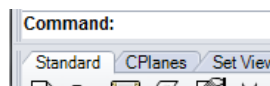Physics 200 (Stapleton)
Designing a Virtual Box in Rhino

General Hints:

- "click" means left click. "Right click" means right click.
- A right click may also be used: 1) instead of "enter" 2)to restart the last command that was entered
- Clicking the arrow tool ⬚ cancels a command.
- Ctrl+Z = undo
- Select multiple things by dragging a box or holding shift while clicking.
- To deselect things, ctrl+click.
- Every once in a while, save your file. Use "incremental save" if you want to save a new version and keep the old versions.
- Sometimes Rhino won't know which item you're clicking, because they overlap. You have to select the correct one and then hit enter.
- Read the suggestions next to the command prompt. They will tell you what to do to carry out each command.

1. Select the Standard toolbar tab.
2. Making the bottom of the box

    a. Select Box tool

        i. In top view, click somewhere to begin your box.
        ii. Type the box width press enter or right click.
        iii. Type the box length and press enter or right click.
        iv. Type the thickness of the box lid (0.13 for cardboard) and press enter or right click.
        v. In the perspective window, right click and drag to roll the lid around to see if it looks right.

3. Making the sides

    a. At the bottom of the Rhino window, select Osnap, and make sure that Ortho is also selected.
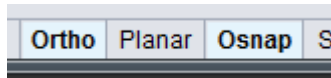
    b. Select these boxes on the bottom left of the window: End, Near, Mid, Int
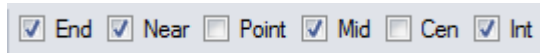
    c. Select the box tool

        i. With your mouse in the front viewport…

            1. Begin your side by clicking on one of the bottom corners of the box bottom.

            2. Type the thickness (0.13) and enter.
            3. Type the height and enter

        ii. Move your mouse to a different viewport
        iii. Stretch the box side that you are making until it is as wide as the box bottom. To finish the side, click on an edge or corner of your box bottom.
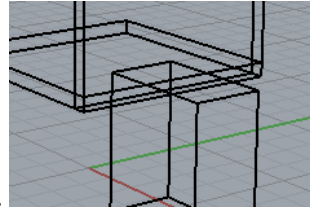
    d. Click the Transform tab at the top of the window and select *move*.

       i.   Click on an outside corner of your box side. Move your mouse until that corner matches up with your box bottom corner, so that the edges of the bottom and side overlap.
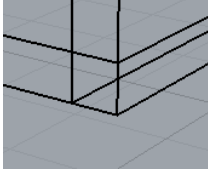
e.   Create mortises in the top and bottom edges of the side panel.
       i.   Draw a box that is about the right size to cut a notch out of your side panel. Then move the box so that the top of the box is even with the top of the bottom panel. Move it near the middle of the panel.

       ii.   Drag the box so that it passes through the side panel.
       iii.   Click the *Transform* tab at the top of the window. Select *mirror*. Create a mirror image box at the top of the side panel.
          1.   Select the box that you just drew.
          2.   Start the mirror plane at the middle (in the vertical dimension). Then move your mouse sideways to create a horizontal mirror plane.
          3.   Finish the command, creating a new box at the top of the side panel.
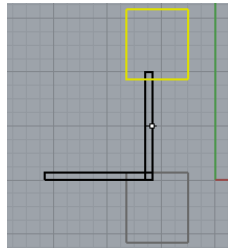
       iv.   Use the boxes that you have made to cut notches (mortises) in the side wall.
          1.   Open the *Solid* tab and click *Difference.*
          2.   Follow the command prompt directions to subtract your new boxes from the side
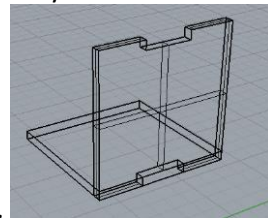
              wall. When you're done, it should look like this.

f.   Create an adjoining side panel.
       i.   In the *Transform* tab, select *mirror.*
       ii.   Working in the Top Viewport, mirror your existing side panel across a diagonal of the bottom panel. Create the diagonal mirror plane by clicking on opposite corners of the
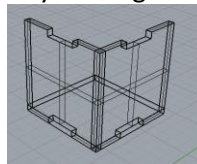
              bottom piece. The result should look like this.

g.   Using the same technique that you used in step e, create mortises in the sides of your original panel.
   i.   First create an overlapping box where the edes of the side panels meet.

ii. Use the *mirror* command to reflect the cutting box across the side panel. Your mirror plane should go through the middle of the bottom piece. Make sure that you see "mid" before
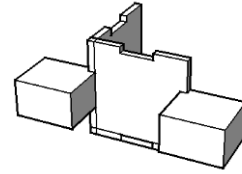
you click your mouse to begin the mirror plane.

iii. Subtract these little boxes from the side panel using the *difference* command. Your notches
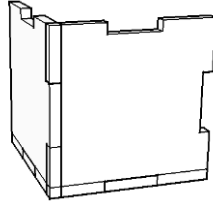
should look like this.

