LINDEN ROBOTICS

FRC-3568 Linden RoboEagles
FTC-7031 Linden Battle Blazers

Autodesk Fusion 360 Training

We need to thank our FIRST sponsor -

AutoCad

Download and install AUTOCAD from the Autodesk website. **LINK**
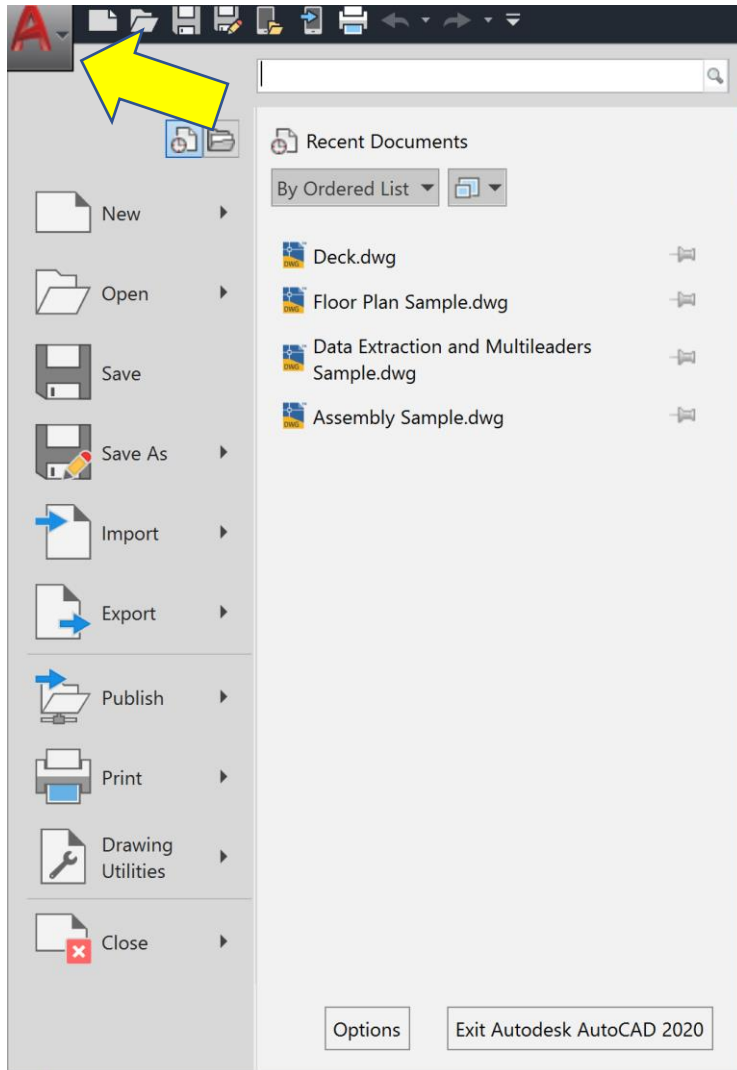
AutoCad Layout
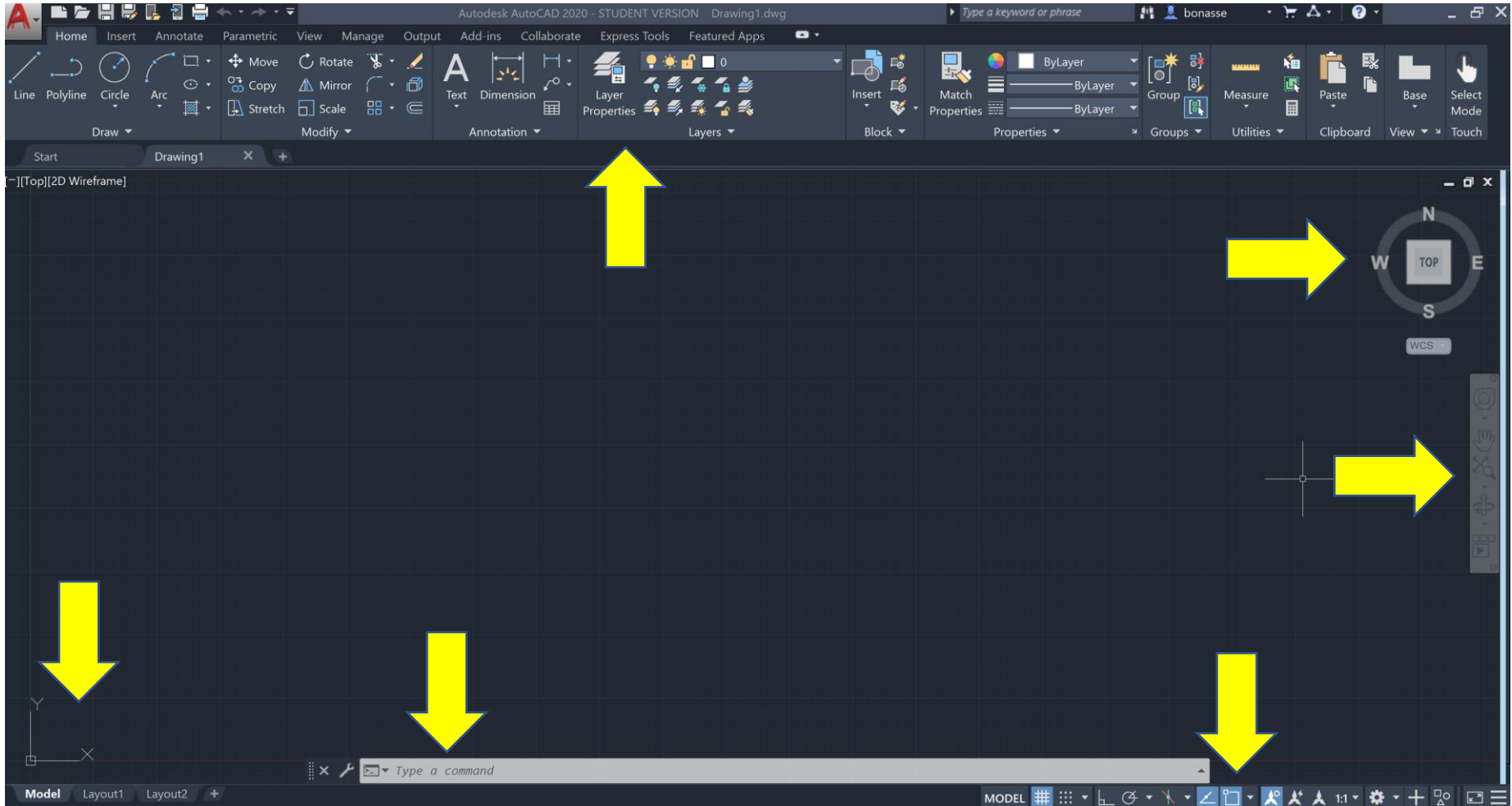
Application Menu

Application Menu

The **AutoCAD Application Menu** is located in the far upper left corner shown as a big red "A". It contains links to your most recently accessed drawings. It also contains File Management and Print Options.
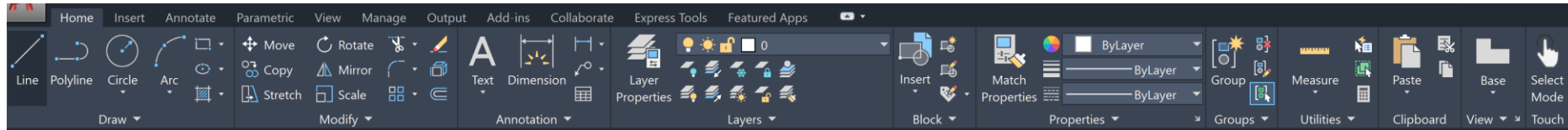
Quick Access Toolbar (QAT)

Right next to the AUTOCAD A, in the title bar area, is the Quick Access Toolbar, or QAT. By default the QAT contains icons for the following commands: New Drawing, Open, Save, SaveAs, Plot, Undo, and Redo.

Application Ribbon

Ribbon

The ribbon contains various commands organized into tabs and panels. Contextual tabs are very powerful, they appear with panels of commands and options relating to whatever task is at hand and/or whatever entity type is selected.

ViewCube

Allows the user to change the view and UCS.

NavBar

Contains Tools like the Navigation Wheel, Pan, Zoom, Orbit, and Show Motion.
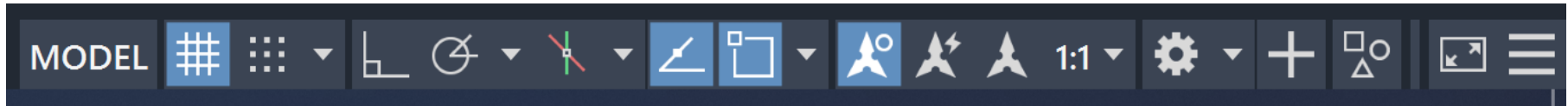
UCS Icon (User Coordinate System)
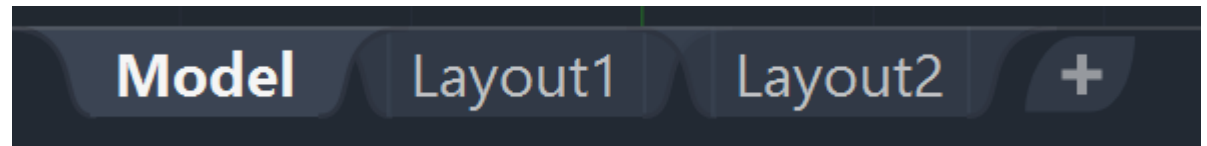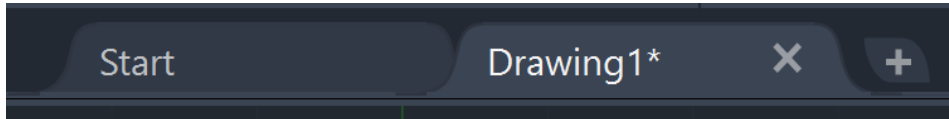
Show the current orientation of the drawing.

Status Bar

The status bar contains various tools such as Model / Paper Space, Grid, Snap, Ortho, Polar, Isometric, Object Snap, Annotation, Workspace, and the ability to customize the toolbar.
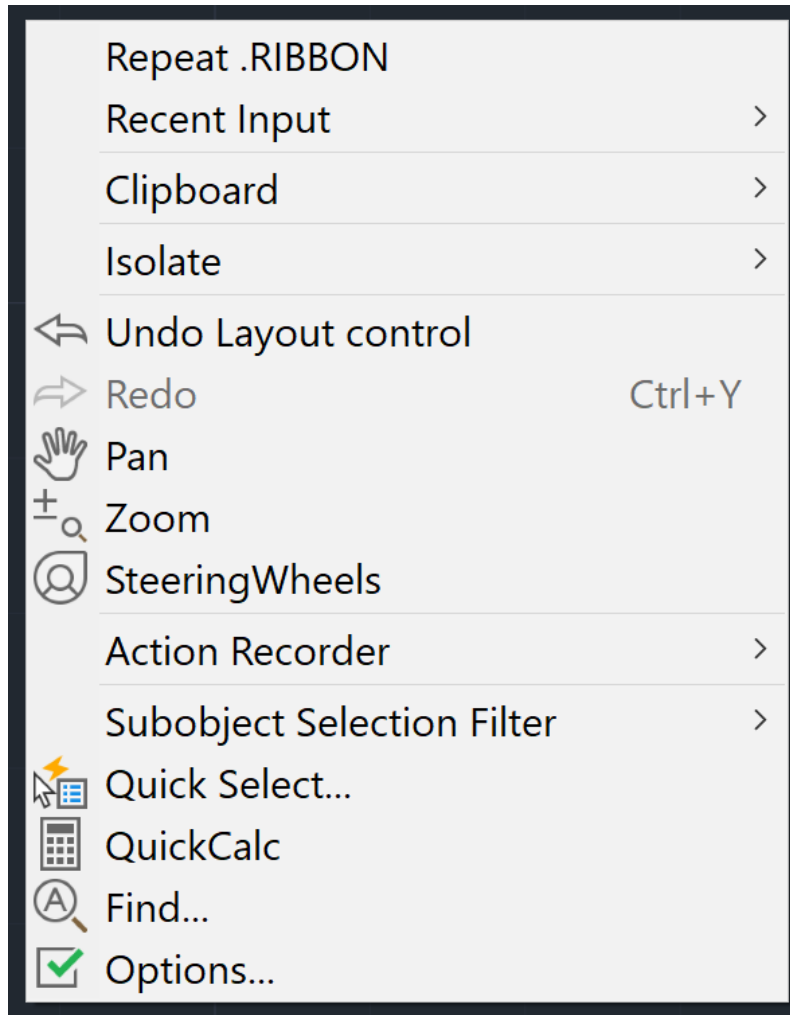
Tabs

File & Layout Tabs

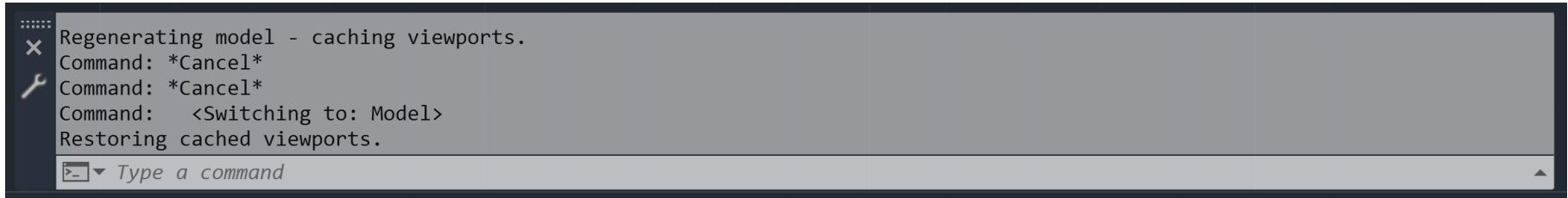The tabs allow the user to easily switch between drawings and drawing spaces.

Shortcut Menu

Shortcut Menu

The Shortcut Menu can be accessed be right clicking anywhere in the drawing.

Command Line

```
Regenerating model - caching viewports.
Command: *Cancel*
Command: *Cancel*
Command:   <Switching to: Model>
Restoring cached viewports.
>_ ▾ Type a command
```
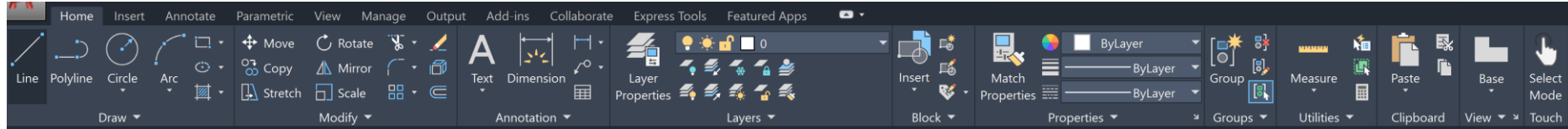
Command Line

The Command Line allows the user to type in command names and/or command responses.

