**Youth Explore Trades Skills Design and Drafting – 2D Drawing**

# CAD Orientation

## Description

This is an introductory computer aided design (CAD) activity designed to give students the foundational skills required to complete future lessons. Students will learn all the key parts of the CAD software (navigating, command line input, menus, opening and saving drawings, etc.) that will be required to complete this activity.

## Lesson Objectives

The student will be able to:

* Navigate software
* Use simple drawing commands
* Move around drawing space (zoom, pan)
* Input xy coordinates into CAD software
* Use command line entry
* Modify commands: copy, move, paste, offset, fillet
* Print a drawing on the classroom printer

## Assumptions

The student will:

* Know how to login to a computer and open up the software
* Not know how to navigate the program they will be using
* Not understand how to start a new drawing or know what drawing commands are

## Terminology

**Absolute coordinate entry**: procedure used in CAD (based on the Cartesian system) to specify a position and establish a point on the x, y, and z axes. For example, if you type 4,2 (no spaces) for a location, the entity would start/end at 4 units along the x axis and 2 units up the y axis.

**Basepoint**: the point on an entity or object that you select when you are moving, copying, scaling, etc.

**Cartesian system**: a system that has x, y, and z coordinates that all intersect at 0,0,0, known as the *origin*.

**Command**: instruction to a computer.



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**Command line**: an area—typically at the bottom of the screen—that allows for keyboard input, and which shows messages or prompts for information. Keyboard entry in CAD software is sometimes easier.

**Computer aided design** (CAD): software used by engineers, artists, architects, etc., to create precision drawings and technical illustrations.

**Entity**: the object in CAD programs (line, circle, text, etc.).

**Fillet**: a command in CAD software allowing you to create a rounded inside or outside curved corner.

**Grid**: a pattern of dots or lines within the work area of the software that can be used to aid in drawing.

**Limits**: a command to set the size of the drawing space for your drawing.

**Object snap** (**Osnap**): a mode that allows you to “snap” to an object (line) at its endpoint, midpoint, etc.

**Offset**: a command that creates a copy of an entity (line, circle, etc.) that is a specified parallel distance away from the current object(s) selected.

**Pan**: a command used to shift the view of your drawing to see different parts. It differs from zoom in that it does not change the size of the viewing area.

**Polar coordinate entry**: allows you to establish an x, y, z position at a specific length and angle relative to the last point you had specified. For example, if you want a 45-degree angle that is

2 units long, the command line would be @2<45.

**Relative coordinate entry**: allows you to establish an x, y, z position relative to the last point you had specified. For example, when drawing a line, your last point was 4,2 (no spaces), now you want to go over 2 on the x and 0 on the y to make a line 2 units long on the x axis. The command line would be @2,0.

**Snap**: used to limit your movement of the crosshairs of the cursor to a predetermined interval to aid in drawing to specific measurements.

**Text**: a command used to add text to a drawing.

**Title block**: an area of a drawing sheet that contains information about the actual drawing, including project name, author, scale, drawing number.

**Trim**: a command used to “trim” off excess length on an object or entity, to end exactly at the end or intersection of another entity.

**Zoom**: a command used to magnify or change the view of a drawing to get a closer or further look at part of your drawing. If you type in the word ZOOM, you have many options with letters on the keyboard, including the following:

* + A = All — Zooms to everything you have drawn, including the limits of the drawing
  + E = Extents — Zooms to everything you have drawn
  + W = Window — Zooms to the window you pick by holding the left mouse button down and dragging the mouse over the area to create a rectangle to zoom into

## Estimated Time

45–90 minutes

## Recommended Number of Students

20, based on *BC Technology Educators’ Best Practice Guide*

## Facilities

Computer lab installed with CAD software (Google SketchUp, AutoCAD, CADopia, Vectorworks, etc.) and Internet access

## Tools

Computer with projector and speakers. Computers with CAD software and Internet access

## Materials

Student activity handout for students with instructions

## Resources

Instructional videos for the teacher and/or students. The teacher can eventually create their own video(s) to match the software they are using in class, as required.

Instructional videos created using AutoCAD 2013:

* + Teacher Video 2.1 - Intro to CAD Software for the Teacher-3
  + 2.1 CAD Program Interface (MCAD)
  + 2.2 Basic Command Line Entry and Page Setup for Activity 2 (MCAD)
  + 2.3 Absolute and Relative Coordinate Entry (MCAD)
  + 2.4 Polar Coordinate Entry and Mouse Entry (MCAD)
  + 2.5 Offset Command-2 (MCAD)
  + 2.6 Fillet Command (MCAD)
  + 2.7 Move Command and Object Snap (MCAD)
  + 2.8 Trim Command (MCAD)
  + 2.9 Drawing a Simple Border (MCAD)
  + 2.10 Inserting Text into a Title Block (MCAD)
  + 2.11 Plotting or Printing Your Drawing-2

## Teacher-led Activity

Before starting the activity, the teacher will demonstrate the software for the students so they understand how it works. The following activity can be covered all at once but is most likely best broken into a couple of demos based on class time:

* + Opening the program and navigating the toolbar and/or ribbon
  + Mouse movement (scroll in/out, right/left buttons, pan)
  + Command line: inputting commands (zoom, limits, grid, etc.)
  + Coordinate entry and the line command (absolute, relative, polar)