h. Make more sides

i. Working in the top viewport, use the *mirror* command to reflect on of the existing sides to an opposite side of the box. To reflect across the middle of the box, make sure that you are using the midpoint of the bottom piece as the starting point for your mirror plane. After you have created the mirror image, make sure that it is in the right place. Zoom in to
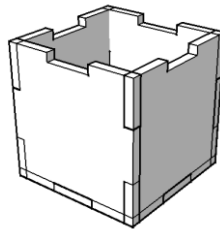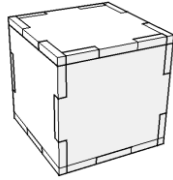
get a good look.

ii. Begin the *Difference* command (under the *Solid* tab), but complete step two below before fully executing the command.

1. The objects "to subtract from" should be the walls that only have mortises (notches) at the top and bottom. Select them both and click enter.
2. Before the selecting the "objects to subtract with", type "D" and hit enter. You will want to keep the sides that you are subtracting with, and typing this D changes the mode to "Deleteinput=No"
3. The objects "to subtract with" should be the walls with mortises in every side. Select them and finish the command. Your new mortises should be cut, and all of the sides should still be present.
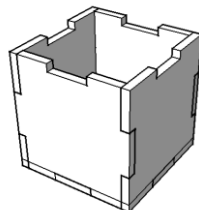
4. Make the top and finish the bottom.

a. Use the *copy* command to copy the bottom onto the top. Click on one of the top corners of the bottom panel, and then click again on one of the top corners of a side panel. Zoom into be sure that things are lining up properly.

b. Make sure that the top overlaps the side panels in the same way that the bottom panel overlaps
the side panels.

c. Use the *difference* command to subtract all of the sides from the top and bottom. Your *difference*
command should still be in "Deleteinput=No" mode, so you will still have the sides after you
subtract them. You can do this all at once. For "subtract from," select both the top and bottom.
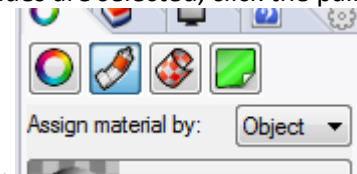For "subtract with" select all of the sides.
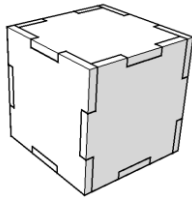
5. Add color so that you can see the different parts clearly.
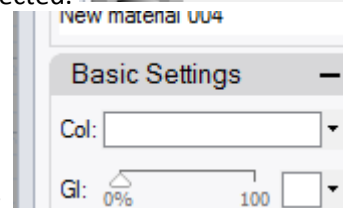   a. Working in the perspective viewport, click the down arrow and select *render* view mode.
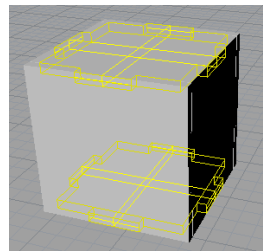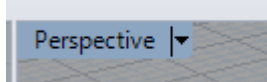
   b. Select two opposite sides of your box.
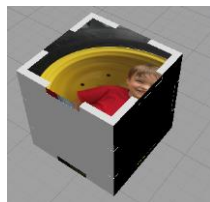   c. Find the tabs on the right side of the window. While your box sides are selected, click the paint
   tube and make sure that "assign material by: object" is selected.

   d. Click the rectangle next to "col" and then select your color
   e. Repeat steps b-d for the two other pairs of opposite sides, but give those sides different colors.
   f. Just for fun, if you want to cover the box pieces with a graphic, you can click the color box under
   textures, instead of basic settings. Then choose a jpeg that you have downloaded to your
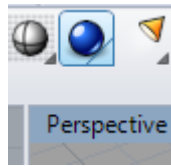   computer.

6. Save your creation on your drive.
7. Create a rendering to turn in.
   a. In the perspective viewport, orient your box nicely.

Perspective

b. Then click the blue render button.
c. Using the file menu, save your rendering as a jpeg.
d. Name it with your name and email it to Mr. Stapleton.
8. Create a layout of your box for laser cutting or 3-D printing.
    a. *Save as*, and create a new Rhino file with a name indicating that this file can be used for laser cutting or printing.
    b. Open the *Transform* tab at the top and select *rotate*.
    c. Rotate the sides and top.
        i. Rotate each of the vertical sides 90 degrees, so that they lie flat. This process will work best if you work in either the *front* or *right* viewport. First click on the bottom outside corner of one of the sides. Then rotate the top of the side outward until the side is lying flat. You can do this by typing in a rotation angle (90° or -90°) or you can rotate using your
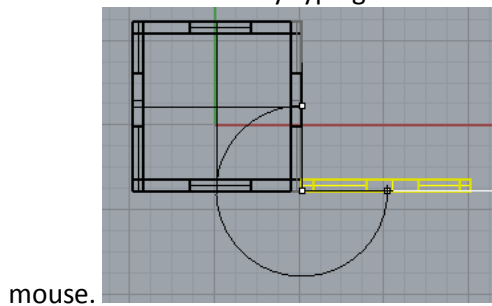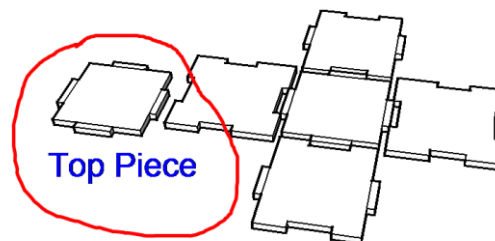