AUTOCAD®

Ribbon Tools

HOME

INSERT
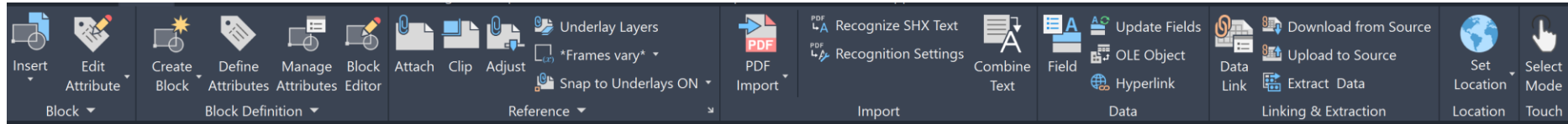
ANNOTATE
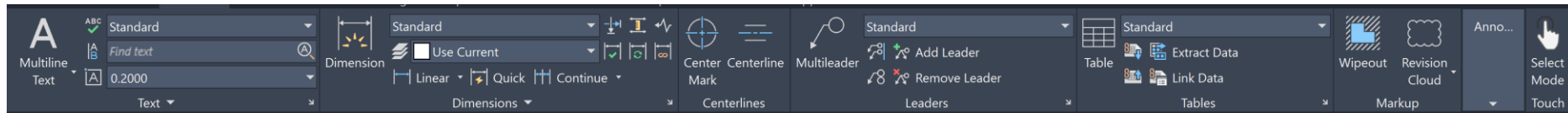
PARAMETRIC
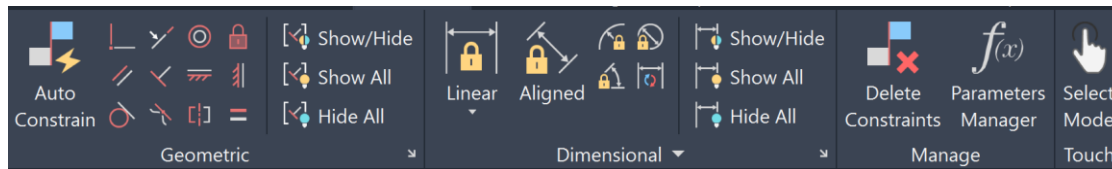
AUTOCAD®

Ribbon Tools

VIEW
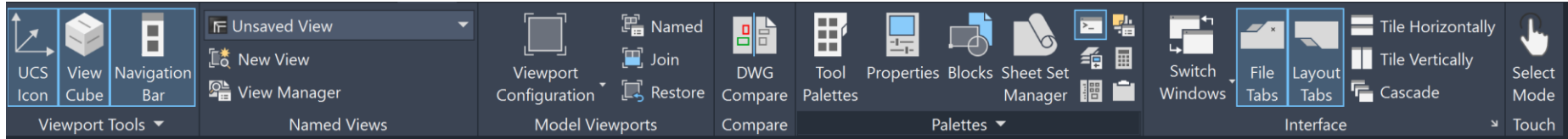
MANAGE
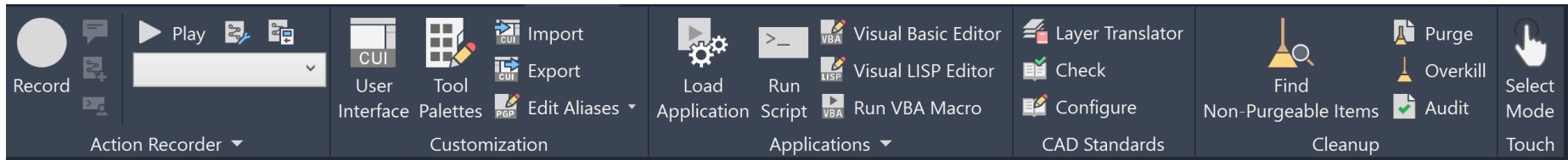
OUTPUT
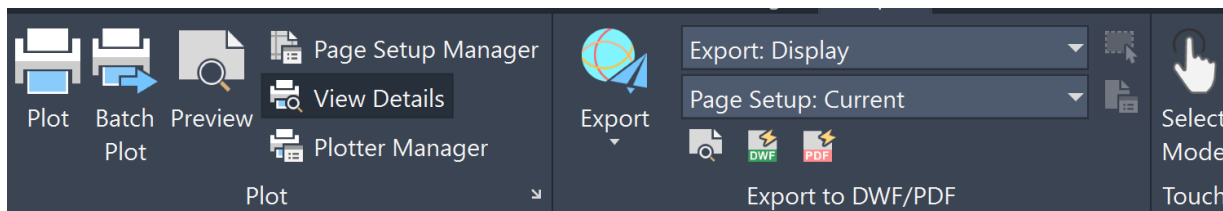
ADD-INS
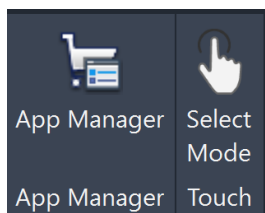
COLLABORATE
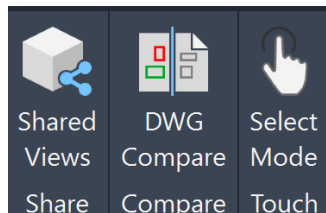
EXPRESS TOOLS
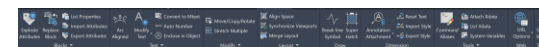
FEATURED APPS

Draw Menu

The Draw Menu contains the Line, Circle, and Arc Tools along with the Rectangle, Ellipse, and Hatch Tools.

Clicking on the drop down gives the user access to the Spline, Construction, Point, Measure, and Change Bubble Tools.
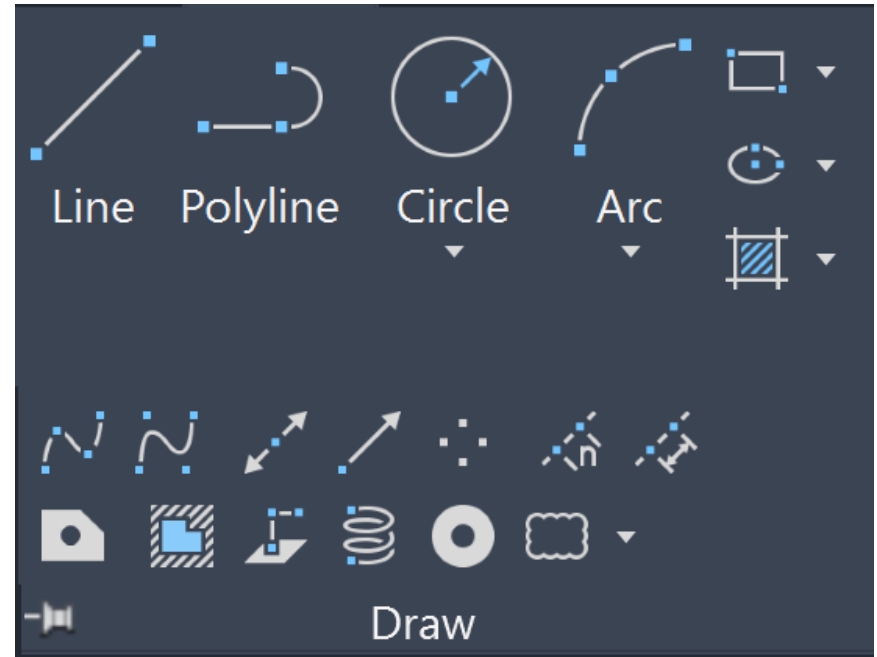
Modify Menu

The Modify Menu contains the Move, Copy, Rotate, Mirror, Stretch, and Scale Tools as well as the Trim, Erase Fillet, Explode, and Offset Tools.

Clicking on the drop down gives the user access to the Lengthen, Set, Edit, Align, Break, Join, Reverse, Copy, Delete, and Order Tools.
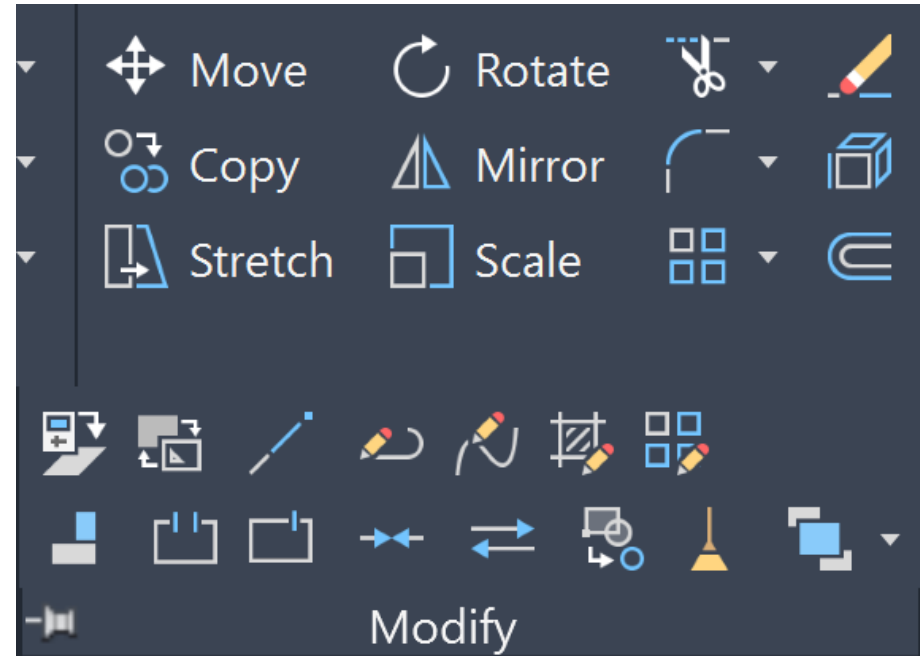
Annotation Menu

The Annotation Menu contains the Text and Dimension Tools along with the Leader and Table Tools.

Clicking on the drop down gives the user access to the Style Tools.

AUTOCAD®
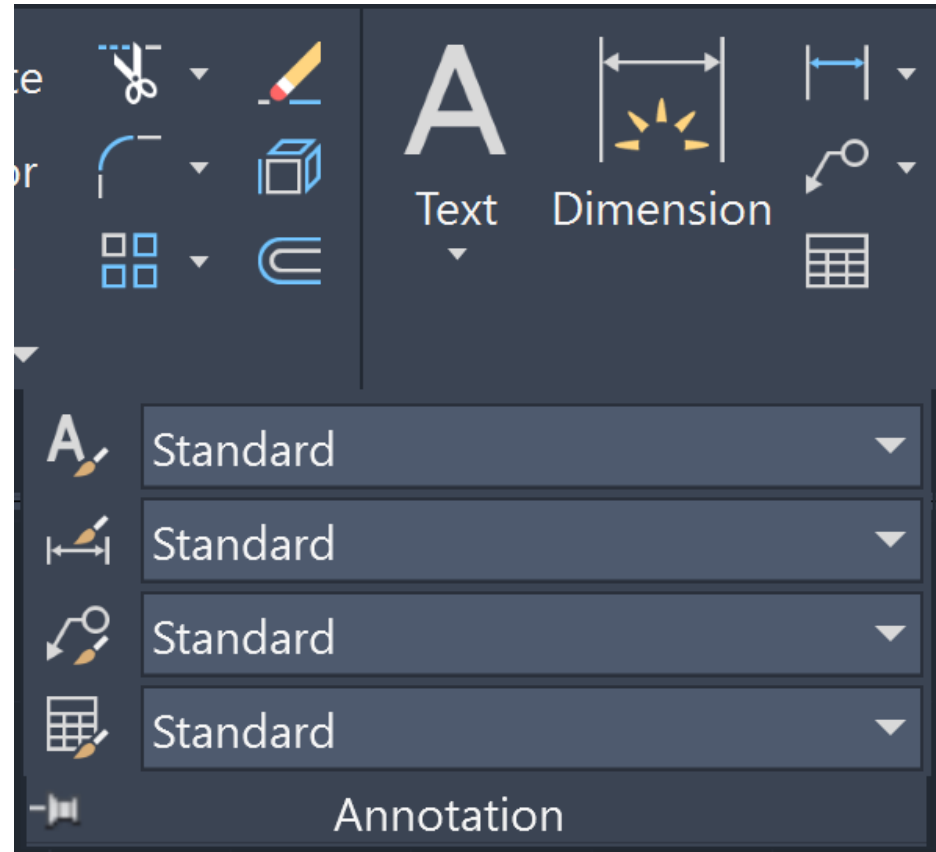
Annotation Menu

The Layers Menu contains the Layer Properties Tools.

Clicking on the drop down gives the user access to additional Layer Control Tools.
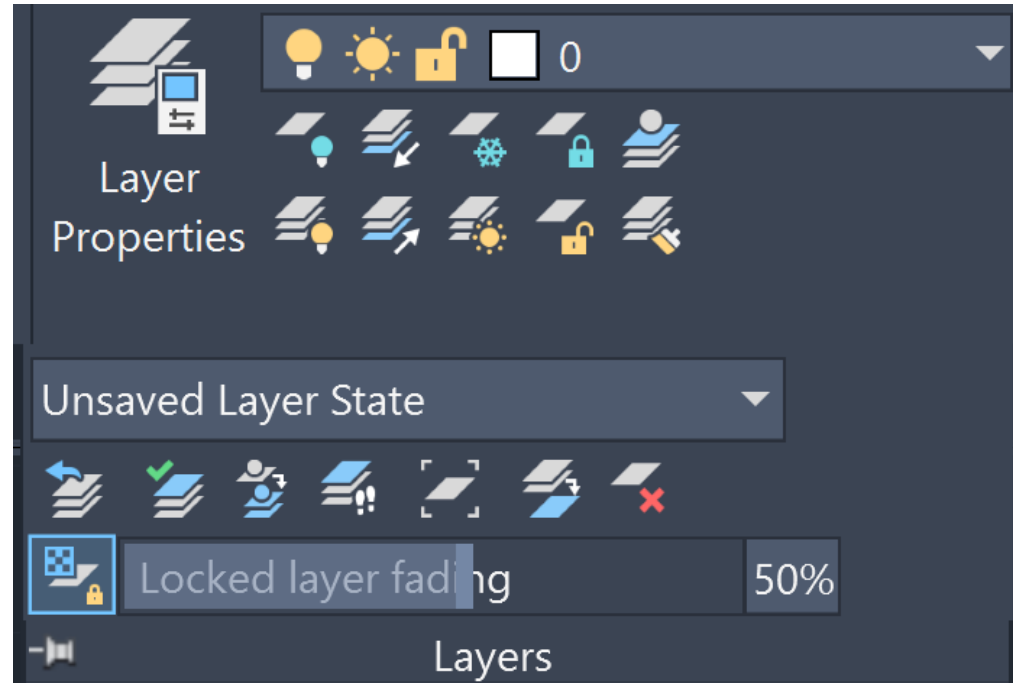
Block Menu

The Block Menu contains the Insert Tool along with the Block Editor Tools.

Clicking on the drop down gives the user access to the Attribute Tools.
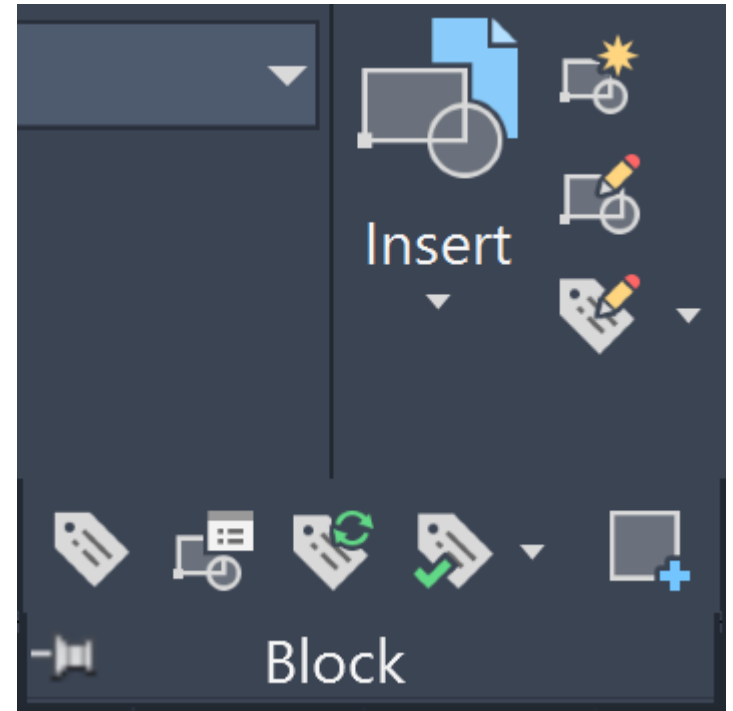
Properties Menu

The Properties Menu contains the Match Properties Tool along with the Object and Line Properties Tools.

Clicking on the drop down gives the user access to the Transparency and Object Properties List Tools.
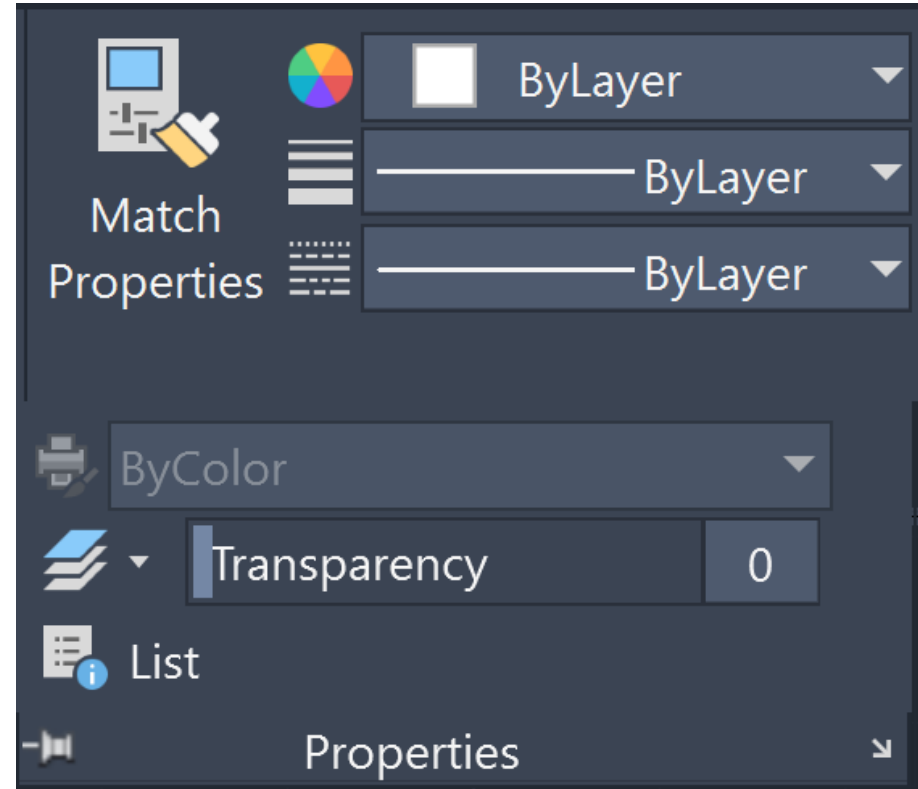
Groups Menu

The Groups Menu contains the Group Tools.