## Student Activity

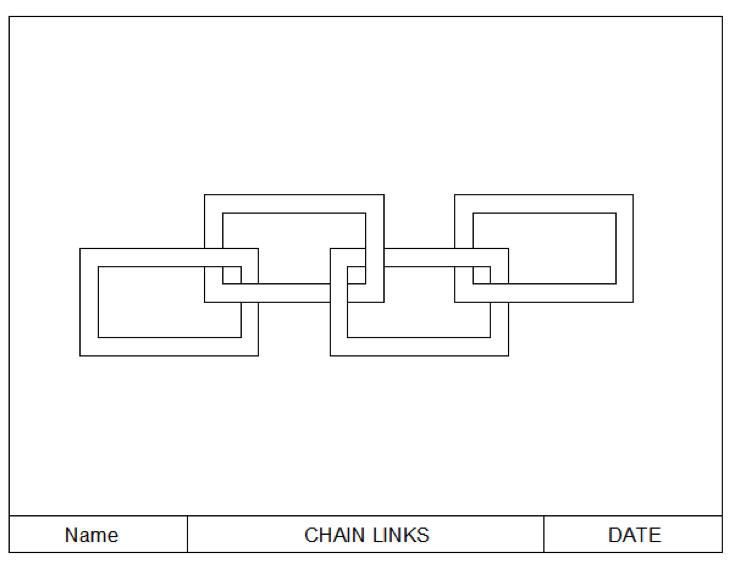
Students will follow the “Student Activity: Intro to CAD” and/or the video tutorials to complete the coordinate entry exercise and introduction to drawing in CAD software.

## Assessment

Students will show the teacher their completed assignment. The teacher can have the assignment printed out or look at it on the computer screen. If the student does not produce exactly what was shown, then an associated mark based on mistakes can be derived.

# Student Activity: CAD Orientation

Using the software, create the following drawing using the commands you have learned through the videos. Videos to support the lesson are located in the “Resources” section.



**Figure 1**

## Commands/concepts to learn in this activity

Absolute coordinate entry:

#### LINE MOVE TRIM

Relative coordinate entry:

#### COPY OFFSET TEXT

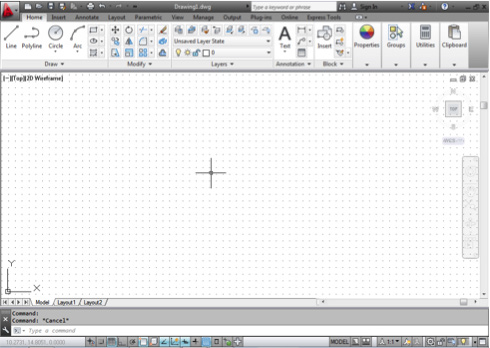
Polar coordinate entry:

#### FILLET PRINT ZOOM

**Procedure**

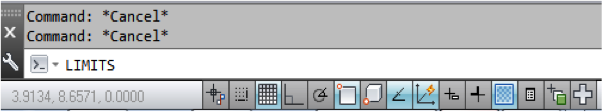
1. **CAD Program Interface (Video 2.1)**

Start the CAD software in a blank drawing. Once the program has loaded you should have a blank drawing space (Figure 2). See Student Video #1.



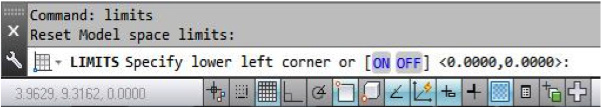
**Figure 2**

1. **Basic Command Line Entry and Page Setup: Limits, Grid, and Snap (Video 2.2)**
   1. Type the word **LIMITS** (Figure 3). You will notice it will show up in the status bar in the bottom left corner of the program. Pressing enter on the keyboard selects the command.



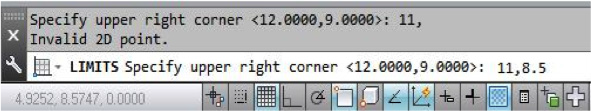
**Figure 3**

* 1. Specify the “**LOWER LEFT CORNER**” (Figure 4). This is the origin. Make sure it is **0,0**. Press **enter**.



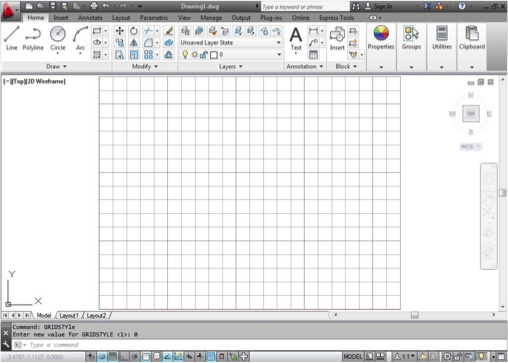
**Figure 4**

* 1. Specify the **UPPER RIGHT CORNER** (Figure 5). Change this to 11,8.5 to match a piece of letter paper that is landscape. Press **enter**. Your drawing limits are now set.



