Lesson Plans for (9th Grade Main Lesson)

Descriptive Geometry (Last updated June 2012)

Overview

The subject of *descriptive geometry* is essentially a course on technical drawing. It continues a theme begun in the eighth grade stereometry main lesson: the visualization of three-dimensional form. In ninth grade we focus on drawing three-dimensional objects.

The course begins with the students attempting freehand drawings of an object, and by doing simple drawings using one-point parallel perspective. The remainder of the course uses the technique of orthographic projection, where the vanishing point, or the point of view of the observer, has moved to infinity. Various objects (pentagonal pyramid, dodecahedron, icosahedron, rhombic triacontaheron, “soccer ball”) are placed inside a “viewing” box, and the students must draw (with great precision!) various views of the object: the top view, the front view, and then either a side view, an edge view, or a vertex view.

Notes for the Teacher

- At my school, there is only room for one math main lesson block in ninth grade. Therefore, the two ninth grade math main lesson blocks (*Possibility & Probability* and *Descriptive Geometry*) are both during one 4-week main lesson block. Usually, I work it so that the first week is only Possibility & Probability, and the last week is only Descriptive Geometry. Thus, each block runs for three weeks, and there are two weeks of overlap.
- Therefore, with what is listed below, days #1-8 are half days, and days #9-13 are full days.
- I do not give any test for Descriptive Geometry. The last week, which is dedicated entirely to Descriptive Geometry, concentrates completely doing drawings.

Day #1

- Course Expectations (including Drawing Standards). Pass out “expectations sheet” and go over it.
- Freehand Drawing of a Dodecahedron.
    - Mention that our goal is to find a method for exactly draw a dodecahedron rotating, or seen from any point of view.
- Six photos of a cube. In groups have the students discuss what the differences are between the photos.
- Hanging questions: How does a camera minimize distortion?

Day #2

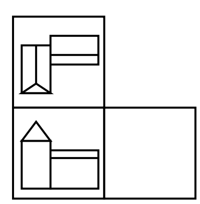
- Six photos of a cube. Discuss yesterday’s findings.
  The general idea is that as the “eye” moves back, then:
    - The object appears smaller.
    - The object appears less distorted.
    - Lines that are parallel appear parallel.
    - The vanishing point moves further away from the object.
  - The answer the yesterday’s hanging question: The camera minimizes distortion by moving back, and zooming in.
- Drawing: *Two Boxes*. Each has the same size square front face (parallel to the viewing plane). Each one is drawn with one-point parallel perspective. The second one has its vanishing point quite a bit further from the box. The sides of the box should run halfway along the lines from the front face to the vanishing point.
- Two Projections: (1) The artist’s canvas, and (2) “Flood-light” projection (where we imagine a light is shining onto an object (such as a cube made of sticks) and we view the shadow projected onto a screen).
- Hanging questions: How can we do a drawing that has the least amount of distortion?

Day #3

- What is the difference between the artists canvas and the flood-light projection?
    - The placement of the canvas…with the artist it is between the point of view and the object, and with the flood-light the screen is on the other side.
    - The size of the image/drawing depends on how close the canvas or screen is to the object.
- What is actually happening when we move the vanishing point further away from the box?
  Ans: The point of view (your eye) is also moving further away.
- yesterday's hanging question…which leads to a new type of projection:
  Orthographic Projection:
    - We imagine that both the vanishing and the point of view are infinitely far away.
    - Also, the canvas (or screen) is perpendicular to the line of sight. This also means that both the canvas and screen will produce the same size drawing no matter how far the screen or canvas is placed from the object.
    - We can either imagine any of the following:
        - We have moved infinitely far away with our camera (and zoomed in to keep the size good).
        - The painter has moved infinitely far away and (with an infinitely long arm) has painted with the canvas very close to the object.
        - The projector (i.e., flood light) has moved infinitely far away.
    - It allows for the least distortion – parallel lines appear parallel.
    - This, as we will see, allows for a drawing technique that uses simple mechanical methods.
- Guided Meditation: There is a bug hovering in the center of a cubic box. There is an orthographic projection of the bug onto the front, top and side face of the box (i.e., a dot in the center of three of the faces). Imagine how these dots (images of the bug) will move once…
        - The bug flies directly up toward the center of the top face, but stops one inch short of touching the face, then…
        - The bug flies directly toward the back face, but stops one inch short of touching it, then…
        - The bug flies back to its starting point at the center of the box.
    - Imagine that you can only view the image on one of the faces of the viewing box. How would each view be different?
- The "Viewing Box"
    - Have the drawing of a simple house on the board with all three views.
    - Using an overhead projector, show the side and front (or back) view of a stick in a variety of positions.
    - Vocab:
        - *Horizontal plane* – parallel to the bottom and top faces.
        - *Frontal plane* – parallel to the front and back face
        - *Symmetry plane* – parallel to the side faces.
- Hanging questions:
    - When is the front view of a stick actual size? (Ans: when it sits on a frontal plane)
    - If we know the top and front view of a stick, how can we exactly know the side view?

