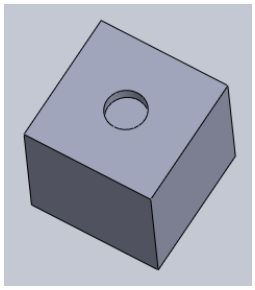
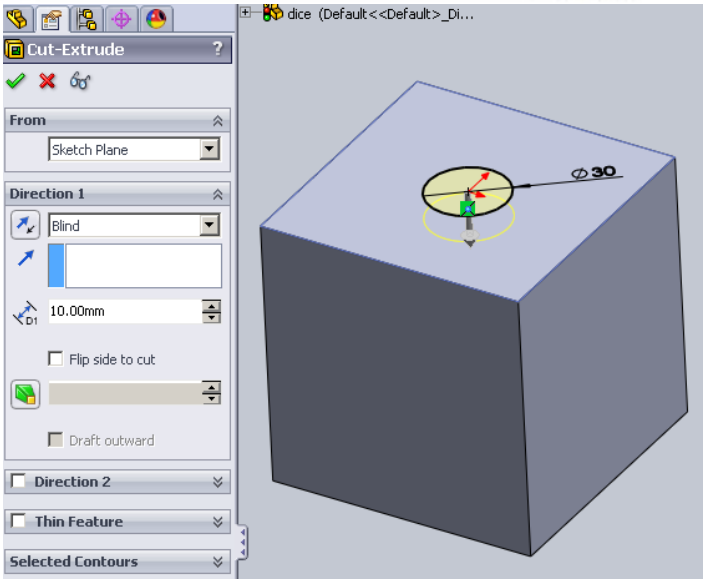
4.1.6. In the option panel, make sure it is “Blind” (cut it blindly, to a certain depth), and type 10mm. You could toggle the extrude direction by pressing the small arrow beside the “Blind” option.

4.1.7. Press the Green tick to confirm.



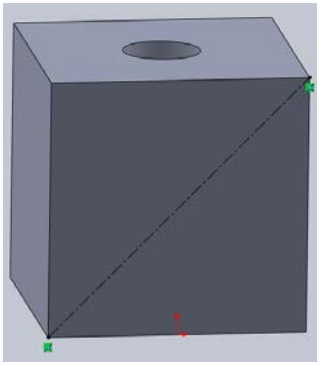


4.2. Draw a THREE:

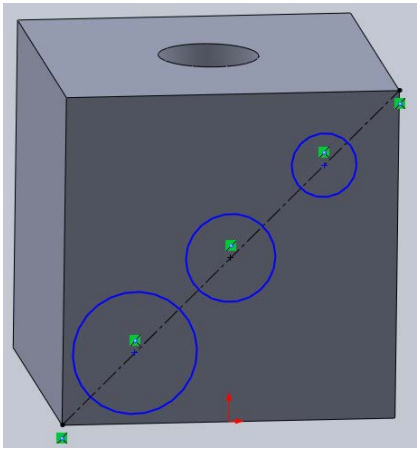
4.2.1. In this part you will try to use a "construction line" to help you sketch and save the tedious dimensioning work.