**Figure 5**

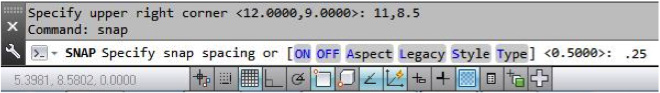
* 1. You cannot see the limits of the drawing yet, so type **GRIDDISPLAY**. Change the value to **0**. Press **enter**. Now type **ZOOM**. Press **enter**, then type **A** for All. Press **enter**. The screen adjusts to show the limits of the drawing (Figure 6).



**Figure 6**

* 1. Type **GRIDSTYLE**. Change the value to **1**. Press **enter**. The lines now change to dots.
  2. Finally, type **GRID**. Press **enter**. Set your grid to **.5**. Press **enter** again.
  3. Type the word **SNAP** (Figure 7). Press **enter**. Change the snap to **.25** by typing it in. Press

#### enter.



**Figure 7**

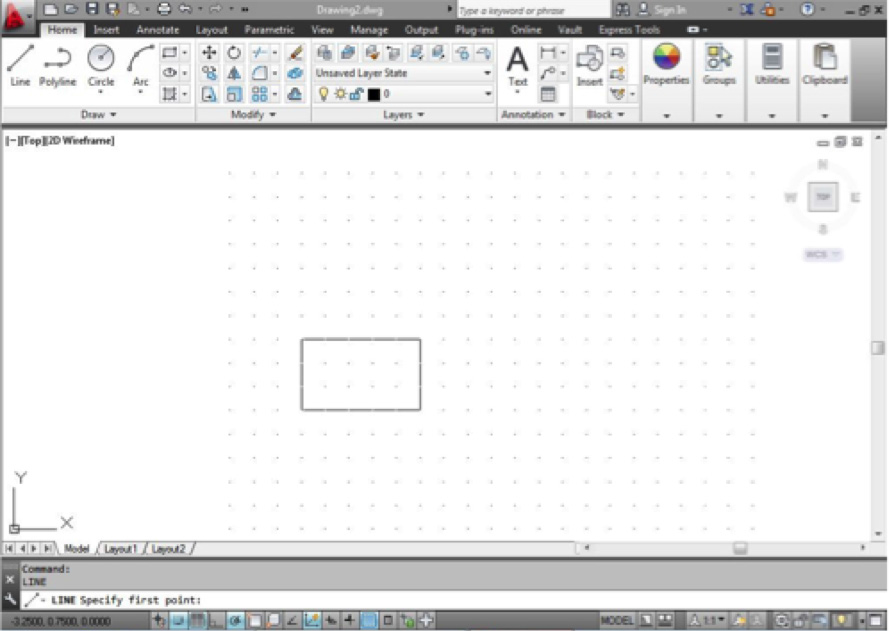
### Absolute and Relative Coordinate Entry (Video 2.3)

You will be learning how to enter coordinates in multiple ways by drawing lines. F12 toggles what is called *dynamic input on/off*. Having dynamic input on/off sometimes helps when drawing lines. In this case, make sure it is off when using command line entries. See Student Video #3.

#### Absolute Coordinate Entry

1. Command: **LINE (enter)**
2. From point: **1.5,3.5 (enter)**
3. To point: **4,3.5 (enter)**
4. To point: **4,5 (enter)**
5. To point: **1.5,5 (enter)**
6. To point: **1.5,3.5 (enter) (enter)**
7. Pressing **return** twice completes the command.

The first completed square should look like Figure 8 below:

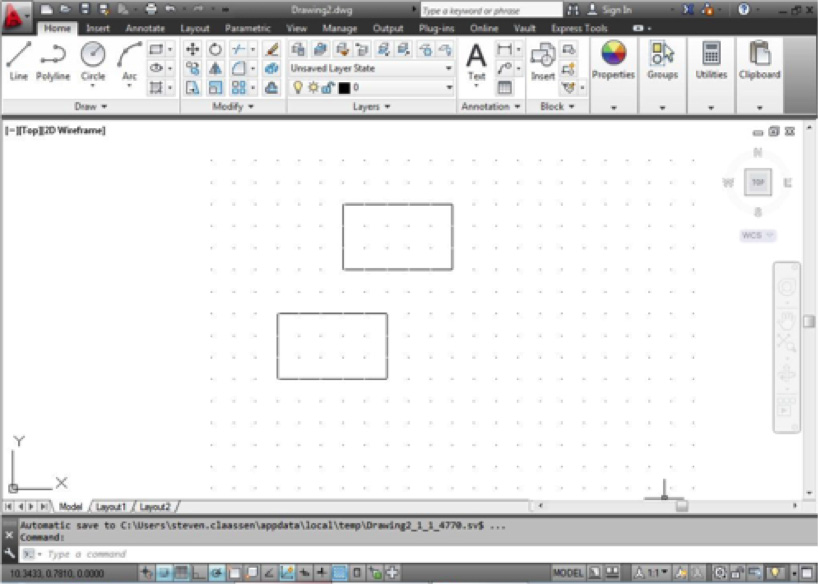


**Figure 8**

#### Relative Coordinate Entry

1. Command: **LINE (enter)**
2. From point: **3,6 (enter)**
3. To point: **@2.5,0 (enter)**
4. To point: **@0,1.5 (enter)**
5. To point: **@-2.5,0 (enter)**
6. **C (enter)** will close a polygon.