Day #4

- Review. Go over yesterday's hanging questions.
- Drawing of a House.
    - Have the drawing of only the top view of a house, and ask what we do and don't know about the house.
    - Then fill in the front view. Now we should know everything about the house.



- What does each view of a point tell us?
    - The front view tells us how far from the top and side it is. (We can't tell how deep the point is.)
    - The top view tells us how far from the front and side it is. (We can't tell how high the point is.)
    - The side view tells us how far from the front and top it is. (We can't tell how far left/right the point is.)
- Group Work: Begin work on Problem Set A.
- Extra Credit: Problem Set B.

Day #5

- Review
  - What would it look like (all three views) if there was a propeller inside the viewing box spinning along a frontal plane?
- Group Work: Continue work on Problem Set A.
  - Show how to use ruler and right triangle to draw parallel lines
- Homework: Write summary of week #1 for Descriptive Geometry.

Day #6

- Group Work: Begin work on Problem Set C. (Extra Credit: write verbal descriptions as well.)

Day #7

- Group Work: Continue work on Problem Set C.
- Drawing: Pentagonal Pyramid.

Day #8

Last half day!

- Drawing: Start the drawing *Three Views of a Dodecahedron*.
  - See document titled *Instructions for Drawing a Dodecahedron*.

Day #9-12

- Finish the drawing
- Homework: Write an essay that summarizes the second week.
- If there is extra time in the Block: Draw the 3 views of a simple building.
- Continue work on various drawings. Possibilities include:
  - *Three Views of a Dodecahedron*. Instruction for this are given in the document *Instructions for Drawing a Dodecahedron*.
  - *Rotated View of a Dodecahedron*. The spacings for the vertical lines are generated by having a slanted line, drawing all of the construction lines perpendicular to that line, and then using the normal technique of copying these spacings with a compass, and then drawing in the vertical lines having those spacings.
  - *Four Views of a Dodecahedron*. The top and front are given. Then you need to do a rotated view, as described above. Essentially, we will use this edge view as the "new" front view, and rotate the top view (by the degree measure that the slanted line was off vertical) to get a "new" top view. This new fourth view is called the "auxiliary view".

    Now we need to determine the spacing of the horizontal and vertical lines for the auxiliary view.
    - *The spacing of the vertical lines*. In creating the edge view, we started by drawing a slanted line, and then drawing lines from each point in the top view over to this slanted line. Now look at the circle segment that is between this slanted line and the top of the box for the edge view. (The arcs drawn with the compass also define this circle segment.) If we imagine that this circle segment closes up by rotating the slanting line until the slanted line becomes horizontal (and the compass arcs therefore disappear), then the top view is rotated into position to become the new top view. Therefore, we will now draw a new slanted line, which is perpendicular to the edge view's original slanted line, and sits above and to the right of the top view. Now we copy every point in the top view perpendicularly to this new slanted line. These spacings are then copied to the top line of the box for the auxiliary view.
    - *The spacing of the horizontal lines*. The spacing of the horizontal lines for the auxiliary view are achieved by drawing lines from the points in the edge view perpendicularly to a new slanted

line, drawn up and to the right of the edge view. These spacings are then copied to left side of the box for the auxiliary view.

- *A Rotating Dodecahedron*. This is simply a series of multiple edge views of the same dodecahedron.
- *Various Views of an Icosahedron*.
- *Various Views of a Rhombic Triacontahedron*.