Clicking on the drop down gives the user access to the Group Manager and Bounding Box Tools.
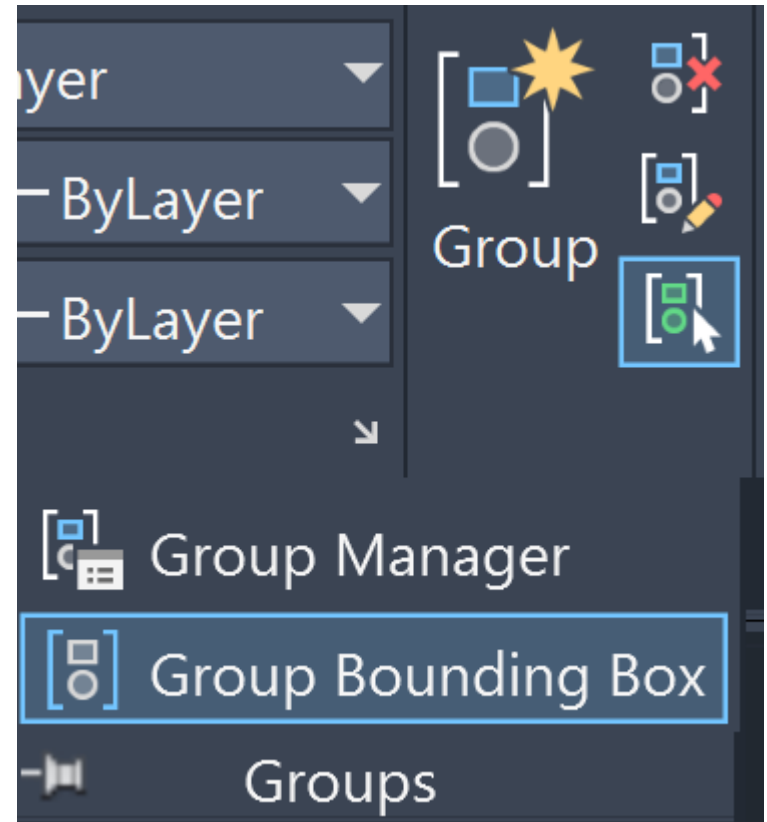
AUTOCAD®

Utilities Menu

The Utilities Menu contains the Measure Tool along with the Select and Calculator Tools.

Clicking on the drop down gives the user access to the Point Tools.
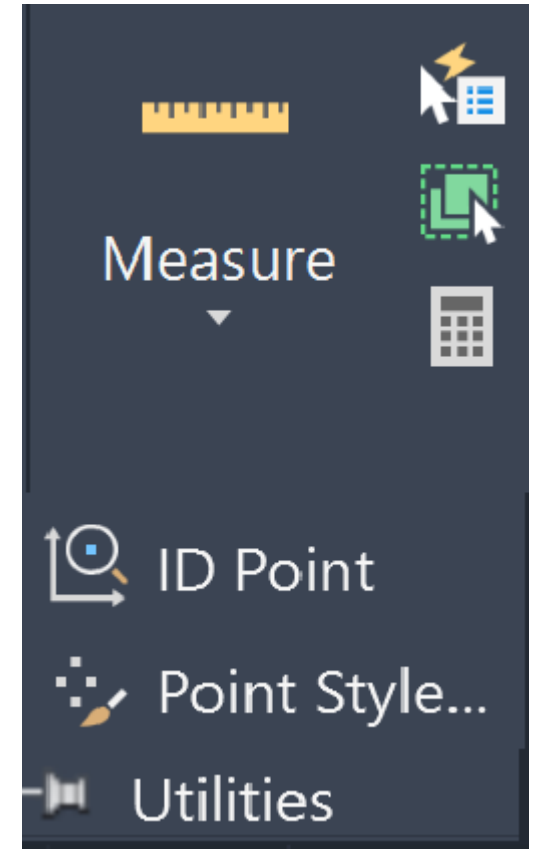
Clipboard, View, and Touch Menus

The Clipboard Menu contains the Paste, Cut, and Copy Tools.
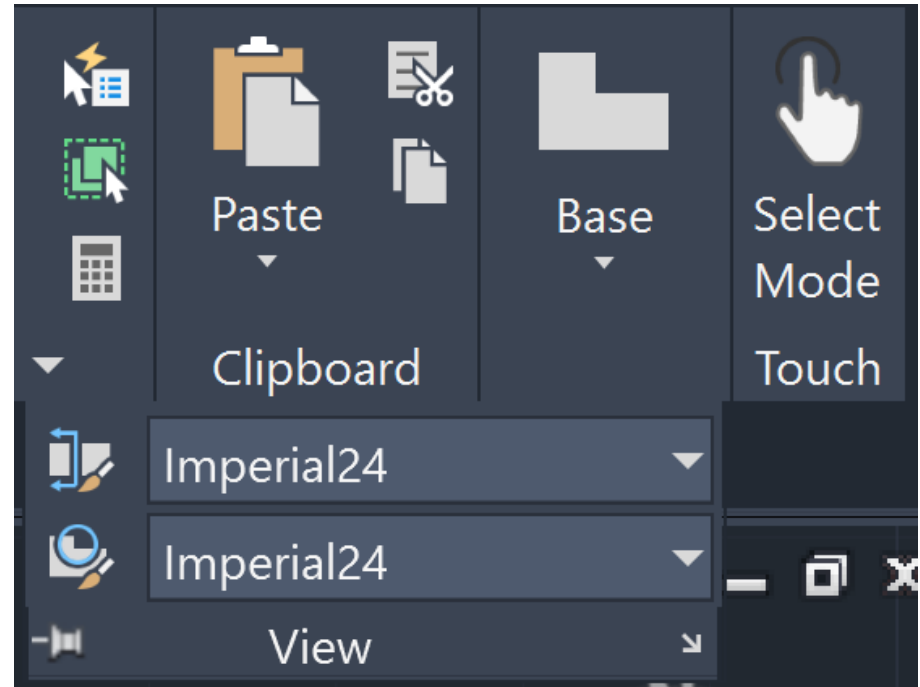
Electrical Prints
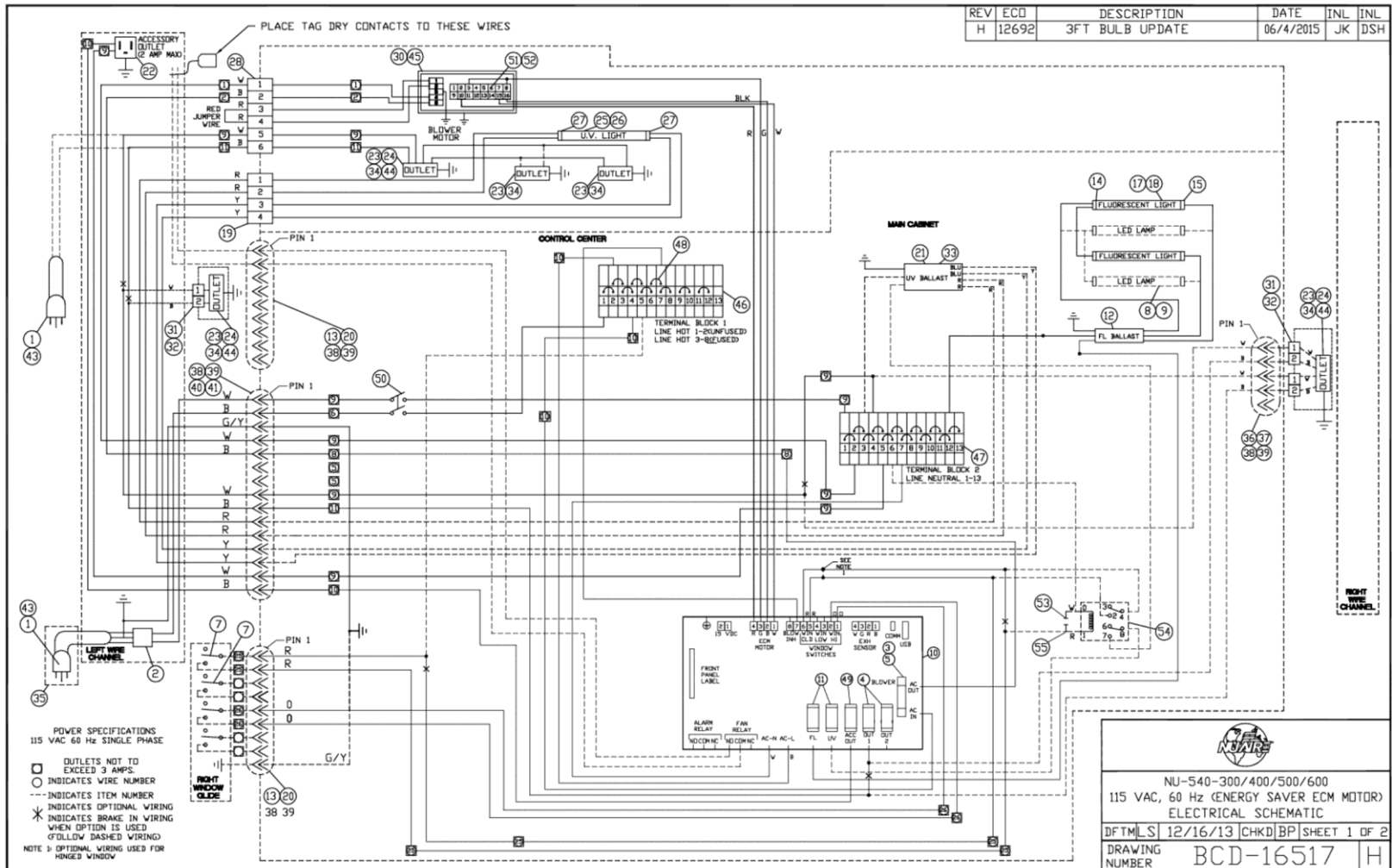
Pneumatic Prints
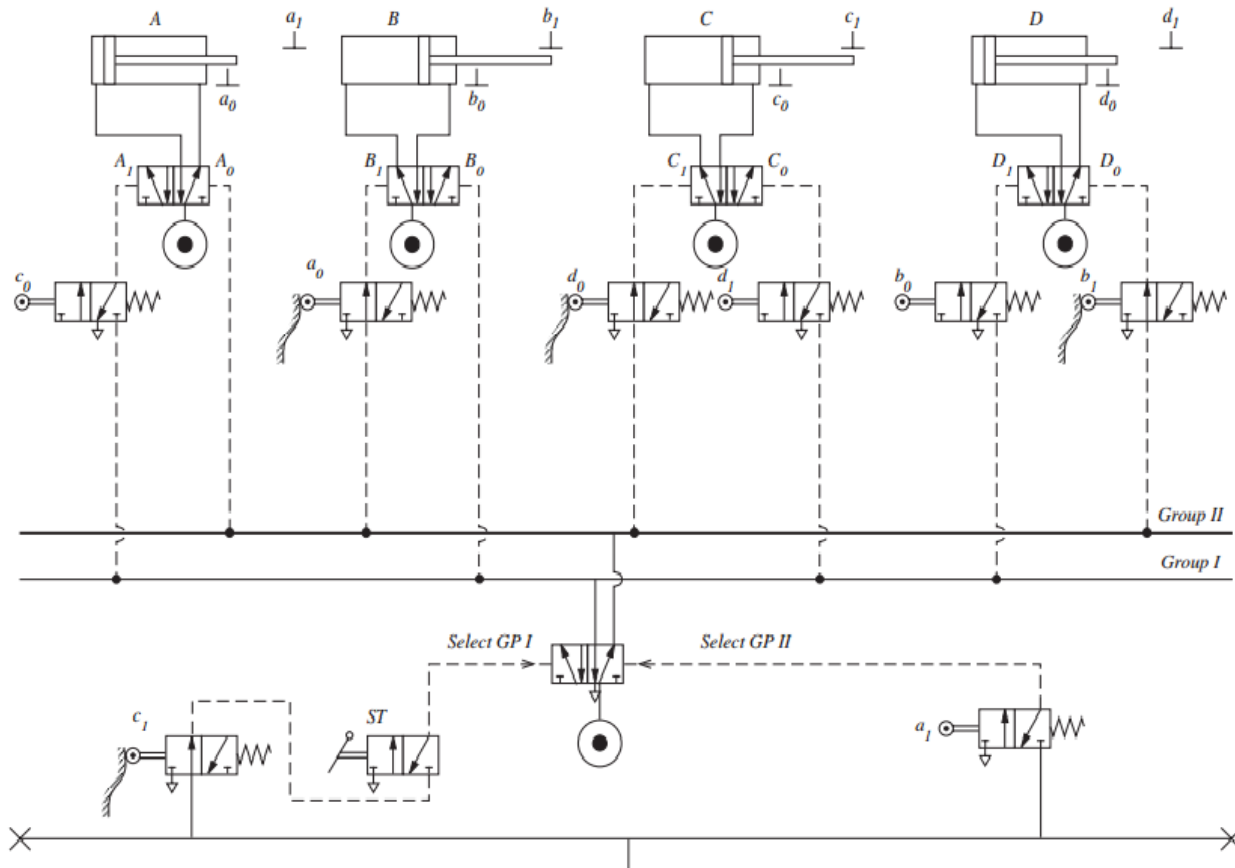
Mechanical Prints

AUTOCAD®

Structural Prints
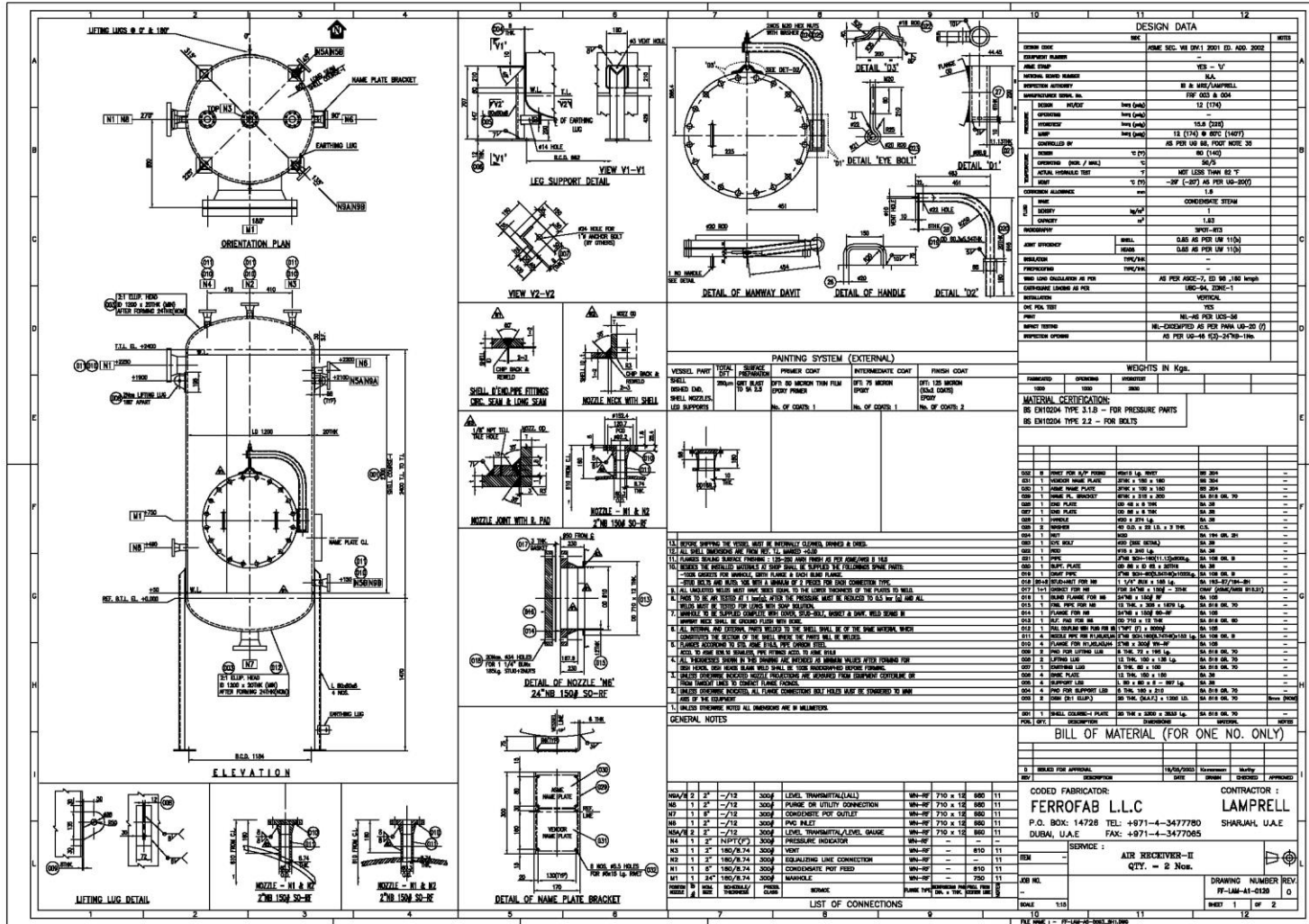
Build Drawings
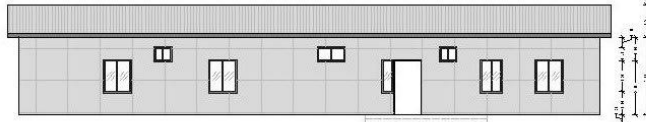
FRONT ELEVATION