You should now have two squares (Figure 9). Did you save your work yet?



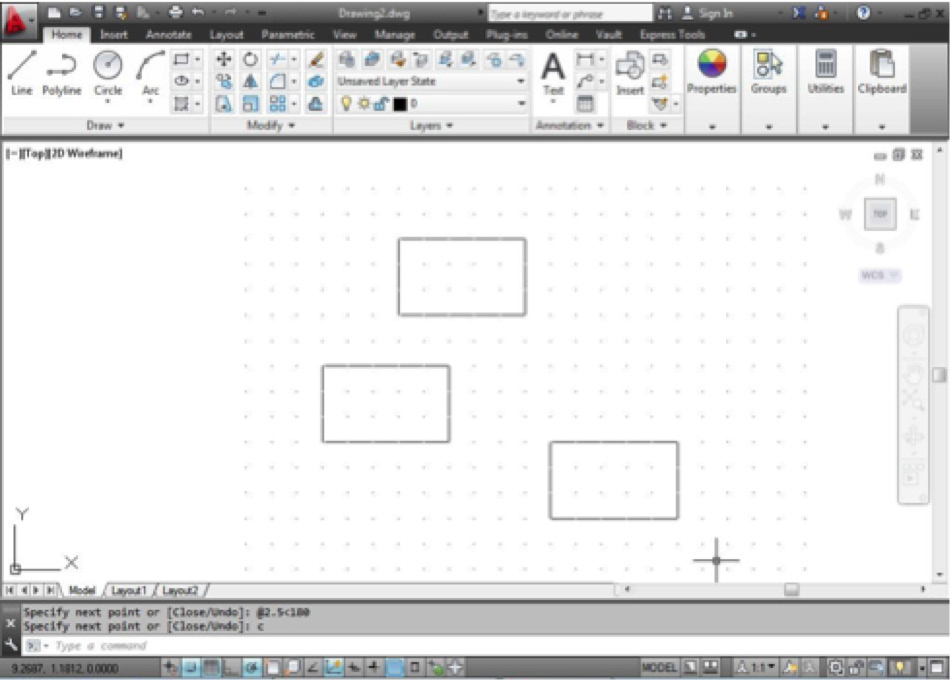
**Figure 9**

### Line Command, Polar Coordinate Entry, and Mouse Entry (Video 2.4)

See Student Video #4.

#### Polar Coordinate Entry (Student Video #4)

1. Command: **LINE (enter)**
2. From point: **6,2 (enter)**
3. To point: **@2.5<0 (enter)**
4. To point: **@1.5<90 (enter)**
5. To point: **@2.5<180 (enter)**
6. **C (enter)** will close a polygon.

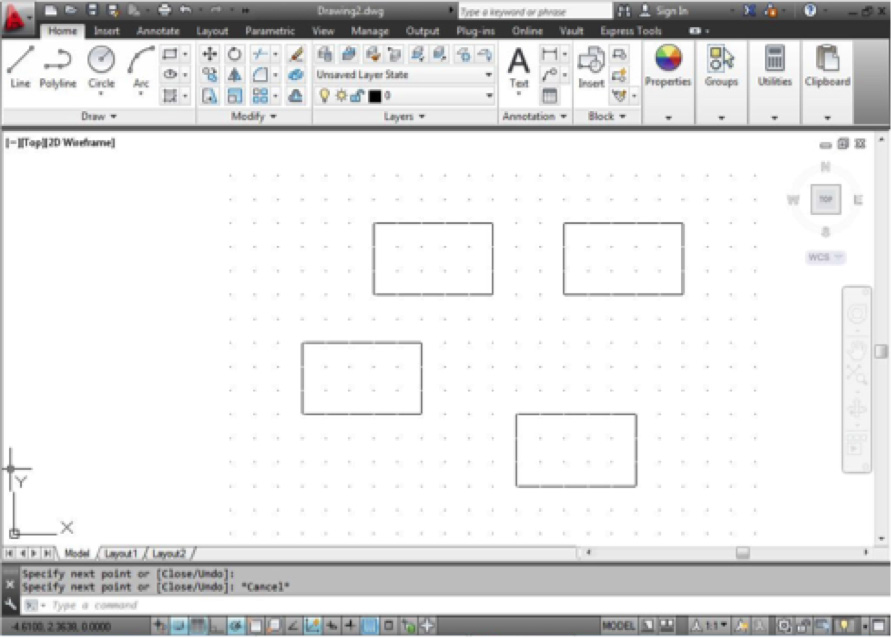


**Figure 10**

#### Mouse Entry Method

1. Command: **LINE (enter)**
2. From point: **7,6 (enter)**
3. Move mouse a length of 2.5@ an angle of 0, left mouse click
4. Move mouse a length of 1.5@ angle of 90, left mouse click
5. Move mouse a length of 2.5@ angle of 180, left mouse click
6. **C (enter)** to close the polygon.

The drawing should now have four rectangles as shown in Figure 11. Keep in mind that this one of many ways to draw lines.



**Figure 11**

### Zoom and Offset Commands (Video 2.5)

Now we will draw four smaller rectangles inside the existing four rectangles using the “Offset” command. But first let’s make the rectangles bigger on the screen. We will zoom in to the rectangles.