4.2.2. Sketch on any one of the remaining planes.

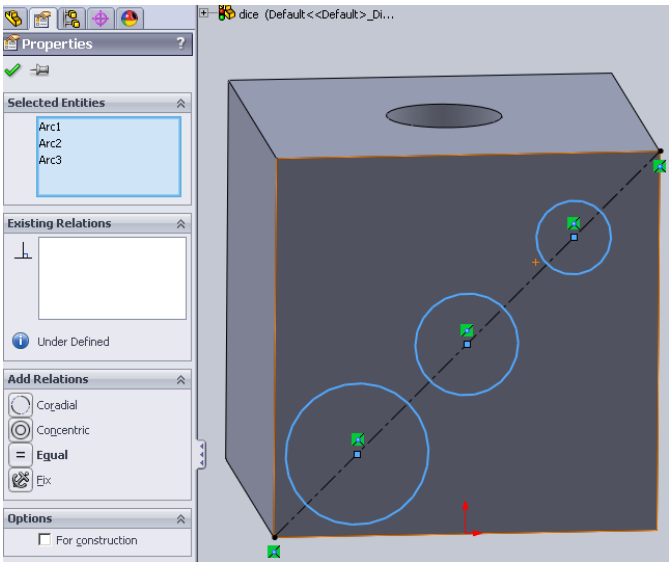
4.2.3. In the line tool  , there is a small triangle nearby. Click it to open a short menu about additional options for this tool. For example, the additional line option is the "centerline". It is NOT a solid line and therefore it cannot be used to build any geometry directly. Select "centerline", then click one corner and its diagonal corner. After that, press "Esc" or double click at other place to complete the centerline drawing. Since the 3D cube is fully defined (i.e. fixed), drawing from the 2 corners also fixes the centerline (it becomes black).



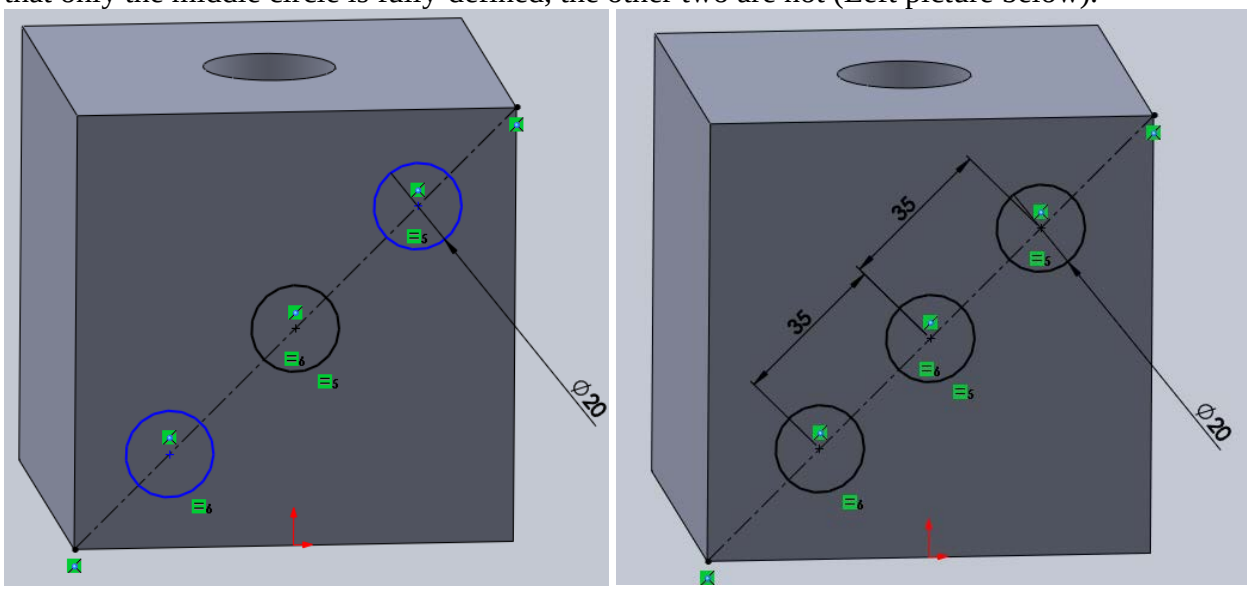
4.2.4. Draw one circle at the middle of the centerline, and then draw 2 more circles near the center circle.



4.2.5. Now, to save the number of times of dimensioning, you can set the 3 circles to be of the same diameter. Hold down the "Ctrl" button, and then select all 3 circles. A property window is shown. Select "Equal" and then press the Green tick. You should see that the circles are changed to equal size.