LEFT ELEVATION

BACK ELEVATION
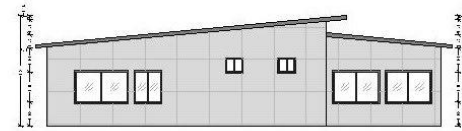
RIGHT ELEVATION
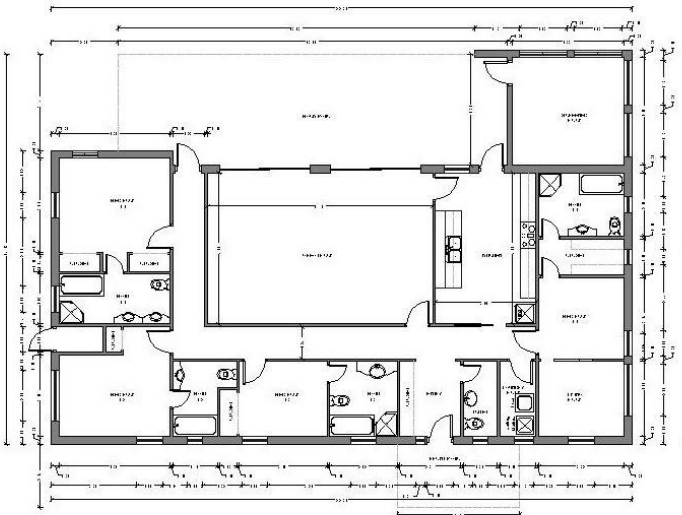
FLOOR PLAN
(AREA = 331.8163 sq.m)
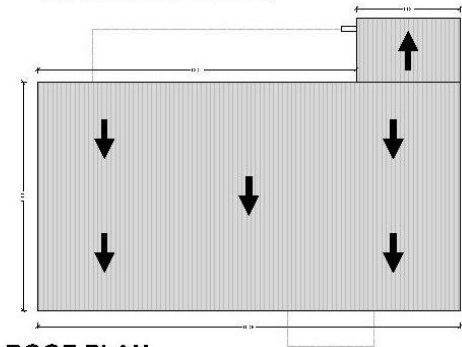
ROOF PLAN

DWG. TITLE		
ELEVATIONS		
SCALE 15:1	DATE	25-07-2020
DRAWN ZUBAIR +923338685272		SHEET NO 03
ADDRESS -- --		SIZE A3

FRC Robot Drawings
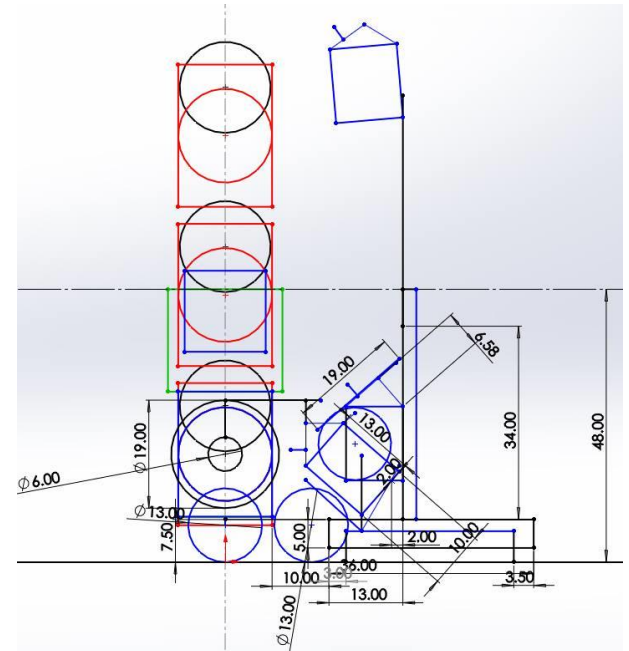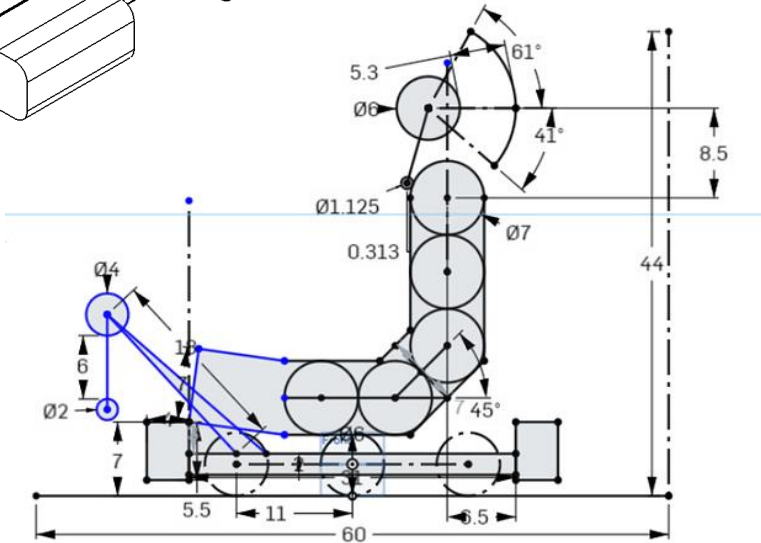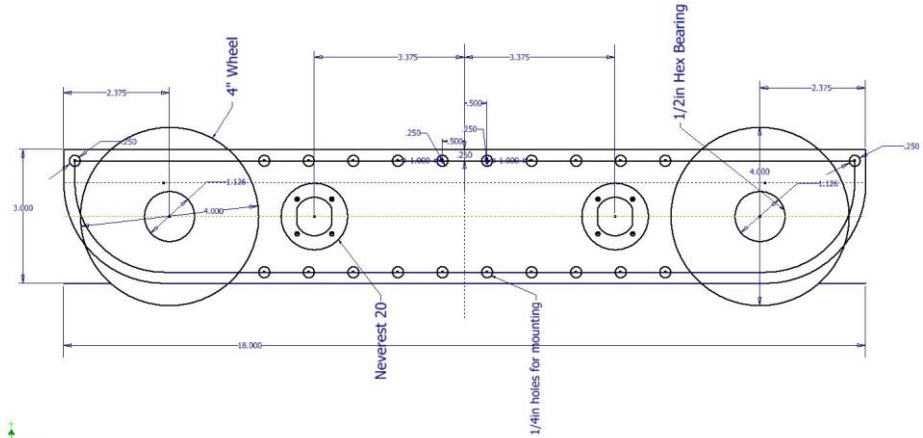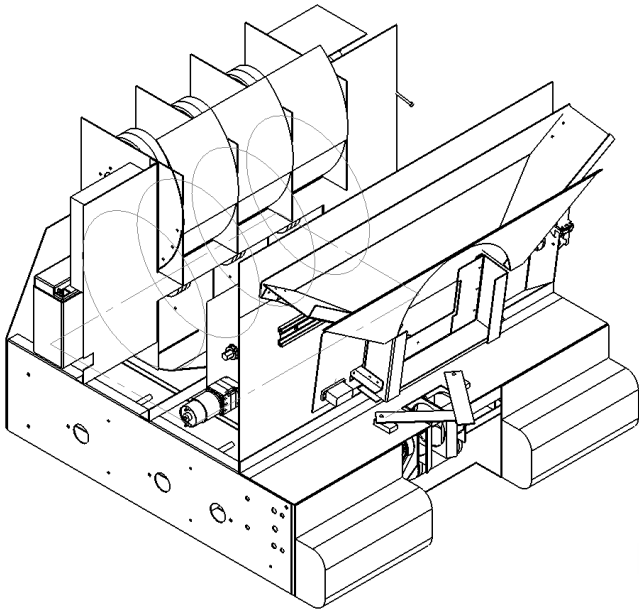
AUTOCAD®

Let's Draw

1 – Open Autocad and start a new drawing.

2 – Start be making a **10.5" by 16.5"** border around the drawing. To do this select the **Rectangle Tool** from the **Ribbon** or type **RECT** in the **Command Line**. Click in the bottom left corner of the screen and enter the dimensions for X and Y positions (16.5, 10.5), use **Tab** to jump from one entry box into another, and press **Enter**.

AUTOCAD®
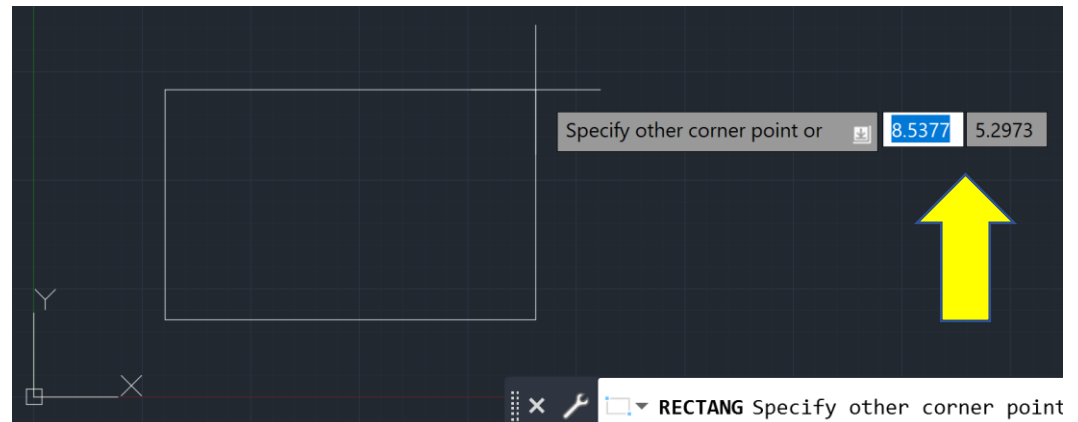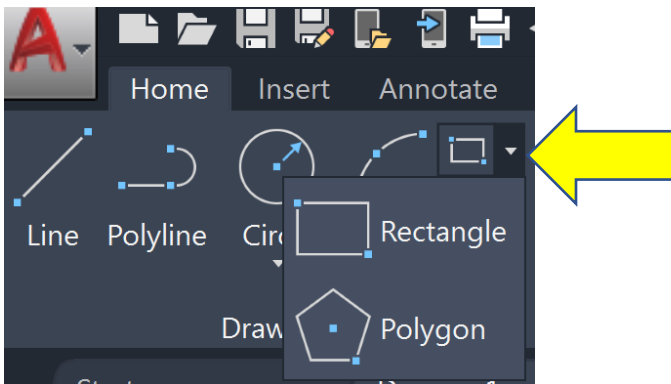
Let's Draw

3 – Zoom to the rectangle by selecting the **Zoom Extents Tool** from the **NavBar** (on the right side of the screen) or by typing a **Z** for **Zoom** and hitting **Enter** followed by an **E** for **Extents** and hitting **Enter**. The view should zoom into the center of the rectangle.
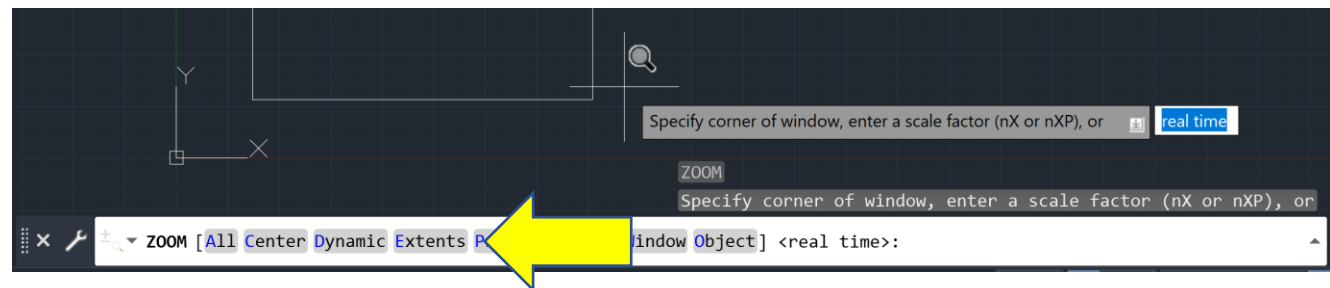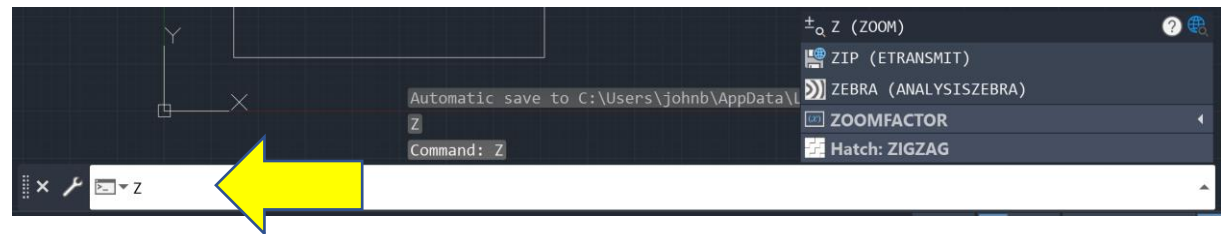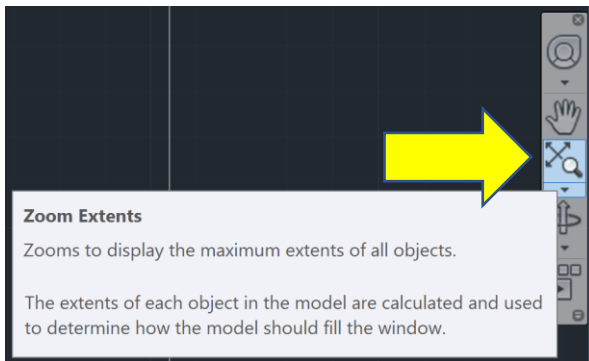
Let's Draw

4 – Let's add a title block in the bottom right corner of the rectangle. Use the **Pan Tool** from the **NavBar** to reposition the rectangle to expose the bottom right corner. Left click, hold, and drag the drawing from the bottom right corner towards the top left until the corner of the rectangle is visible.

5 – Draw a **Rectangle** by clicking on the corner of the first rectangle. You should see a green square showing the **Endpoint**. Left click and enter the X and Y dimensions **(-4", 2")**, press **Enter**.

Pan

Moves the view planar to the screen.

Position the cursor at the start location and press the mouse button down. Drag the cursor to the new location. You can also press the mouse scroll wheel or middle button down and drag the cursor to pan.

Endpoint

Command: RECTANG
Specify first corner point or [Chamfer/Elevation/Fillet/Thickness/Width]:

× ✕ ⚒ ⬛ ▾ **RECTANG** Specify other corner point or [Area Dimensions Rotation]:

Let's Draw

6 – Using the scroll wheel on the mouse, zoom to the smaller rectangle.