mouse. After you have rotated the sides, in perspective
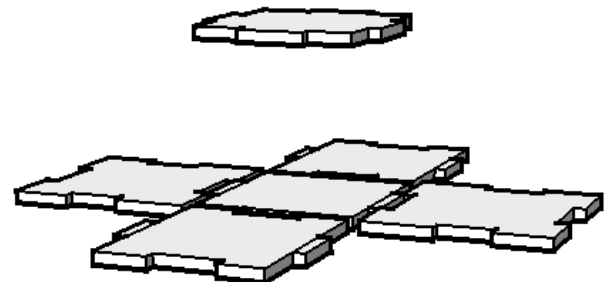
view, your box might look like this.
   ii. Rotate the top of the box 180°.
    d. Position the pieces.
        i. Select the top piece. Then, working in the *top* view, drag the top piece to one side, so it no


longer overlaps the other pieces.
   ii. Open the *Transform* tab and select *move*.

iii. Move the pieces until they fit together nicely. If you have designed your box correctly, the tenons (tabs) on one piece should fit into the mortises (notches) on the neighboring piece.
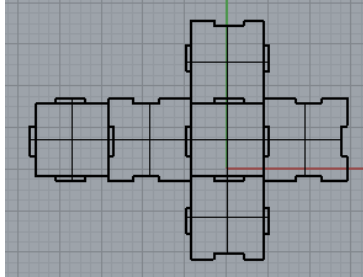
iv. Make sure that all edges that appear to be lined up are lined up exactly. Zoom in to make sure. If you can't line them up, move them apart. We don't want the laser burning through the same place twice.

e. Do another *save as*. You are about to alter this file to make it better for laser cutting. Then you may want to go back to the current file and alter it for 3-D printing. The formats are a little different.

f. Create a 2-D drawing of your cutting layout.

i. Working in the *top* viewport, select all of the pieces.

ii. Open the *Dimension* tab and select *2-D drawing*. Follow the directions to create a 2-D

Original   2-D Drawing
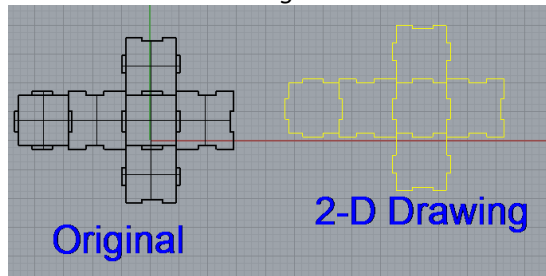
drawing of your layout.
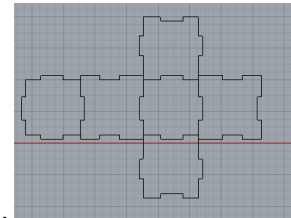
iii. When the 2-D drawing is complete, delete your 3-D parts.

iv. Make sure that your file units are set to *inches.*

1. Open the *Tools* tab at the top of the window. Select *options* near the bottom of the list.

2. In the list on the left, under *Document Properties*, select *units*.

3. Make sure that the model units box is set to *inches.* If you make a change, you will be asked if you want to scale the drawing. In this case, select *No*.

v. Save your file with your name in the file name and e-mail it to Mr. Stapleton.

g. Optional – prepare your file for 3-D printing.

i. Open up the version that you saved in step e.

ii. Working in the *front* or *right* viewport, make sure that the bottoms of all of the pieces are at an even level. Adjust them if necessary by using the *move* command under the *Transform* tab.

iii. Working in the *top* viewport, drag the pieces so that there is a little bit of space between them. If there is no space, the plastic of one part will stick to the neighboring part.

iv. Arrange your six sides into a 2 piece x 3 piece rectangle for optimal space saving.

v. Confirm that all of your pieces are on the same level. Perspective view should look
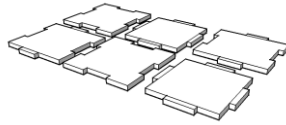
something like this.   Top view.   Side view.

vi. Save your file under a new name including your name and 3D printing. This file is a Rhino (.3dm) file.
vii. Save again, but this time save your file as a .STL file.
viii. This .stl file can be opened in Cura, the software that runs the Library 3-D printer. You can also open this file with the software that runs the Fab Lab 3-D printer.