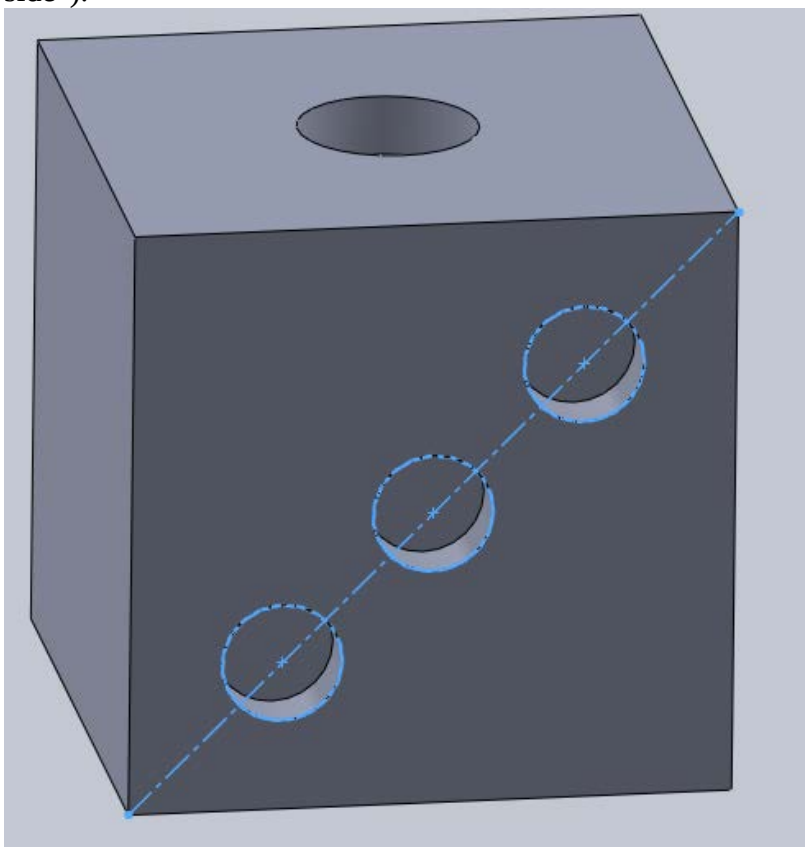


4.2.6. Now dimension either one of the circle to 20mm. All 3 circles will change correspondingly. Notice that only the middle circle is fully-defined, the other two are not (Left picture below).



4.2.7. Dimension the distances between the circles by using the smart dimension tool. Clicking any two circles will give you the distance between their centers. Set the distances to 35mm (see the right picture above).

4.2.8. Go to Feature tab, select "Extrude Cut" and cut it 10mm deep (same as before for the "ONE-side").



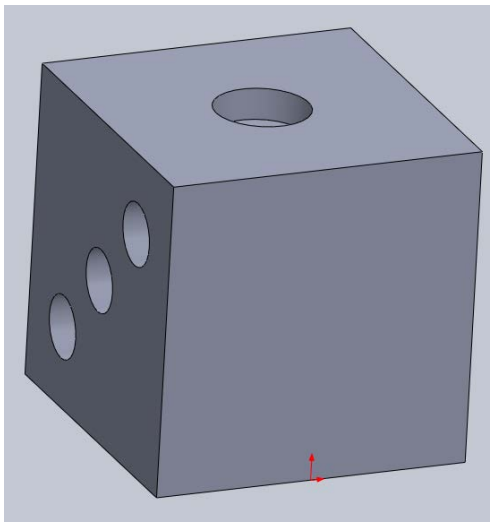
4.3. Draw a TWO:

4.3.1. This is left for your own exercise. You can use the techniques in "Draw a THREE" to complete this part.

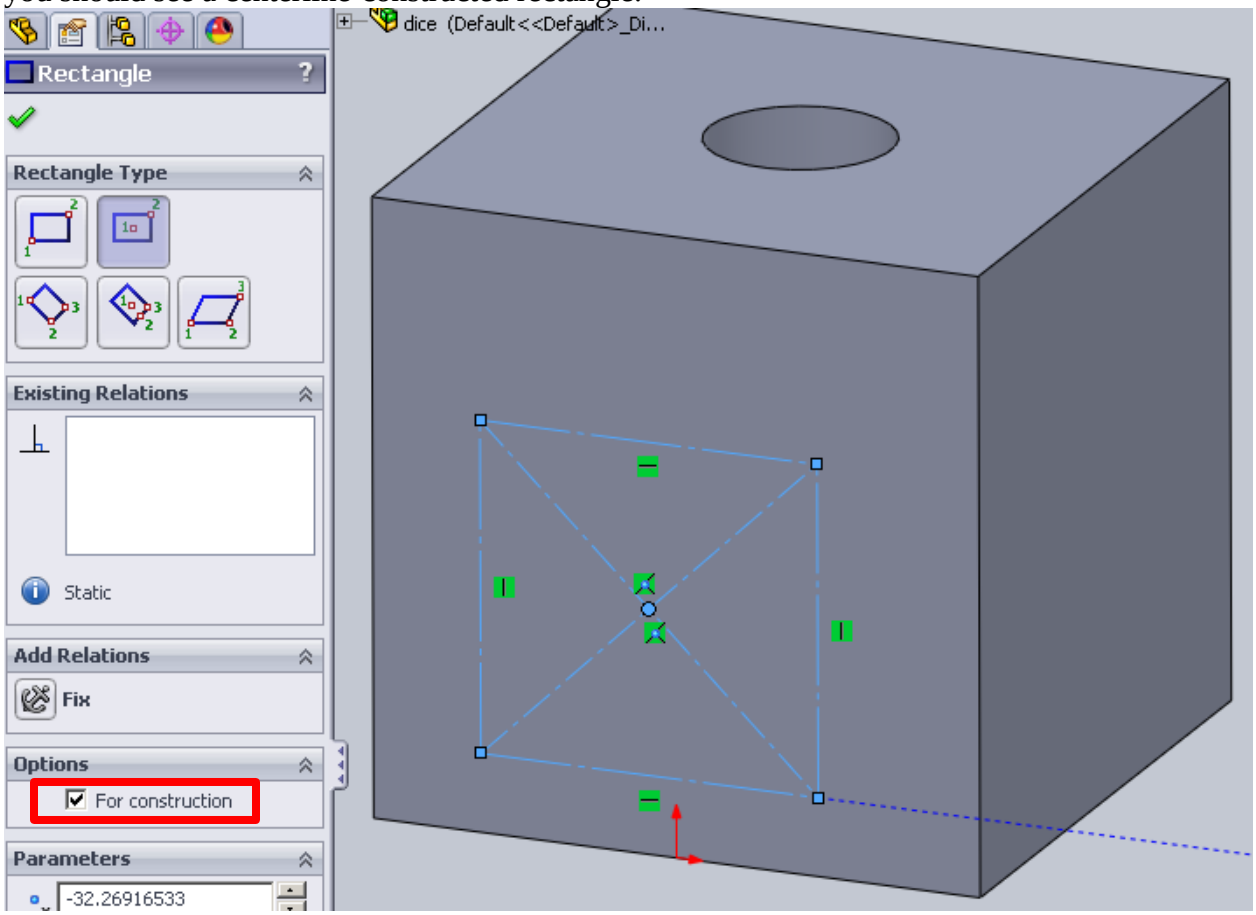
4.4. Draw a FOUR:

4.4.1. In this part you will practice how to use more complex constructional geometries to help you sketch.

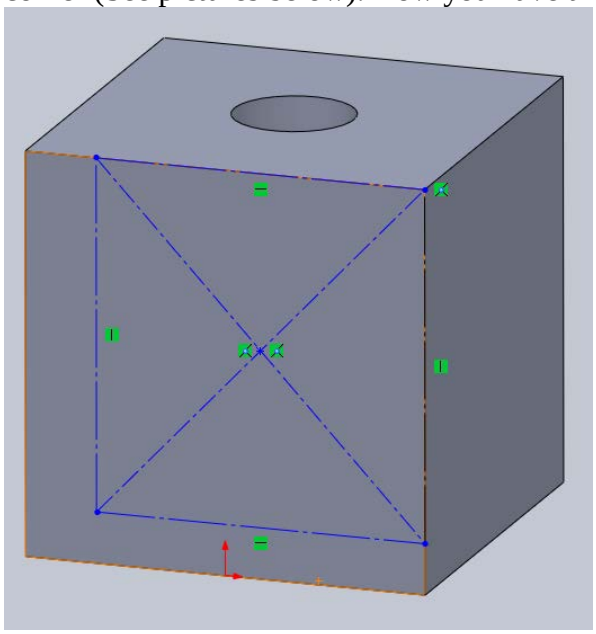
4.4.2. Sketch on any one of the remaining sides which DOES NOT HAVE AN ORIGIN AT THE MIDDLE.

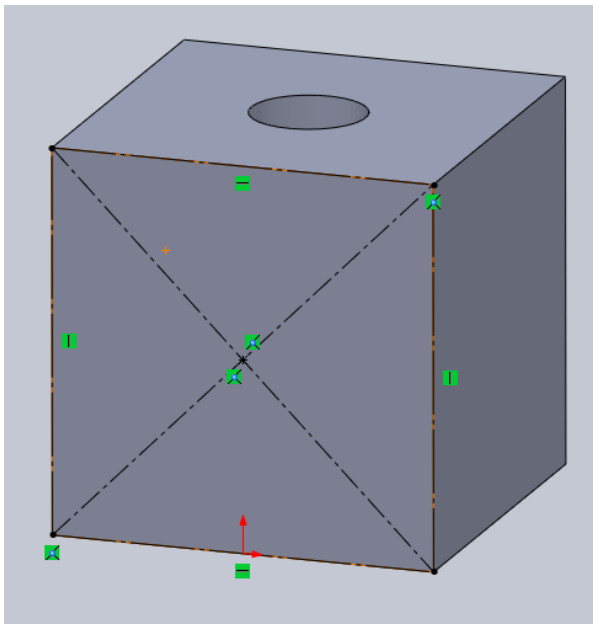


4.4.3. Go the sketch tab. Click the small triangle near the rectangle  and select the 2nd option "Center Rectangle"  . This tool can be used like the circle tool by first clicking the center of the rectangle, then clicking one of the corner of the rectangle. DO NOT CONFIRM yet. In the options panel of the rectangle, check the "For construction" option. Press the Green tick to confirm, and you should see a centerline-constructed rectangle.

