Physics 100 (Stapleton)
Modifying Cars in Rhino

These directions will help you take advantage of the files in the "auto parts store" folder.

1. **Creating new wheels and adding wheel thickeners.** The "wheel thickeners" allow you to make your wheels thicker while conserving cardboard.

   a. Click the "transform" tab and select the "scale 2-d" command.
   b. If you want wheels and thickeners that are compatible, select your wheel and the thickeners.
   c. To select the "origin point," go to a window where your wheel appears as a circle. Use Osnap to click on either the center of the circle or the "point" at the circle's center.
   d. Either type in the scale factor or click somewhere. If you click, you will need to move your mouse until your wheel is the right size. Then click again.
   e. Make sure that the axle is aligned with your wheel. Then click the "solid" tab and choose the "difference" command to use the axle to cut a hole in the center of your wheel.
   f. Transfer your new wheels and thickeners to the "axles and reinforcers" file.
      i. Option 1: select them and "copy & paste."
      ii. Option 2: Save the whole file under a new name. can be copied and pasted into the file

   g. ** When you get to the point where you are laying out your parts to be cut on the laser cutter, you can "ungroup" the thickeners, which are actually three pieces. "Ungroup" is under the "edit" tab, but you can also press (ctrl + shift + G).
   h. You may want to add extra wheel locks to all of your wheels to cut down on wheel wiggling (see diagram with wheel locks in green).
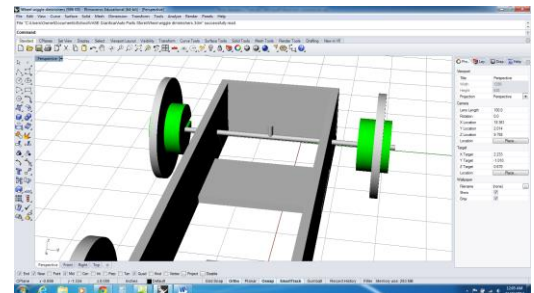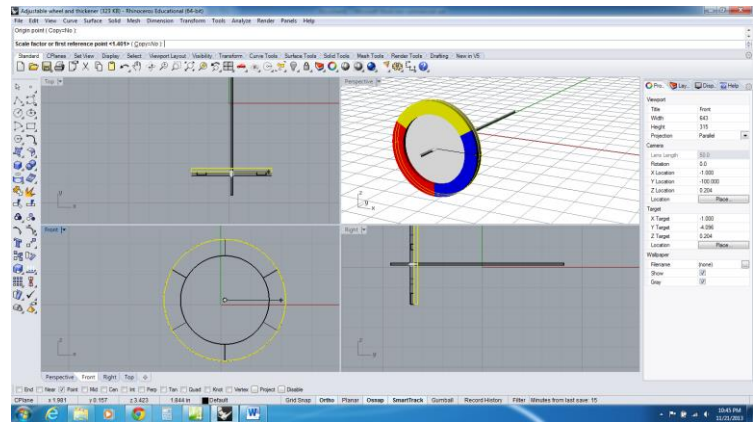
2. **Changing the frame length.**

   a. Decide how long you want the frame to be.
   b. Choose a method of lengthening
      i. Method 1: Cut off the existing frame members.
         1. Create a box that overlaps the frame members.
         2. Under the "solid" tab, use "difference" to use the box as a tool to cut off the members.
      ii. Method 2: draw your own frame members.
         1. Use the box tool, in the solid menu.
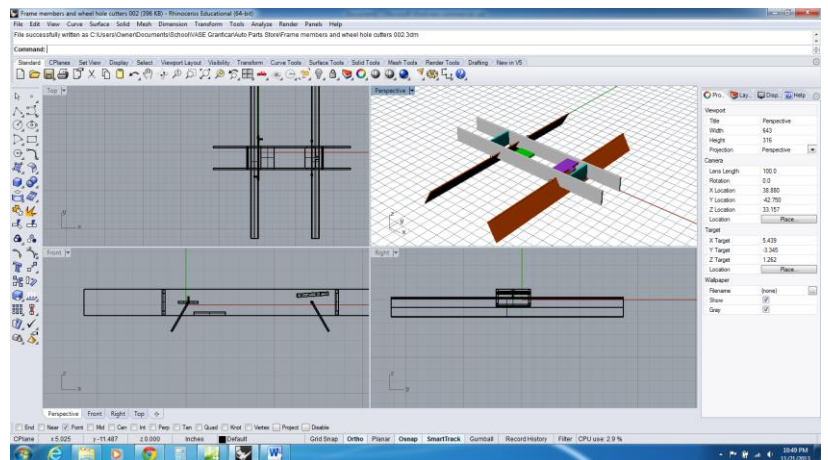
2. In top view, click on the starting point of your box. Then type the length inches and press enter. Next type the thickness, which is around 0.188 for most cardboard (3/16"). Next either type the height of the frame or go to the front view window and move your mouse until the frame is as tall as you want it. Click.