7 – Divide the rectangle in half using the **Line Tool** from the **Ribbon** or by typing **L** in the **Command Line** and pressing **Enter**. Select the **Midpoint** on the left side, indicated by a green triangle, by left clicking on the triangle and selecting the opposite side **Midpoint**. Press **Enter** or **ESCape** to finish the **Line Tool**.
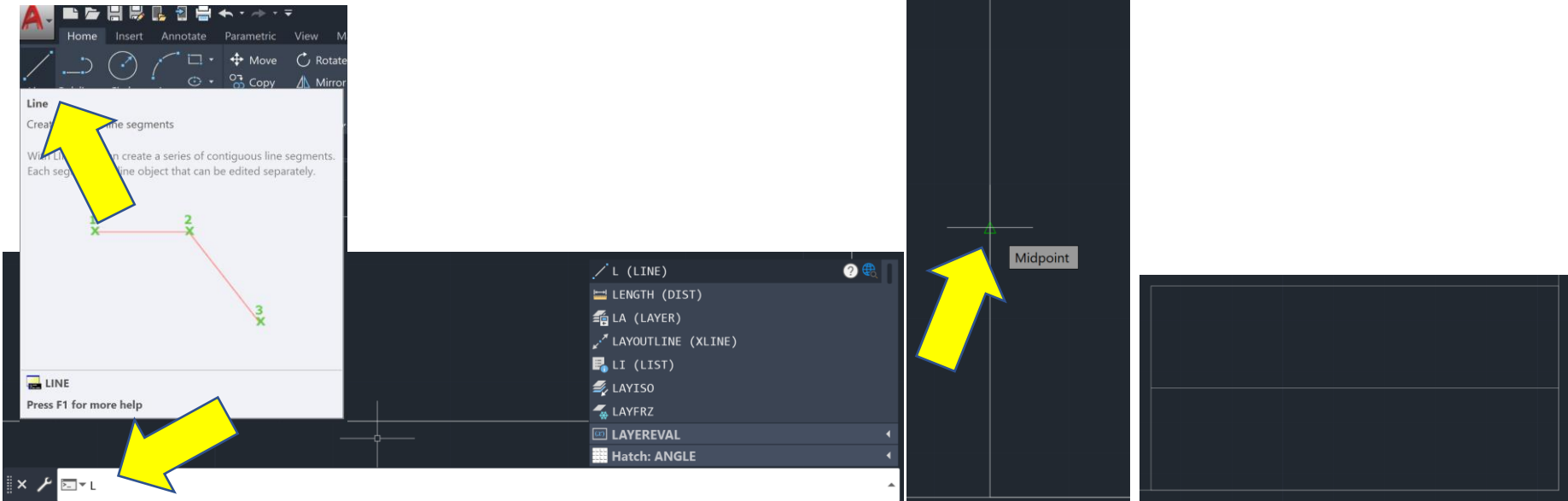
Let's Draw

8 – Draw two additional **Lines** as shown below using the **Midpoints**.

9 – Add text to the top rectangle using the **Multiline Text Tool** from the **Ribbon** or typing a **T** in the **Command Line**. Select the top left corner and drag down to the bottom right corner.

AUTOCAD®
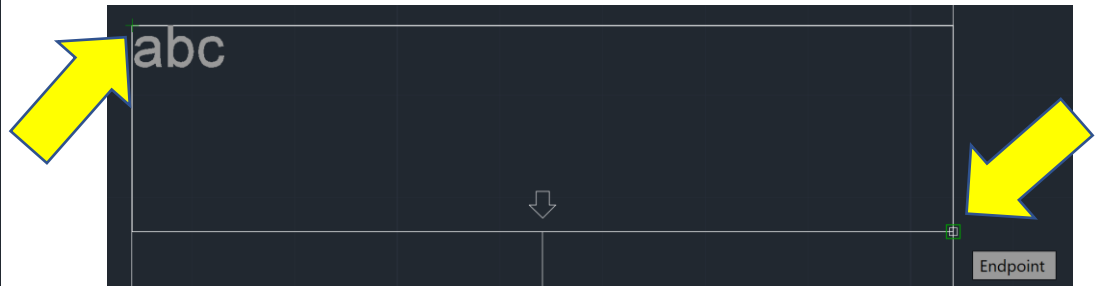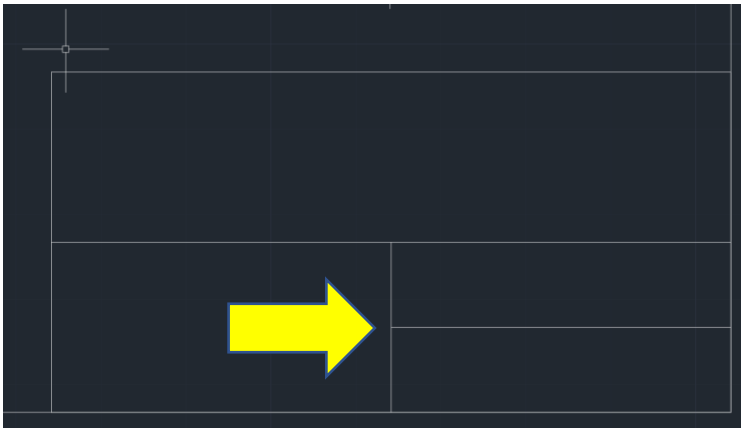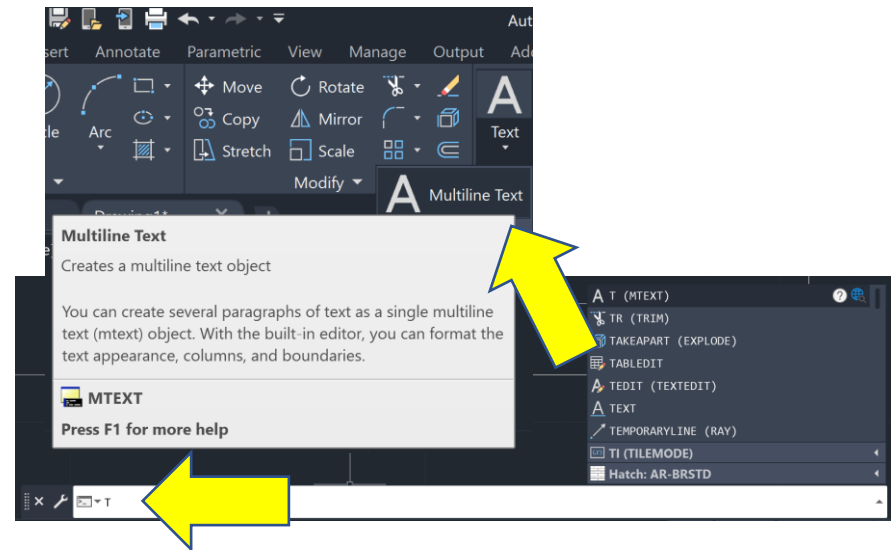
Let's Draw

10 – Type the following,

Linden RoboEagles
FRC-3568
2021 Infinite Recharge @ Home

11 – Select the text and change the **Text Height** to **.1500**.
12 – Change the orientation to **Middle Center** using the **Justification Tool**.
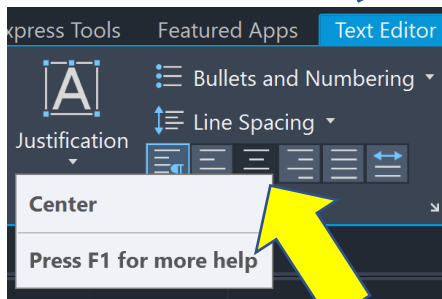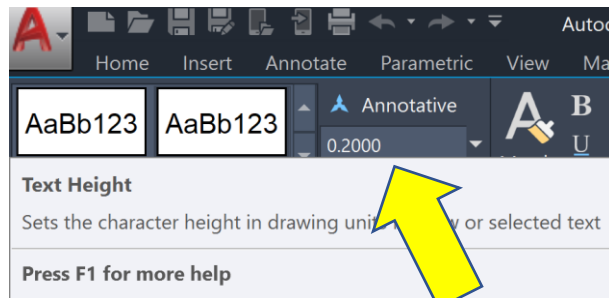
Let's Draw

13 – Add the additional **Multiline Text** as shown below.

14 – Save the drawing as **3568Template**.

Linden RoboEagles FRC-3568 2021 Infinite Recharge @ Home	
Template Drawing	Date : 2/19/21
	Rev. 1 JPB

Save
Saves the current drawing

QSAVE

Press F1 for more help
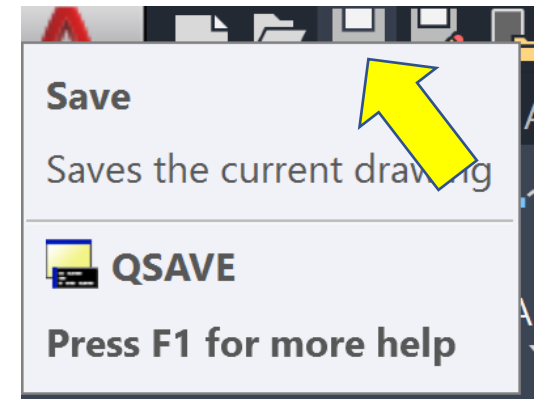
Let's Draw

15 – Use the Template drawing to start a new drawing by selecting **Save As** from the **Quick Access Toolbar** and naming the drawing **CubeHandler**.

16 – Draw a 2" by 2" square to represent a Waffle Cube using the **Rectangle Tool**.

17 – Use the **Copy Tool** to make 4 more Cubes. Click on the **Copy Tool**, left click on the square, right click to end selecting objects, left click on the bottom left corner of the cube to set the **Base Point**, and drag the copy over to the left of the original cube (do not click or hit Enter yet).
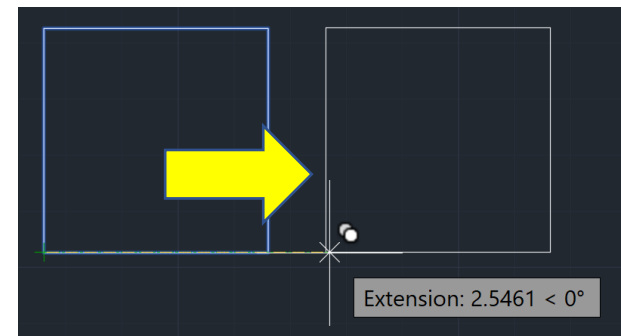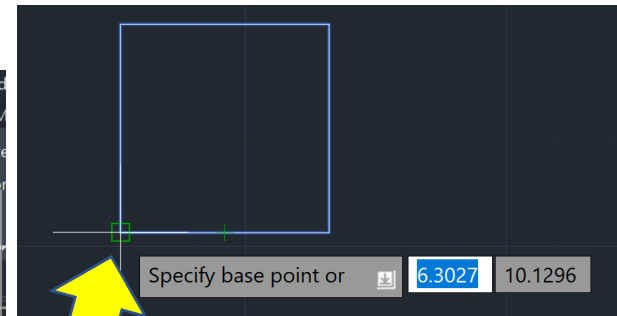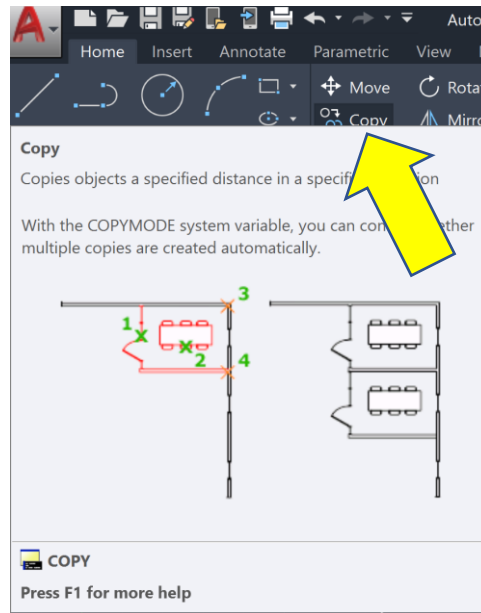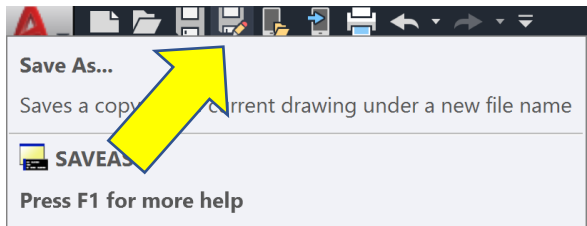
Let's Draw

18 – Note that you can move the copy in any direction. To limit the movement to horizontal or vertical click on the **Ortho Tool** at the bottom on the **Status Bar**. Enter a distance of **2.125"** and press **Enter**. Repeat for the remaining cubes.
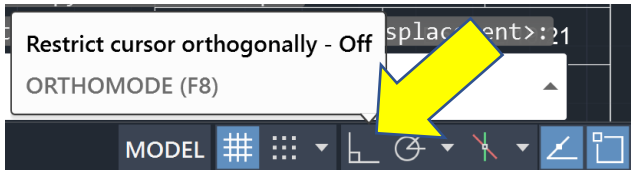
Let's Draw

19 – Draw three **Construction Lines**, one on each side of the outer blocks and one across the bottom using the **Line Tool**.

20 – Use the **Offset Tool** to offset the three lines by **.125"**. Click on the **Offset Tool** icon and type **.125** and press **Enter**. Select each line to offset it.

21 – Offset the new lines by **.250"** and delete the original three lines by clicking on them and pressing **DELete**.
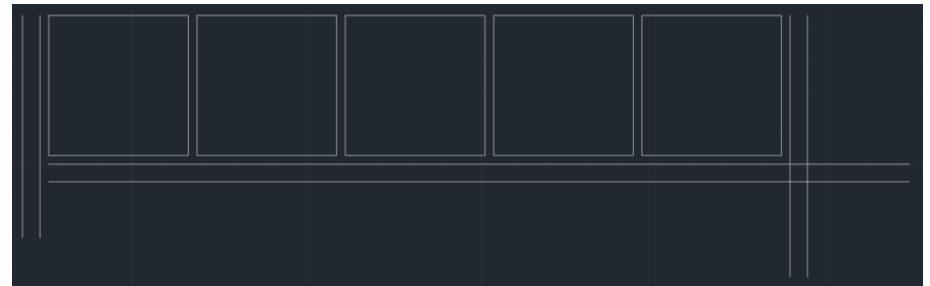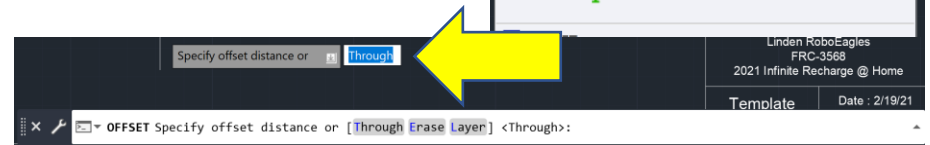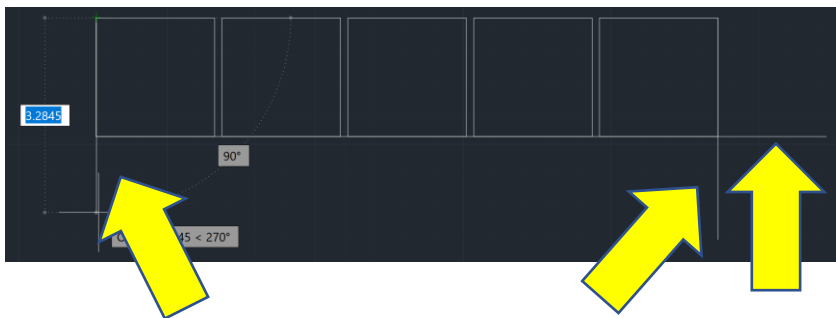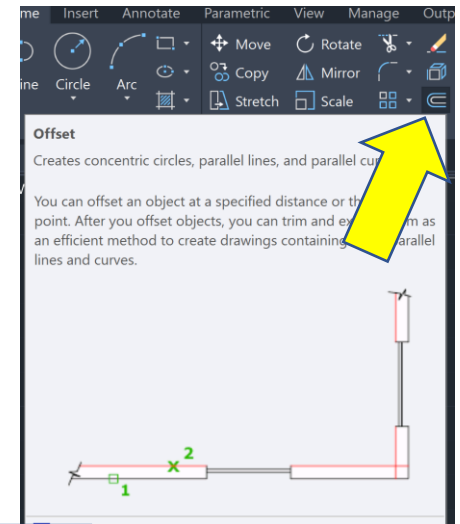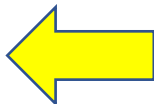
Let's Draw

22 – Use the **Trim Tool** and **Extend Tool** to create the block holder. Start by selecting the **Trim Tool** and select the four intersecting lines and press **Enter**. Select each of the six pieces of lines that need to be removed. Use the **Extend Tool** to extend the two bottom lines out to the left. Start by selecting the **Extend Tool** and select the four non-intersecting lines on the left and press **Enter**. When you hover over the top line you'll see it extend to the first selected line, click and it will extend to the line. Hover over the bottom line and again it will show the line extended to the first selected line. We want it to extend all the way to the second line so you will need to double extend the line or reselect just those two lines to extend the full distance.
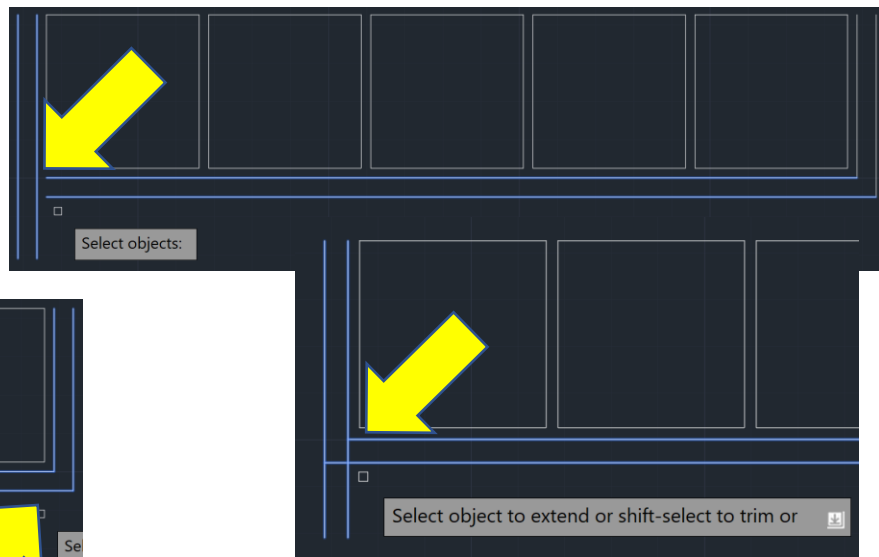
Let's Draw

23 – Use the **Trim Tool** to delete the extra lines.