#### Zoom

1. Command: **ZOOM (enter)**.
2. The capitalized letters (e.g., A, E, W, etc.) are shortcut keys:

A = All. This shortcut zooms to everything you have drawn, including the limits of the drawing

E = Extents. This command zooms to everything you have drawn.

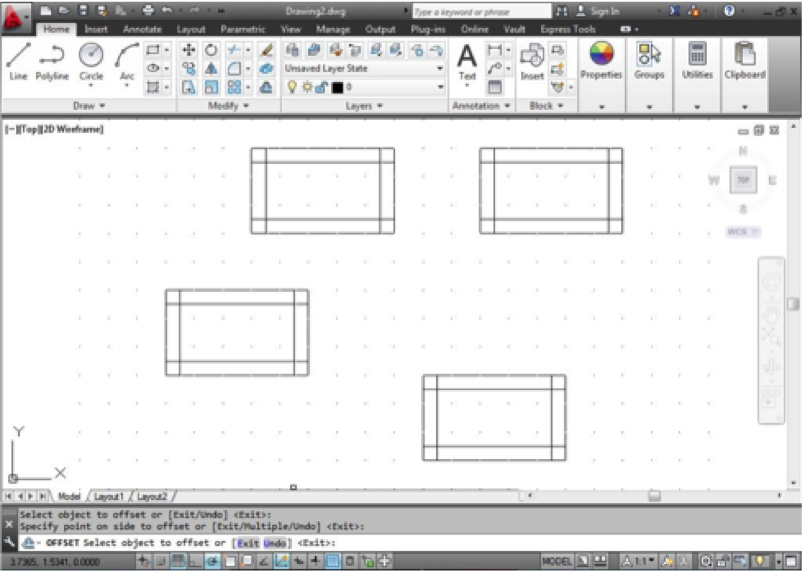
W = Window. This command zooms to the window you pick by holding the left mouse button down and dragging the mouse over to the area to create a rectangle to zoom into.

Type the shortcut key **W (enter)**. Use the mouse to pick a point in the upper left corner, then hold the left mouse button down and drag the mouse across to the lower right corner. You now zoom in.

#### Offset

Now use the Offset command to create a box in a box (Figure 12). See Student Video #5.

1. Command: **OFFSET (enter)**
2. Offset distance or through: **.25 (enter)**
3. Select object to offset: (with the mouse pick one side of a square)
4. Side to offset: (pick a point inside the square)
5. Select object to offset: (repeat the above two steps until all the squares are doubled)
6. The drawings should now look like the picture in Figure 12. Have you saved recently?

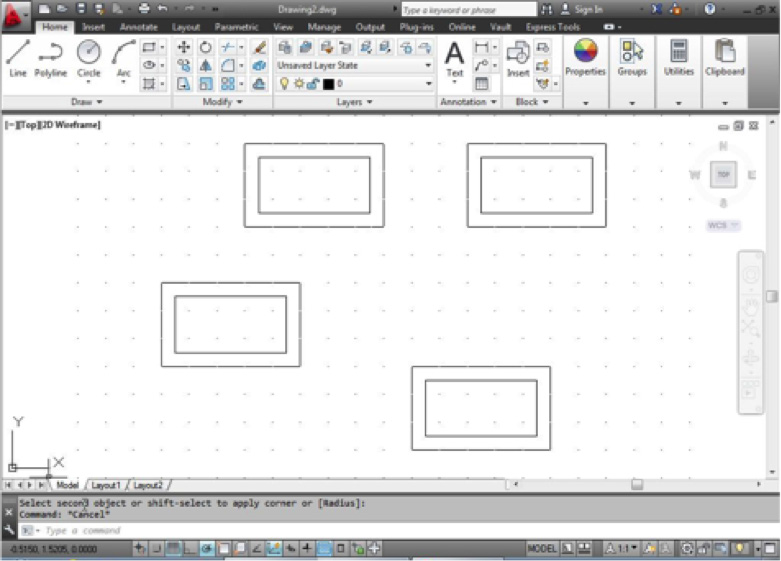


**Figure 12**

### Fillet Command (Video 2.6)

Now clean up the corners of the inside squares with the Fillet command (Figure 13). See Student Video #6.

* 1. Command: **FILLET (enter)**
  2. Fillet (radius=**0.5000**): Radius/Settings/Polyline /: **R (enter)**
  3. Enter fillet radius **<0.5000>**: 0 (**enter**)
  4. Fillet (radius=0.0000): Radius/Settings/Polyline /:
  5. With the mouse pick the two sides of an inner square.
  6. Command: **spacebar** or (**enter**) to repeat the fillet command
  7. Repeat step f for all four corners.