c. Make sure you have two sides for your frame. If you just have one, you can create another using the "mirror" or "copy" commands in the "transform" menu.

d. If you want extra strength, now is a good time to create double or triple thick frame members. You can do this by copying or mirroring.

e. **Position the front and back cross members (colored in the file)**

   i. Make sure that Osnap is turned on, and make sure that you have selected "end" in the Osnap menu.

   ii. In the "transform" menu, select the "move" command. Then, in perspective view, click on one of the corners of a front or back cross member and click it into place at the front of the frame (as in diagram on the right).
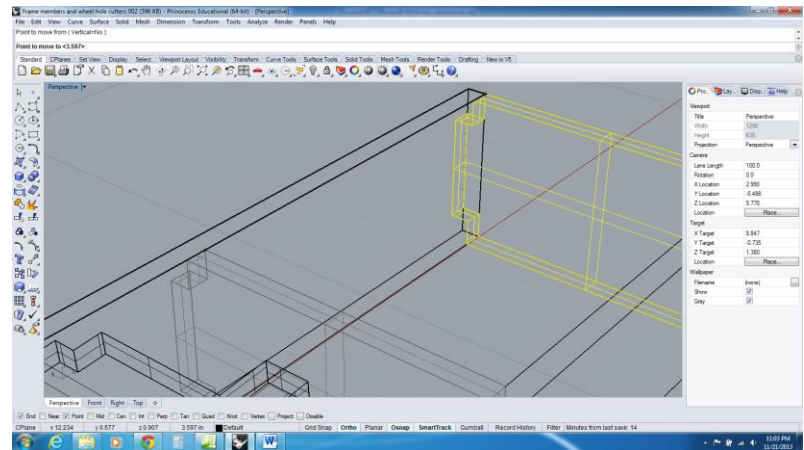
f. **Position the other cross members.** Making sure that you are in Ortho mode, shift the other cross members to wherever you want them.

g. If you want extra sturdiness, you can double the cross members. You can also create extra cross members at new points along the car's frame.

h. Cut notches for the cross members.

   i. Choose the "difference" command from the "solids" menu.

   ii. For "subtract from" select both of the length-wise frame members.

   iii. Before you finish the command, type "d" and "enter," so that you see "delete input = No" in the dialog box. This will prevent your cross members from getting deleted in the next step.

   iv. For "subtract with," select all of the cross members.

i. Cut the axle holes.

   i. Position the axle hole cutters where you want them.

   ii. Now "ungroup" the axle hole cutters. They include axles, and you want the axles to be left behind when you are done. To ungroup, use the edit menu or hold (ctrl + shift + G).

   iii. Use the "difference" command to delete the axle hole cutters, but not the axles. This time, you'll want to have the input deleted, so after you begin the difference process, you will probably need to type "d" to change the mode to "delete input = Yes."

   iv. Save your file.

3. **Assembling your car:**

a. Open the "axles and reinforcers" file. Make a copy in your folder. Change the file name to "[your names or group name]V2"

b. Import and incorporate your frame file.

   i. Snap the axles with reinforcers into position.

      1. Make sure that Osnap is turned on and that "point" is selected.

      2. Use the "move" command in the "transform" menu to move the axles with reinforcers to the same position as the axles that came with your frame file.

a. There is a tiny white dot at the center of each axle. Using the "move" command, click on to this point and move it to the corresponding point on the frame axle.

b. You don't need two identical axles in the same place, so you can delete one.

c. Import and incorporate your wheels. They should also have points that correspond to points on your axles. The points are there to help you click the wheels into place. You can also use the "cen" option with Osnap.

d. Incorporate any other features and fully assemble your car.

4. **Create a bounding box around your car and determine your car's new volume.** For the final contest, this cannot exceed 600in^3.

5. **Send the finished file to each group member. Each group member must e-mail Mr. Stapleton a jpeg rendering of the car with the parts he or she worked on highlighted. Everything else should be grey.** ***Important note: sometimes you will find that you can't change an object's color the way you want. The solution is usually to select the object, then select "duplicate," and then choose a new color. (see diagram on the right)

6. **Prepare your car parts for laser cutting.**

a. Rotate all parts as needed.

b. Organize your parts into batches that will fit on pieces of cardboard that you will provide.

c. Use the "make 2-D drawing" command in the "dimensions" menu to create 2-D drawings for the laser cutter.

d. Upload the finished laser cutter file to your class' folder on the google drive.