24 – Use the **Line Tool** to close off the tops of each side.
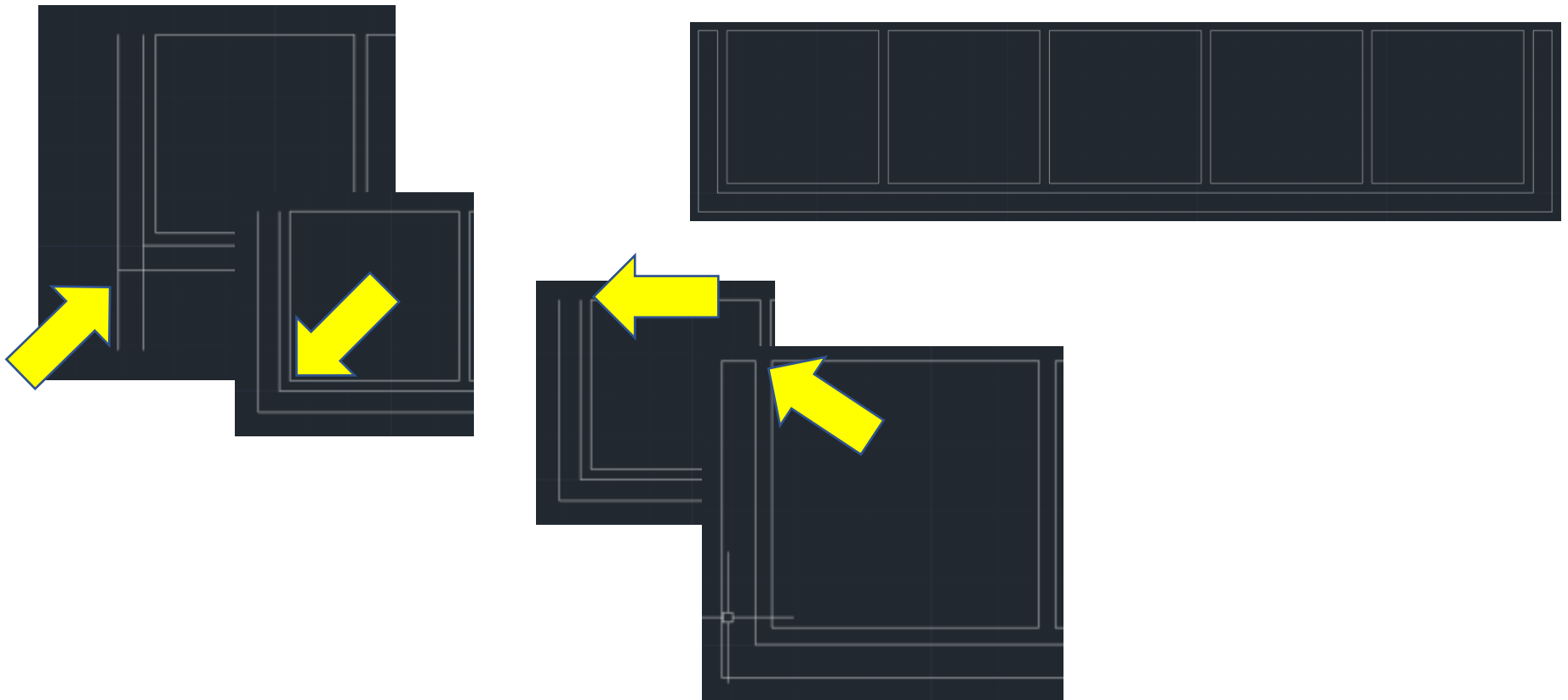
Let's Draw

25 – Use the **Group Tool** to group all the elements into one assembly. To do this choose the **Group Tool** from the **Groups Menu** or type **Group**. Select all the objects and press **Enter**. All of the objects should turn blue and there should be a handle (solid box) at the center of the new object. **Group** locks in the relationships between the objects.

26 – Use the **Move Tool** to move the **Group** down towards the bottom of the drawing.

27 – Use the **Text Tool** to add the description **Front View** below the object.

FRONT VIEW

Linden RoboEagles
FRC-3568
2021 Infinite Recharge @ Home

| Template Drawing | Date : 2/19/21 |
| | Rev. 1   JPB |
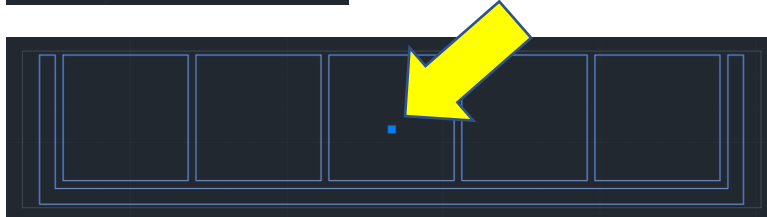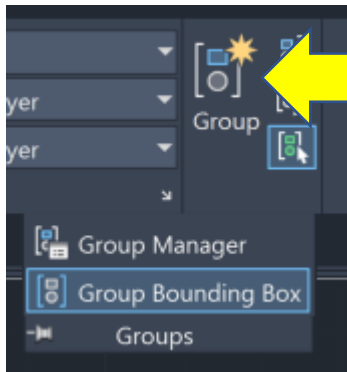
Let's Draw

28 – Use the **Copy Tool** to make a **Copy** of the Group, make sure the **Ortho Tool** is **ON** and drag it above the **Front View**.

29 – Use the **Rotate Tool** to rotate the objects by **180** degrees. (The Top View of the object is actually the same use the Front View but 180 degrees different.) To do this select the **Rotate Tool** from the **Modify Menu** or type **Rotate**. Select the **Group** and press **Enter**. Select the **Midpoint** of the bottom line as the **Base Point** and type **180** for the rotation angle. Press **Enter** to accept the angle and finish the **Rotate Tool**. Use the **Move Tool** to drag the newly rotated objects towards the top of the drawing. Use the **Text Tool** to name the view **Top View**.
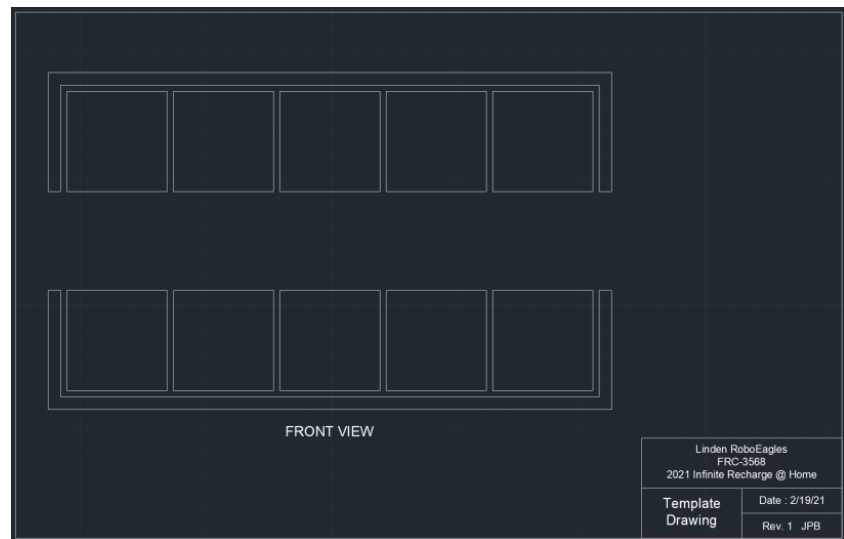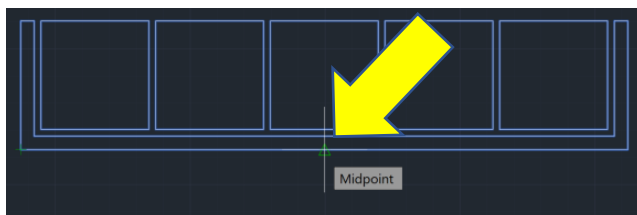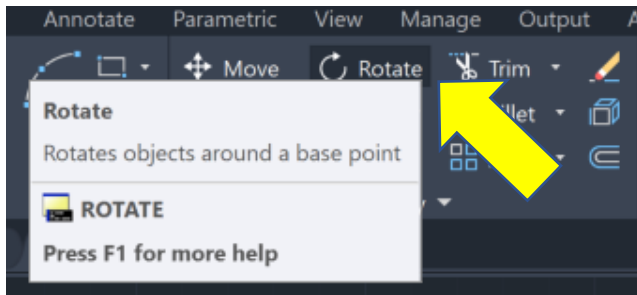
Let's Draw

30 – Using the **Construction Line Tool**, create an **Orthographic Projection Line** to create a **Side View** of the objects. To do this make sure the **Ortho Tool** is **OFF** and select the **Construction Line Tool** from the **Draw Menu** and pick a point between the two views, just to the side of the holder. Move the cursor towards the upper right corner of the drawing, press the **TAB** key and enter **45** for the angle, and then press **Enter**.

Construction Line
Creates a line of infinite length

XLINE
Press F1 for more help

Specify a point or 15.9266 8.7166

Specify through point: 7.4791 < 45°

TOP VIEW

FRONT VIEW

Linden RoboEagles
FRC-3568
2021 Infinite Recharge @ Home

Template Drawing

Date : 2/19/21

Rev. 1 JPB
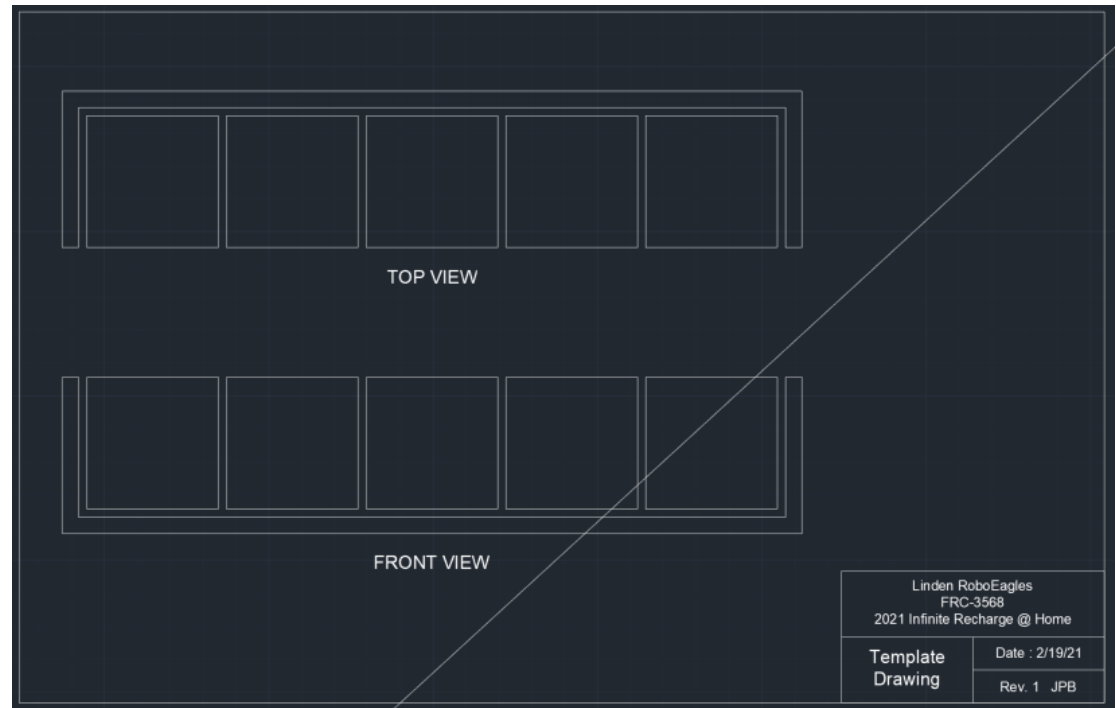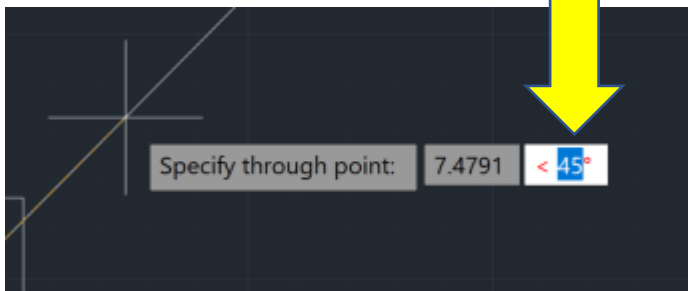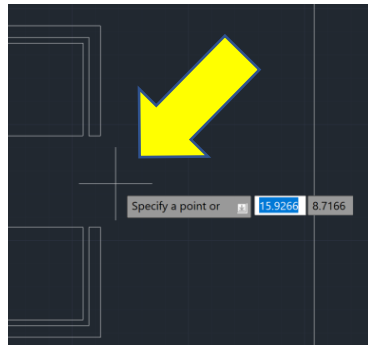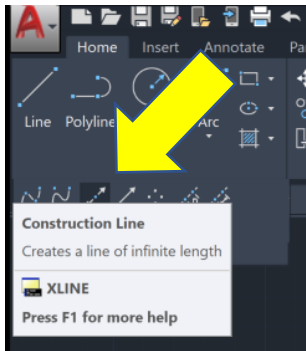
Let's Draw

31 – Using the **Line Tool**, project the edges of both the **Top View** and **Front View** objects. Make sure to have the **Ortho Tool ON**.