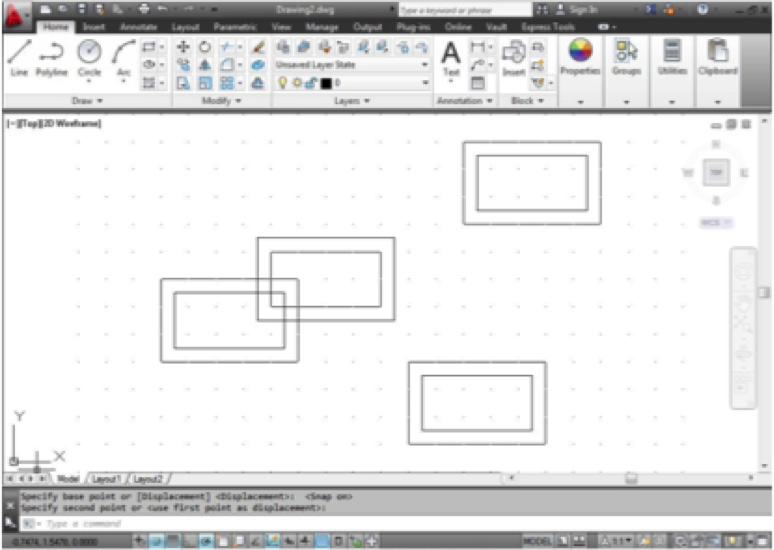


**Figure 13**

### Move Command and Object Snap (Video 2.7)

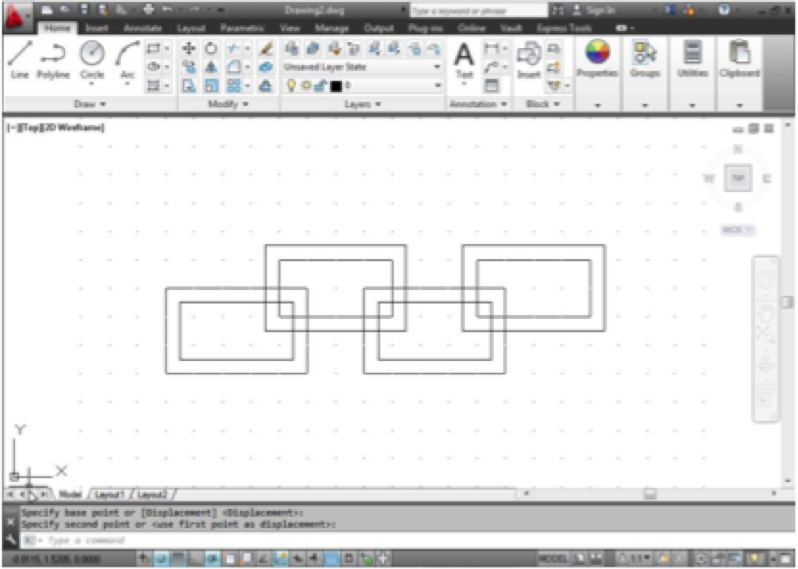
Now move the rectangles to create the chain link (Figure 14). See Student Video #7.

* 1. Command: **MOVE (enter)**
  2. Highlight the second rectangle you drew by holding down the left mouse button and dragging over the entire object from right to left.
  3. Right mouse click.
  4. Specify base point: left mouse click on the bottom left corner of the rectangle.
  5. Move the rectangle to create the first chain as show to the right.
  6. Left mouse click to place it.



**Figure 14**

* 1. Repeat the above process until you have all the links in place (Figure 15).

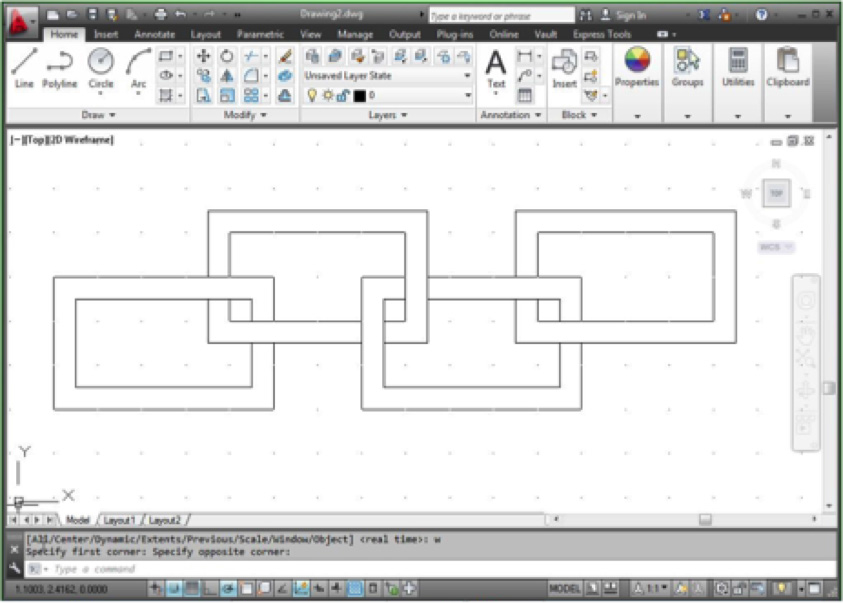


**Figure 15**

### Trim Command (Video 2.8)

Now use the Trim command to remove the pieces out of the lines to give the appearance that the links are connected to form a chain (Figure 16). See Student Video #8.