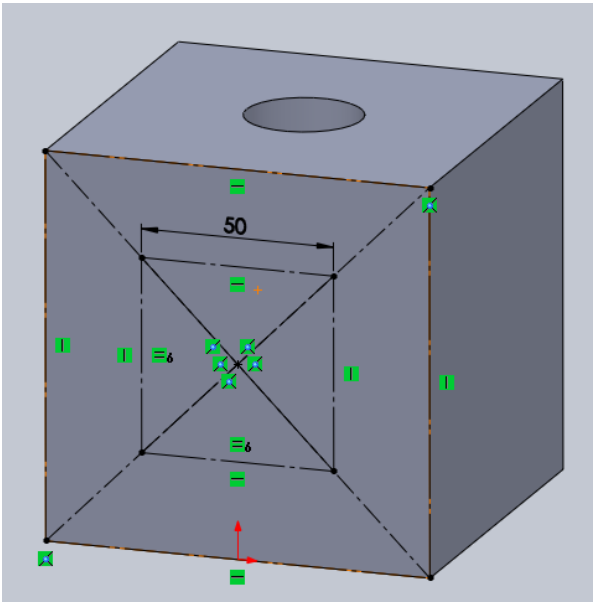


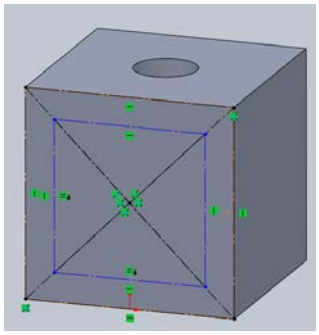
4.4.4. Now, drag one of the corner to the corner of the square. Then drag another corner to the diagonal corner (See pictures below). Now you have the center at the middle!

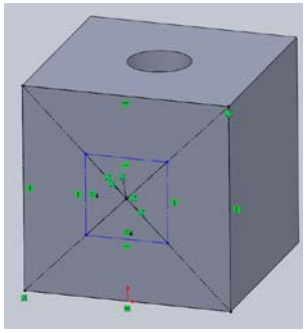




4.4.5. Draw another center rectangle starting from your newly created center, and place another corner along one of the diagonal centerline that you just created. Again, DO NOT CONFIRM yet. Under the options of the rectangle, check the "For construction" option. Due to geometry constrains, you now have a squared construction rectangle. You can drag the blue edge to change the size of the square. Now dimension the top blue edge to 50mm and confirm it

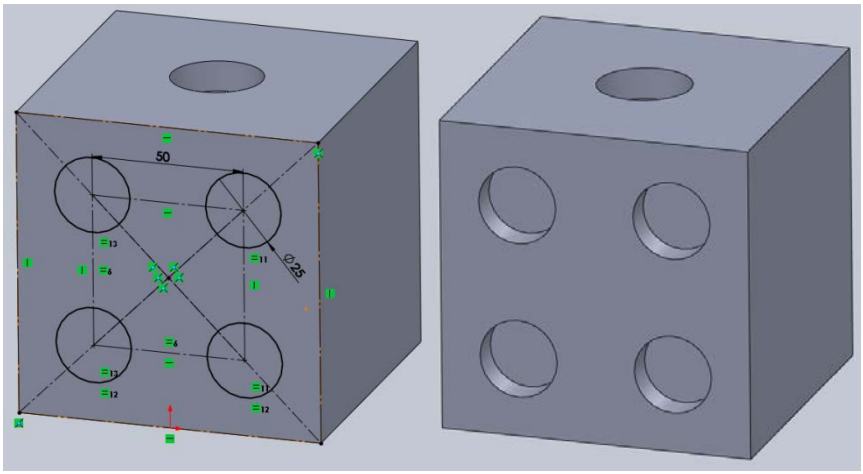






4.4.6. Draw 4 circles centered at the corners of the 50mm construction rectangle. Set them to "Equal" (in diameter) and set diameters to 25mm.

4.4.7. Extrude cut for 10mm.



4.5. Draw a FIVE:

4.5.1. This part is left for your own exercise.

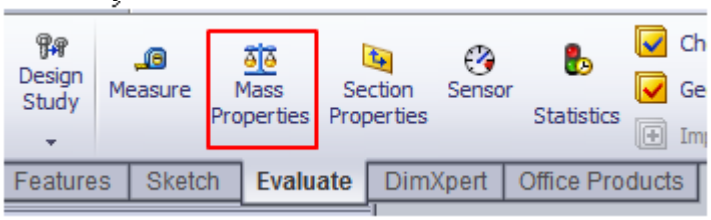
4.6. Draw a SIX:

4.6.1. This part is left for your own exercise.

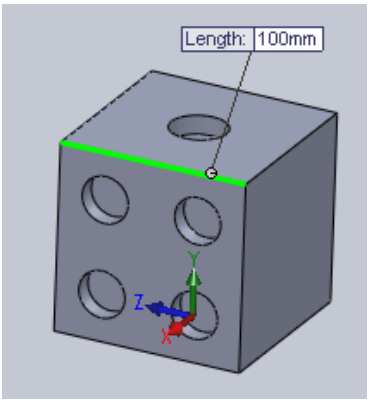
5. Measure and Volume checking:

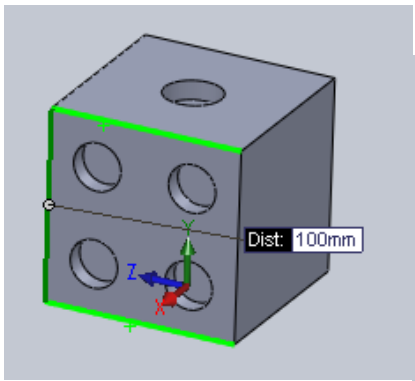
5.1. There exists functions for you to measure distance between features, and to measure the volume of your created parts.

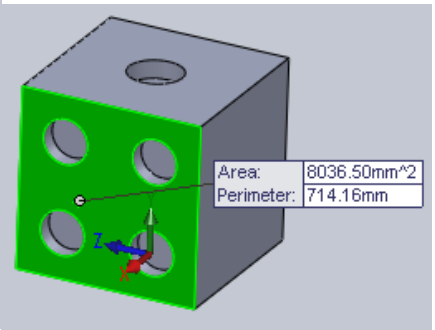
5.2. To measure the volume of a part, go to the "Evaluate tab" and select "Mass Properties". An information window is shown, and you could find the item of "Volume = xxxxx.xx cubic millimeter". Your submitted parts may be subjected to a maximum volume limitation, so try your best to design your parts efficiently!

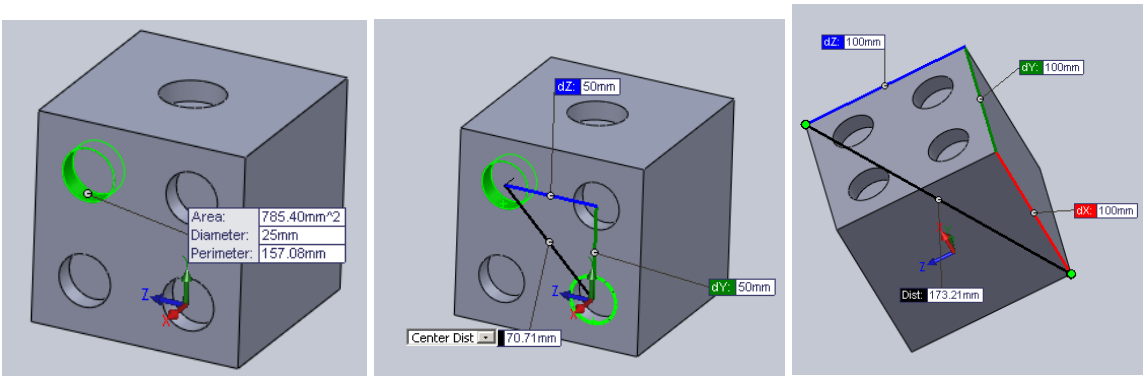


5.3. To measure the distance between different points/planes, in the "Evaluate tab" select "Measure". Then you can click on any planes/points to measure the quantity. Pictures below show some examples of measurements related to the clicked part(s) in green. Remember to unclick those part that are needed in the measurement.









6. Saving files for submission:

6.1. It is always suggested to save the files many times to keep a roll-back option. You could rollback to your previous saved design when you encounter a software clash.

6.2. To save files, you can press "Ctrl + S" on keyboard, or move your mouse cursor to the top-left corner of the software and select File→Save.

6.3. If you have to submit file for 3D-printing, select File→Save as to save a file with the extension ".STL", for example, "dice.stl".

7. More detailed information regarding the descriptions of the software are given in the Solidworks tutorials ppt/pdf files