32 – Using the **Line Tool**, draw vertical lines down from the horizontal lines that intersect the **Orthographic Projection Line**. The intersection points will be indicated by a green **X**.
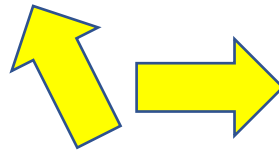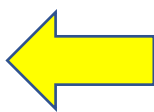
Let's Draw

33 – Delete the top horizontal projection lines by selecting them and pressing the **DELete** key. Use the **Trim Tool** to remove the lines that extend beyond the outside edges of the **Side View** by choosing the **Trim Tool** from the **Modify Menu** and selecting the four outside lines of the object and press **Enter**. Select each of the lines to trim the extra length from each line. Using the same process, delete the four extra lengths at the bottom right corner of the cube.
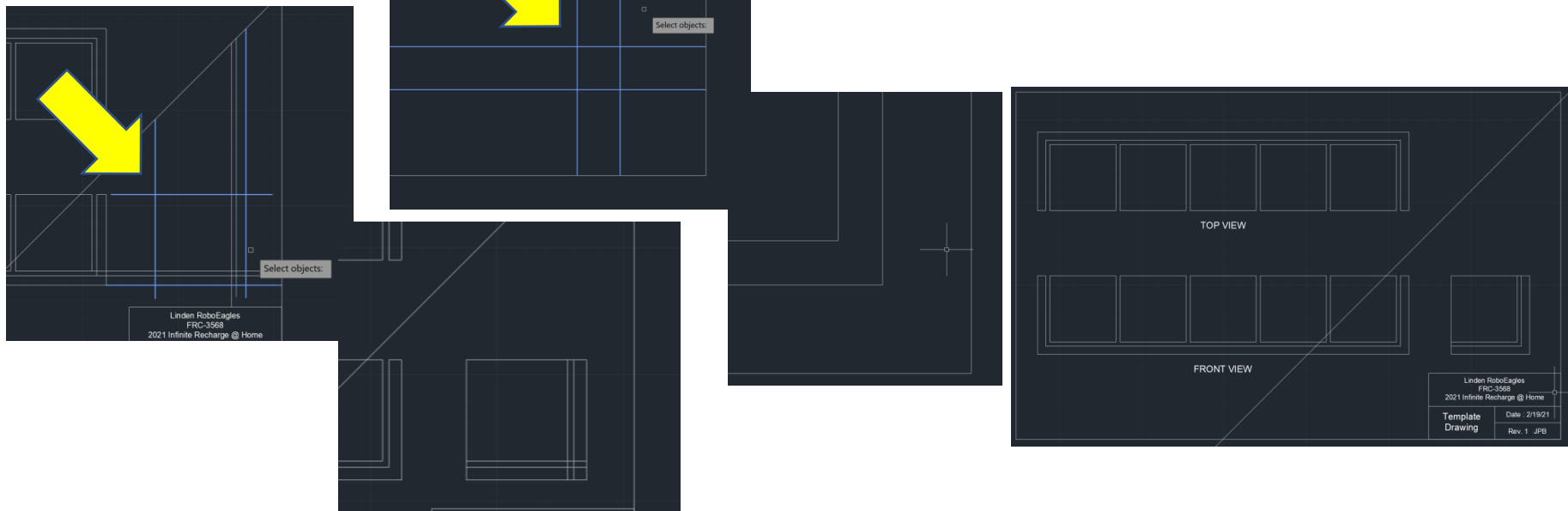
Let's Draw

34 – The lines at the bottom and right side of the cube are actually hidden by the Cube Holder and the **Line Type** needs to be changed. To do this select the **Line Type** drop down from **Properties Menu**, and choose **Other...** at the bottom. In the **Linetype Manager** pop-up window select **Load...** and scroll down to **HIDDEN**, select it and click on **OK**. The **Hidden Line Type** will be added to the **Line Types Menu**. Select both lines and use the drop down to select the **Hidden Line Type**.
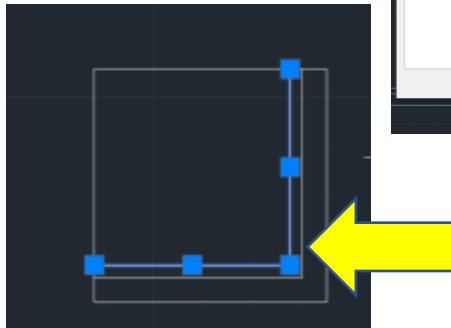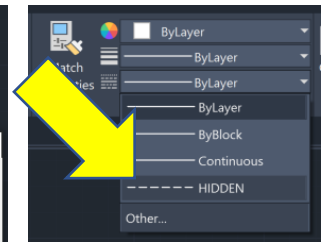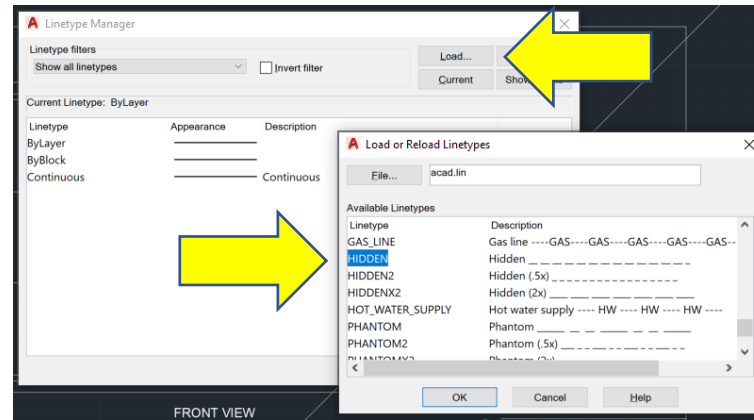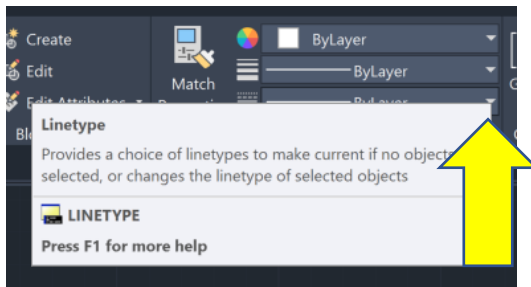
Let's Draw

35 – Delete the **Orthographic Projection Line** by selecting it and pressing the **DELete** key.

36 – Use the **Copy Tool** or the **Text Tool** to label the **Side View**, and edit the **Title Block** date and drawing name. To edit existing **Text** just double click on it.

37 – Save your drawing using the **Save Tool** in the **Quick Access Toolbar** at the top left corner of the window. (We should have been saving our progress all along!)
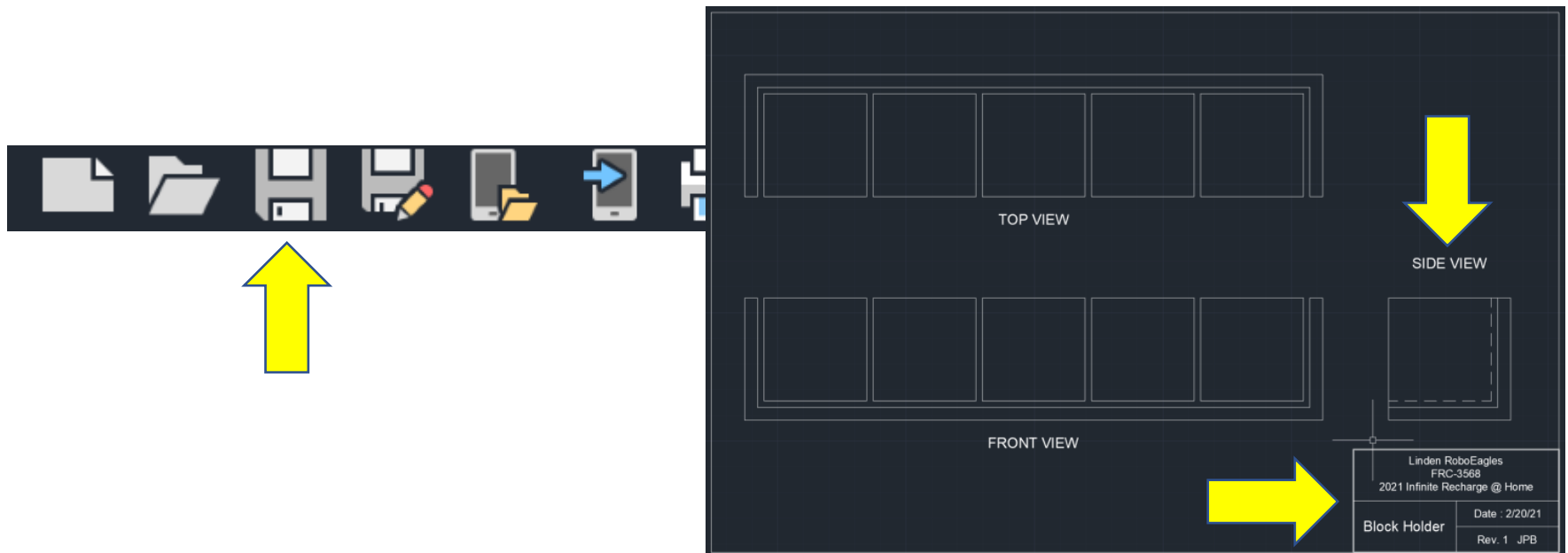
Let's Draw

38 – Now that we have our drawing maybe we don't quite like what we see. We can modify the drawing. To start let's measure the distance from the bottom right corner of the **Block Holder** to the top left corner of the **Waffle Block**. To do this select the **Measure Distance Tool** from the **Utilities Menu**. Click on the bottom right corner and the top left corner, the distance will be shown as below.

39 – Draw a **Center Radius Circle** from the bottom right corner with a radius of **3.5"**.
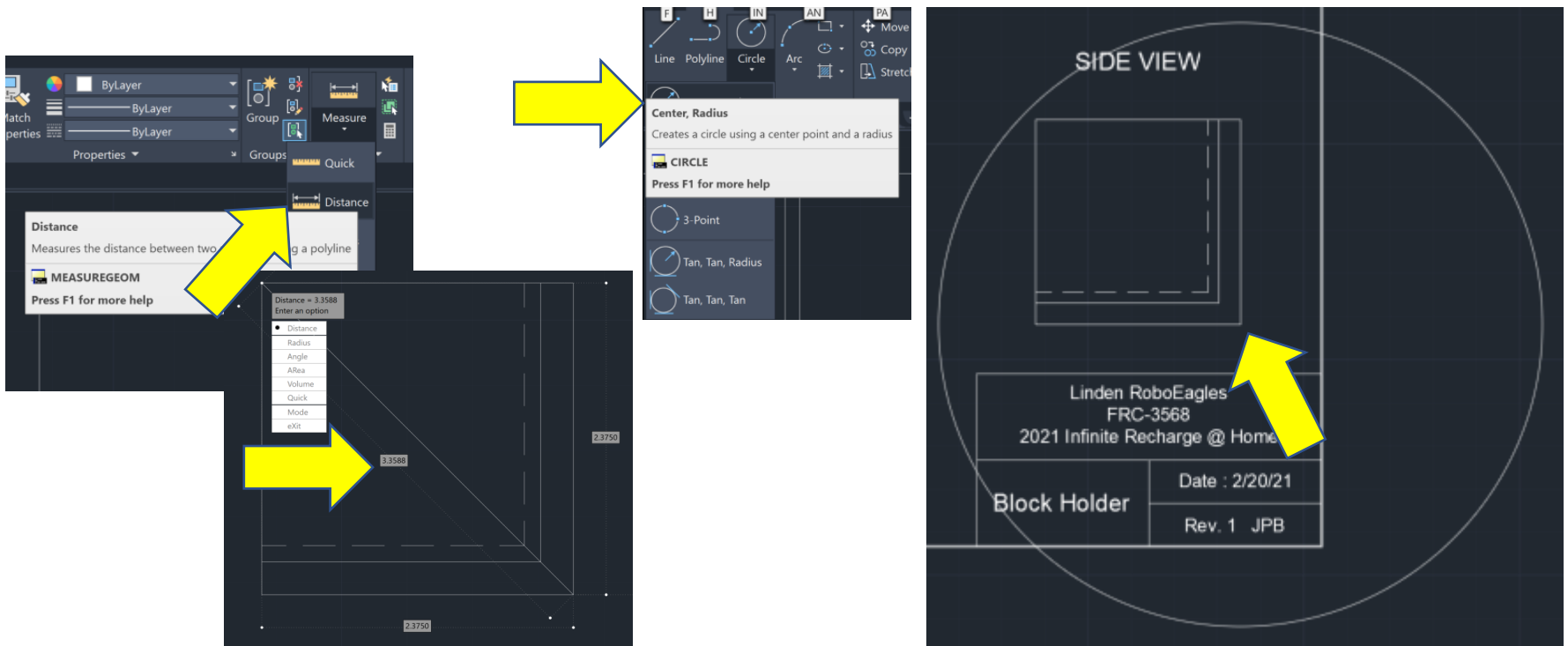
Let's Draw

40 – Extend the sides of the **Block Holder** to the **Circle** using the **Extend Tool**.

41 – Use the **Trim Tool** to trim the lines as shown.

42 – Use the **Line Type Tool** to change the lines that are hidden by the side of the **Block Holder** into **Hidden Lines**.

43 – Use the **Move Tool** to move the **SIDE VIEW** text above the object, and to move all the **SIDE VIEW** objects to center the image in the available space. Make sure the **Ortho Tool** is **ON** and only move the objects horizontally.
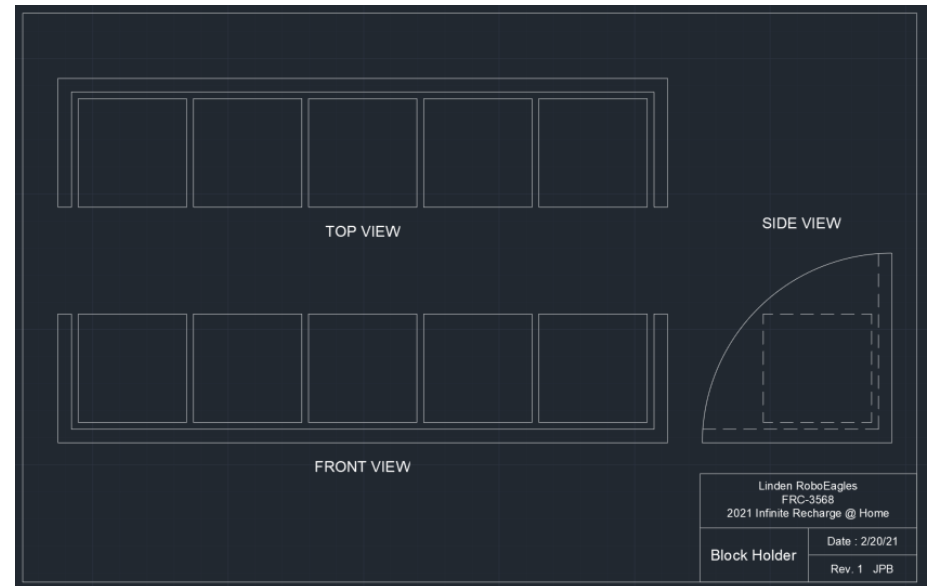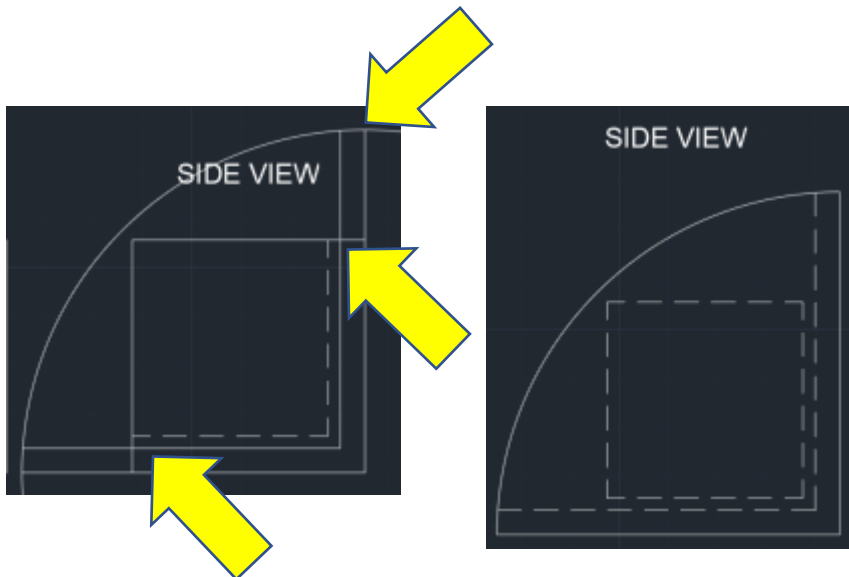
Let's Draw

44 – Use the **Line Tool** to project the newly formed top of the **Block Holder** to the left side of the drawing.

45 – Use the **Extend Tool** to extend the **Block Holder** sides to the new top line.

46 – Delete the old top edges of the **Block Holder** using the **DELete** key.

47 – Trim the projected line using the **Trim Tool**.