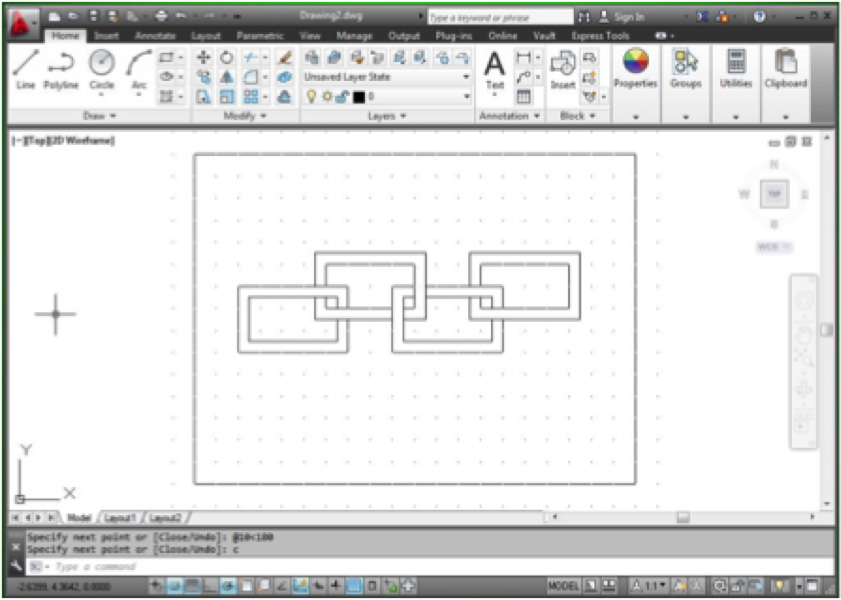
* 1. Command: **TRIM (enter)**
  2. Pick the two lines you want to trim between using the left mouse button (right mouse click).
  3. Pick the short pieces (left mouse button) that you want gone between the highlighted lines and they will disappear.
  4. Press **Esc** to cancel.
  5. Press **space bar** to repeat the command.
  6. Your drawing should now look like Figure 16 below. Time to save again.



**Figure 16**

Finish the drawing properly by zooming to full limits (All). Always leave and save your pictures as a full view (Figure 17). Remember Zoom?

a. Command: **ZOOM (enter) A (enter)**



**Figure 17**

### Border and Title Block (Student Video #9)

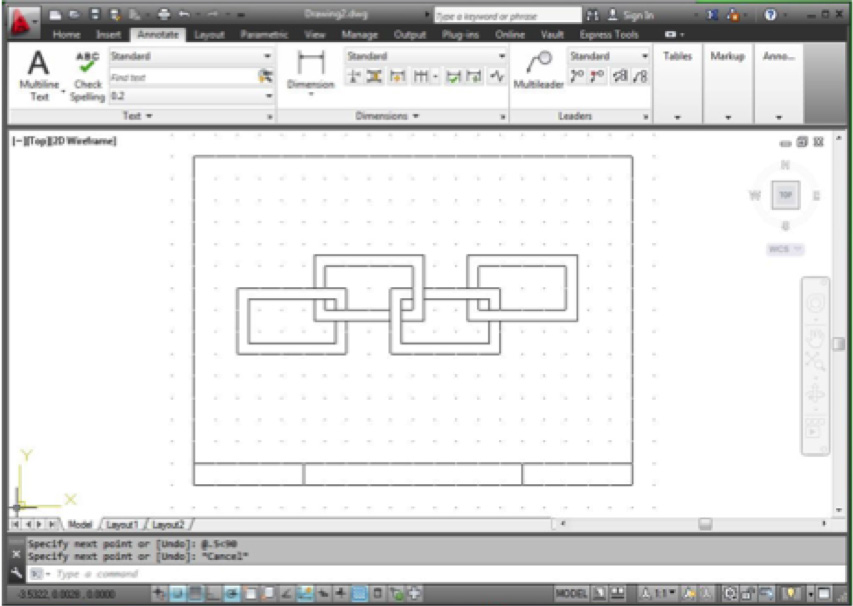
Now we need to finish this off with a border, a title block, and some text.

#### Border

1. Draw lines to create a border. Start at **.5,.5.** Make the border box **10** wide and **7.5** high. Which coordinate entry command will allow you to do this correctly?

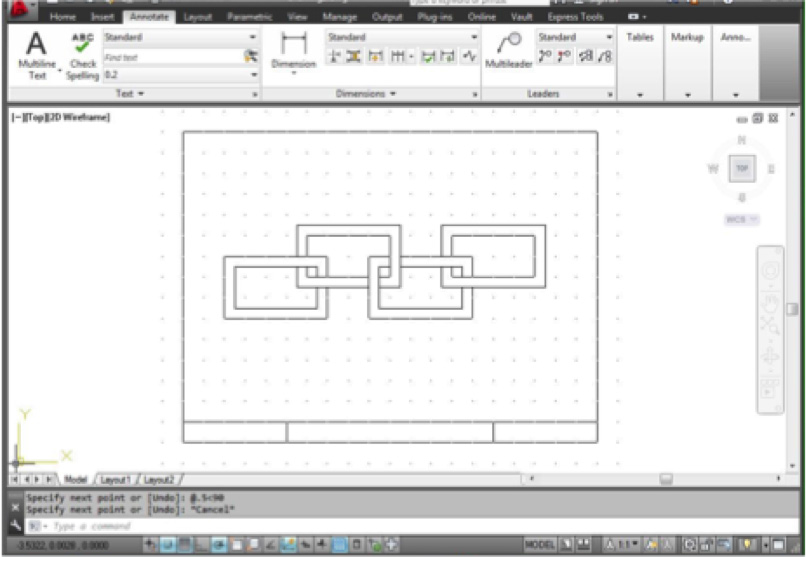
#### Title Block

A. **OFFSET** the bottom line **0.5** for the title block (Figure 18).



**Figure 18**

1. Next draw 2 vertical lines, one at **3.5,.5** and the other at **8,.5** (Figure 19). Which coordinate entry is the quickest?



