You may work alone or in a group of 2, 3, or 4 people. Your group will earn a score that you will then divide up between you. For instance, if a group of 3 earns 60 points, you may choose to allot 20 points each.

Choose a room that you will draw in perspective by plotting 2D points using the Perspective Theorem. Big picture: First find the 3D coordinates of important points in a room, relative to an origin. Then choose your viewer's position and use the Perspective Theorem to calculate the 2D perspective images of these points using Excel or some other spread sheet. Finally, graph your results, and connect the dots to form your room.

For extra credit, use your understanding of 3D coordinates, common sense, and basic arithmetic to add the 3D coordinates of features that are **not** in the room but that you think would be a nice addition. Then use the Perspective Theorem to find these additional points' 2D perspective images and add them to your graph.

- You need to choose the artist's/viewer's position, an xy-plane, and an origin. What order you do this in will depend on you and the features of the room you've chosen.
  - If you happen to be able to find a room with a tiled floor, you could use the tiles as the units of measurement (i.e. as the grid in the xz-plane. Choose one particular pair of perpendicular lines to be the x and z axes.

    Otherwise, it will be easiest to choose as the x and z axes to edges of the floor that meet in a corner of the room – that is, have the x axis be one edge where a wall meets the floor, and the z axis be a perpendicular edge where a wall meets the floor. That will make it easiest to measure, and hence to find the coordinates.

    Tiled floor or no, you probably want the y axis to be one edge where two walls meet.
  - Note that the xy-plane will be defined by your choice of x and y axes. It doesn't have to be anything real in the room, but the easiest choice would be for the xy-plane to be one of the walls of the room, as described earlier. Because the xy-plane has to be between the position of the viewer's eye and the scene you want to draw, this choice will mean that you are assuming the viewer is outside of the room looking through the wall with x-ray vision, but that's okay. Your data, combined with these choices, will allow you to create a vision of the room that you can't actually see!.

    Choosing the xy-plane to not be parallel to any of the walls may be more fun and/or interesting. It will also be harder, as that means your x axis can't be any edge of the room, and the y axis may not be either. It makes setting up all the axes described above more time-consuming.
  - Set up some grid lines: first, use painter's tape (like what we used in the window experiment) to mark measurements along the 3 axes – maybe one hashmark every foot. Next, you'll probably find the next steps easier if you add either some grid lines – strips of tape parallel to the x, y, and z axes every 5 feet or so, for instance – or marks forming the corners of the grid every square foot or so.
  - Choose where you want the viewing position (the viewer's or artist's eye) to be. If you've already chosen your x and z axes, you don't have a lot of choice over this – the viewer's eye needs to be somewhere on the negative z-axis. The only thin you

have choice over is how far back. If you've chosen the x and z axes to be two edges of the room that meet in a corner, then the view of the room you will be drawing will be from floor level, looking into the room from outside but along a line determined by one far side of it. The only choice you will have is far outside of the room the viewer is located.

- Figure out d, the distance from the origin to the viewer's eye along the z-axis. This is just a matter of measuring how far the viewing position you chose above is from the origin along the z-axis. If you have a measuring tape that measures in centimeters rather than inches, I'd suggest using metric units. Remember the coordinates of the viewer's eye are $(0, 0, -d)$.
- Once you have clear in your mind what directions x, y, and z are and what units you're measuring in, start figuring out the real-life 3D coordinates of key features of the room by determining their x, y, and z coordinates relative to the origin you chose. *Note: You are* **not** *measuring the distance from the origin to the point – you are measuring how far over, how far up, and how far out from the origin it is – 3 measurements for each point.*
- Clearly label each point you collect in terms of what it is ("bottom of front right chair leg"); it seems time-consuming but without it putting all your points together into a drawing later will be nearly impossible.
- Be sure to collect enough points to draw features that are not just parallel to the picture plane.
- Key features to pay attention to: each corner of the room that lies on the positive side of the picture plane, as well as corners of windows or pieces of furniture – especially windows or furniture that is **not** parallel to the picture plane.
- Use the Perspective Theorem to find the perspective image of each of these points on the picture plane, as it would appear to a person whose eye is located at the viewing position you chose. As you calculate each image point, carefully label what it represents. (I would suggest using a spreadsheet to do this, but you're welcome to do it by hand if you'd rather.)
- Very very carefully plot each of these image points on a set of 2D axes on graph paper, and then connect those dots that should be connected, to obtain (if all went well) a pretty good perspective image of the features of the room you recorded.
- Feel free to then color in the result as you see fit!
- Please write a description of what you did and an analysis of how it turned out.

Possible points: Your group score for this project will depend on how many points in the room you find the 3D coordinates of, whether you corrected your measurements for consistency and accuracy, how correct your calculations using the perspective theorem are, how careful your final graph/perspective drawing is, and whether you added any 3D points that weren't actually present for the bonus. 20 points in the room could earn a score of up to 75 to be divided among your group (if done well, and there's some perspective on display), while 40 points in the room (again, done well and with some perspective on display) could earn a group score of up to 105 points to be divided among you, and 60 points could earn a score up to 120 points to be divided among you.