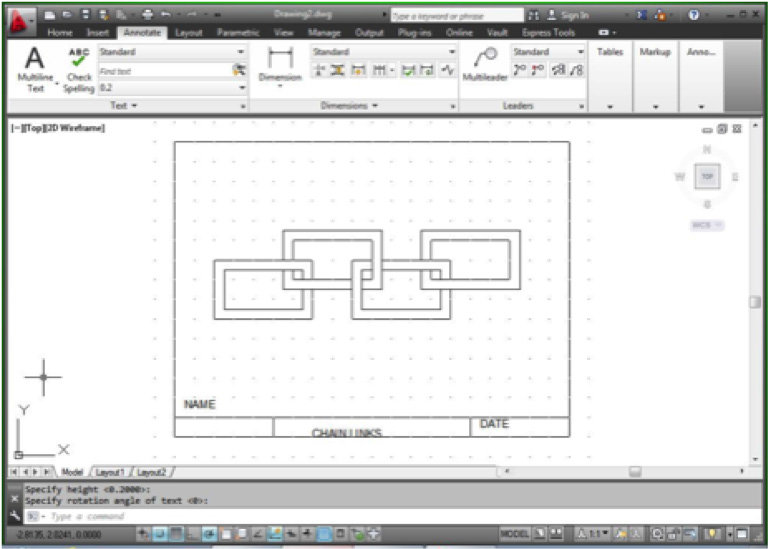
**Figure 19**

### Inserting Text into a Title Block (Student Video #10)

#### Create Text for Title Block

Now use the Text command to fill in the title block (Figure 20). See Student Video #10.

* + 1. Command: **TEXT (enter)**
    2. Pick the point you want to start at. Don’t worry about it not being where you want it. We will move it after.
    3. Height of Text: **<.20> (enter)**. Rotation angle of text: **<0> (enter)**.
    4. Now, type in the text you want in CAPITAL LETTERS.
    5. Press (**enter**) twice to exit the command.
    6. Repeat this command sequence for each of the title block entries below.

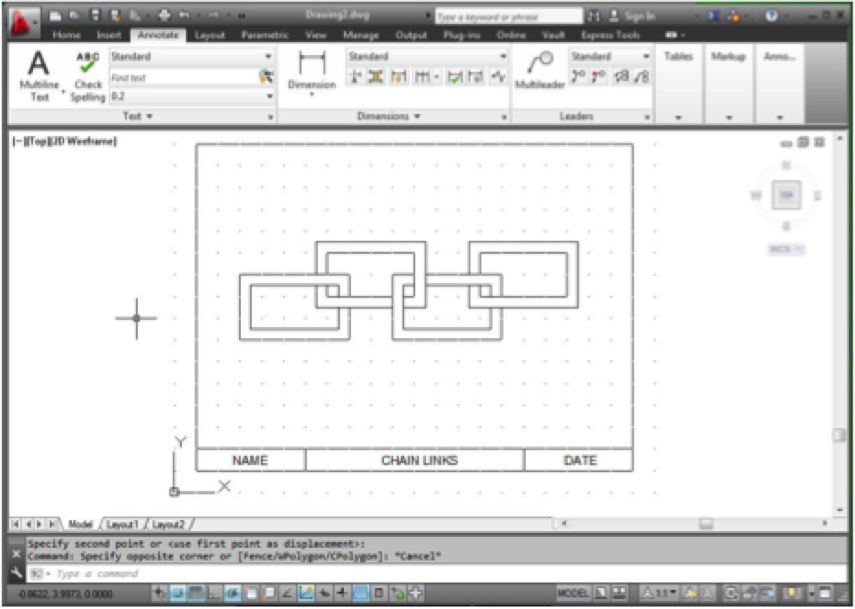


**Figure 20**

#### Move Text into Title Block

Now that you have the text entered, you are going to move the text into position. The problem is the snap setting won’t let you centre the text, so you have to change it.

* + 1. Command: **SNAP (enter)** Type **.05 (enter)**
    2. Command: **MOVE (enter)**. Select one of your texts **(enter)**.
    3. Use your mouse to move your text to where you want it so it is centred in the box.
    4. Repeat the command sequence for the other two texts so they are centred in the appropriate spots as shown in Figure 21.



**Figure 21**

#### Save and Print Your Drawing

* + 1. Save your drawing as *chain links-name.dwg*.
    2. Show your instructor the completed drawing.
    3. To print the drawing, see Activity 10: Set Up Your Plot Window, Print on 8.5” × 11” Paper (Student Video #11).