NOTE: By not moving the SIDE VIEW vertically we retained the relationship between the SIDE VIEW and the FRONT VIEW. The relationship between the SIDE VIEW and TOP VIEW was lost when we deleted the Orthographic Projection Line and moved the SIDE VIEW.
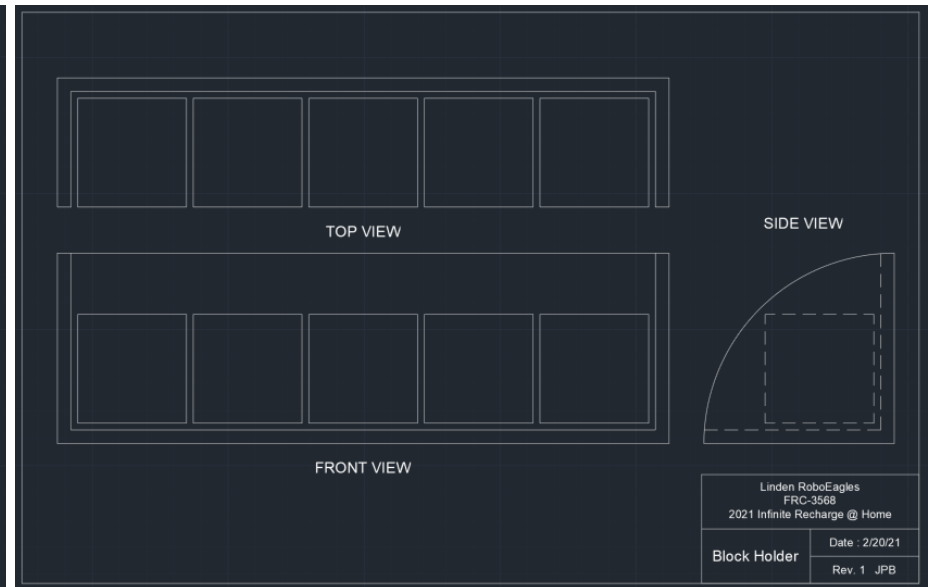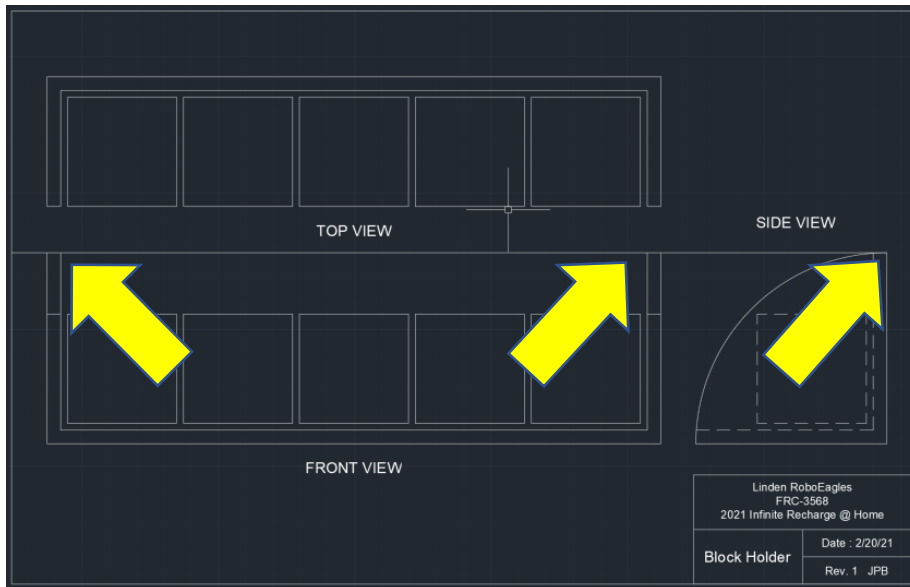
Let's Draw

48 – With the **Ortho Tool ON**, move the **TOP VIEW** up vertically and the **Front View** down to make room for the changes. This process will destroy any relationship between the **FRONT VIEW** and **SIDE VIEW**.

49 – Use the **Measure Distance Tool** to measure the length of the **Cube Holder** sides.

50 – Use the length measured in Step 49 to change the length of the sides of the **Cube Holder** in the **TOP VIEW**. To do this click on the outside line on the right side of the Cube Holder and select the bottom node (solid square at the end). Use the **TAB** key to move the Cursor to the length measurement and enter the measured value. You may need to use the **Ungroup Tool** before you can edit the length of the lines.

AUTOCAD®
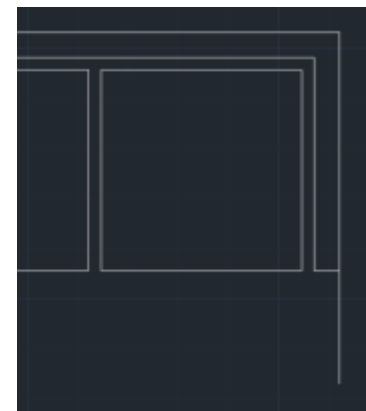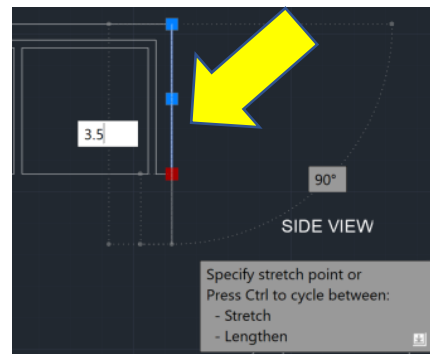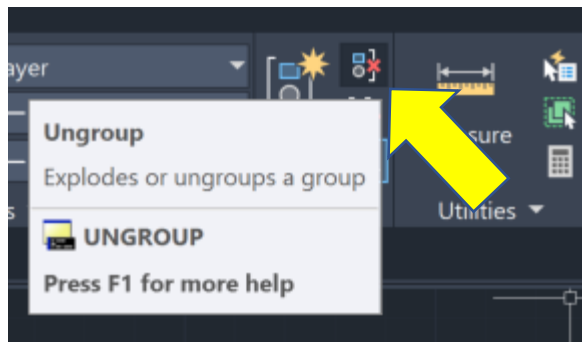
Let's Draw

51 – Using the **Line Tool** draw a **Projection Line** from the new end point of the line.

52 – Extend the **Cube Holder** sides using the **Extend Tool**.

53 – Trim the projected line using the **Trim Tool** and delete the old end lines from the **Cube Holder** sides using the **DELete** key.

54 – Add a **Revision History Legend** in the top right corner of the drawing and edit the **Revision Number** in the **Title Block**.

55 – Save the drawing using the **Save As Tool** in the **Quick Access Toolbar**, save your drawing as **Block Holder rev2** to preserve the history of your part development.
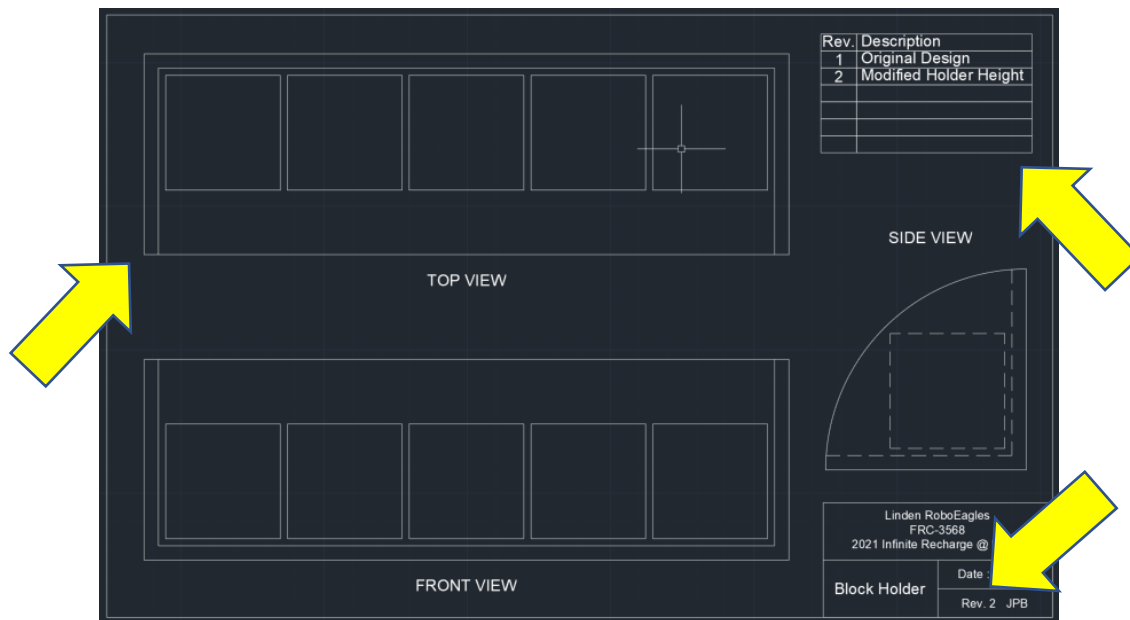
Let's Draw

56 – Add a **Pivot Pin** to the side of the **Cube Holder**. To do this, start by using the **Offset Tool** to offset the bottom line by **.50"**. Then use the **Line Tool** to draw a line up from the **Midpoint** of the bottom line. This will give us the **Center Point** for our pivot pin.
57 – Draw a **.250"** circle using the **Center Diameter Circle Tool** from the **Center Point** we made in Step 55. Delete the **Construction Lines** we drew using the **DELete** key.
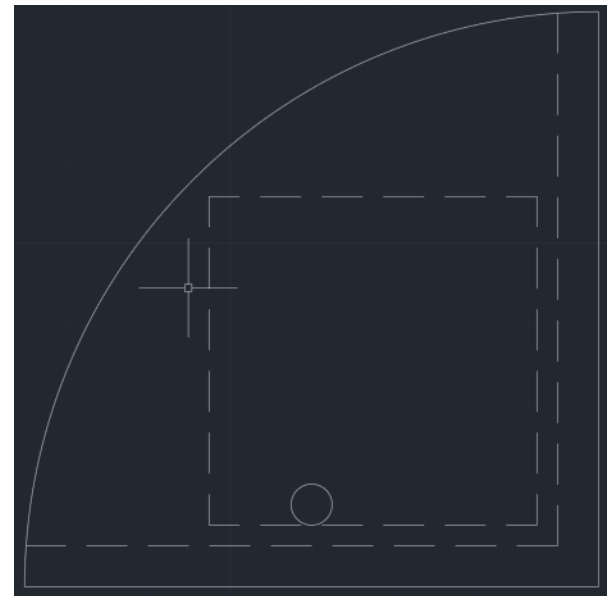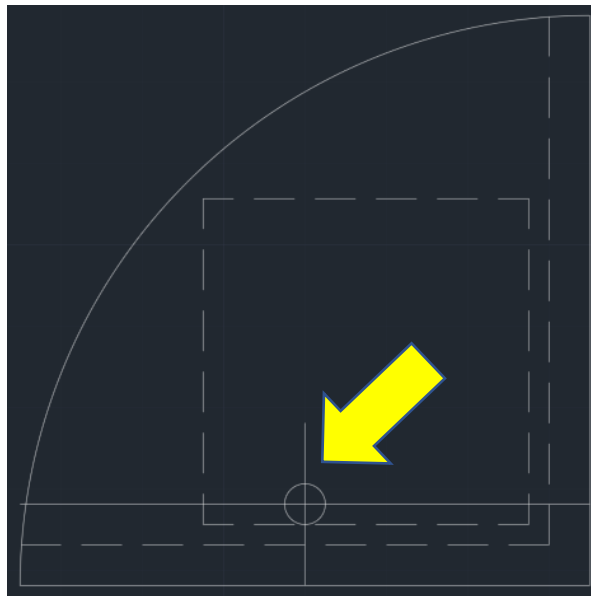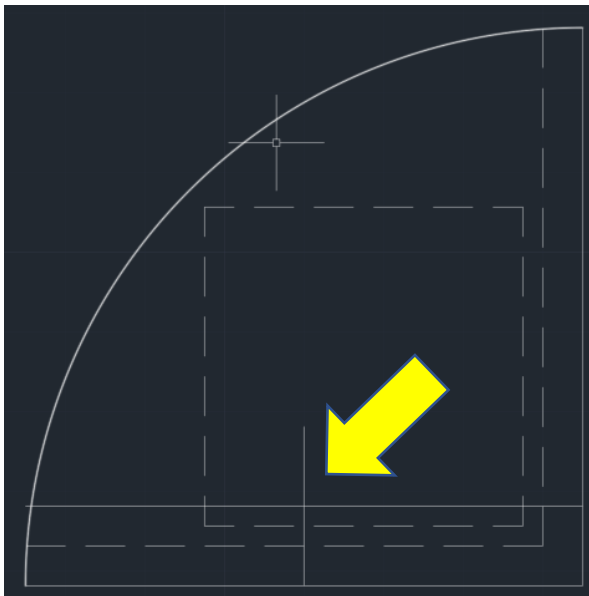
Let's Draw

58 – Transfer the **Pivot Pin** to the **FRONT VIEW** and **TOP VIEW** drawings. Unfortunately we destroyed any relationship between the **SIDE VIEW** and the others so we will need to do this manually. Start with the **FRONT VIEW** by offsetting the bottom line by **.50"** and then extending the line by **.50"** by selecting the **End Point Handle** and typing **.50** into the dimension entry box. This is the center of our **Pivot Pin**.

59 – Offset the new line by **.125"** in both directions and delete the original center line.

60 – Trim the two new lines at the side of the **Cube Holder**.

61 – Draw a line connecting the ends of these two new lines.

Let's Draw

62 – Duplicate the pin on the opposite side of the **Cube Holder** using the **Mirror Tool**. To do this select the three lines that make the **Pivot Pin**, and select the **Mirror Tool** from the **Modify Menu**. Select the **Midpoint** of the bottom line and the **Midpoint** of the top line as the **Mirror Line**. You will see the pin appear on the opposite side of the **Cube Holder**. Make sure to select **NO** when prompted to **Erase Source Objects**.
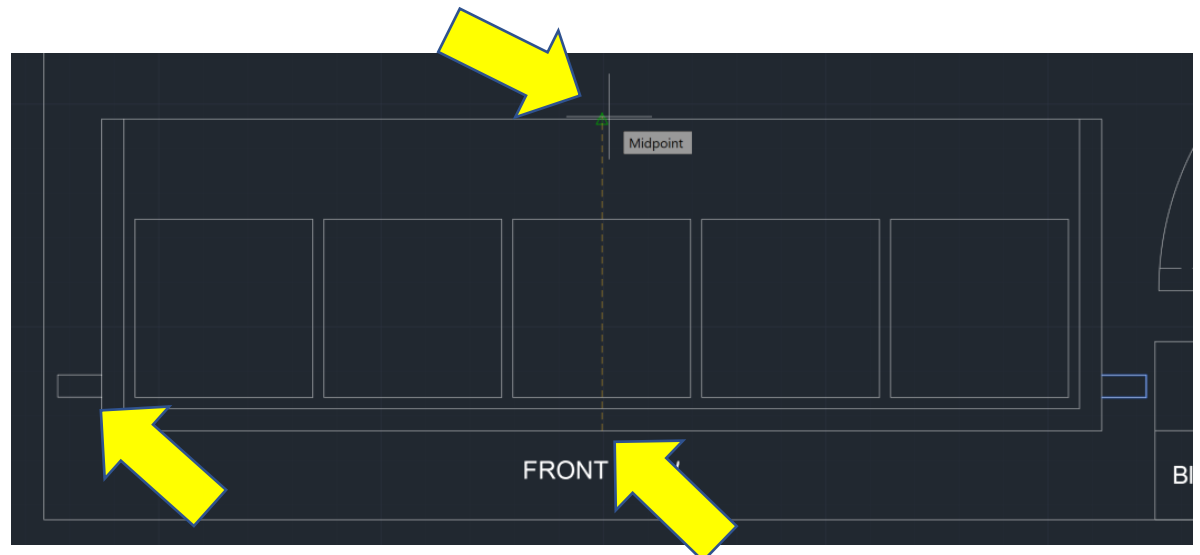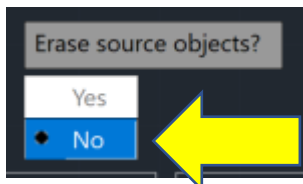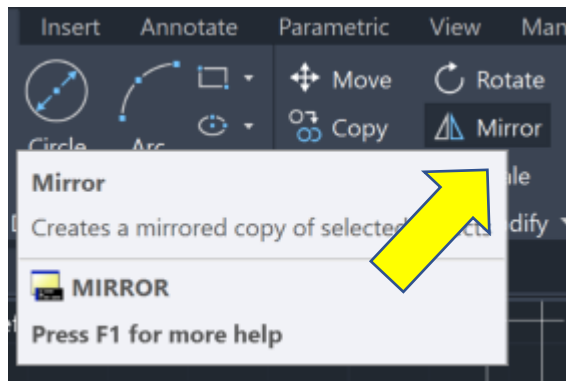
Let's Draw

63 – Repeat the previous steps for the **TOP VIEW** using the measured distance from the center of the **Pivot Pin** to the back of the **Cube Holder**.

64 – Update the **Title Block** and the **Revision History Legend**.

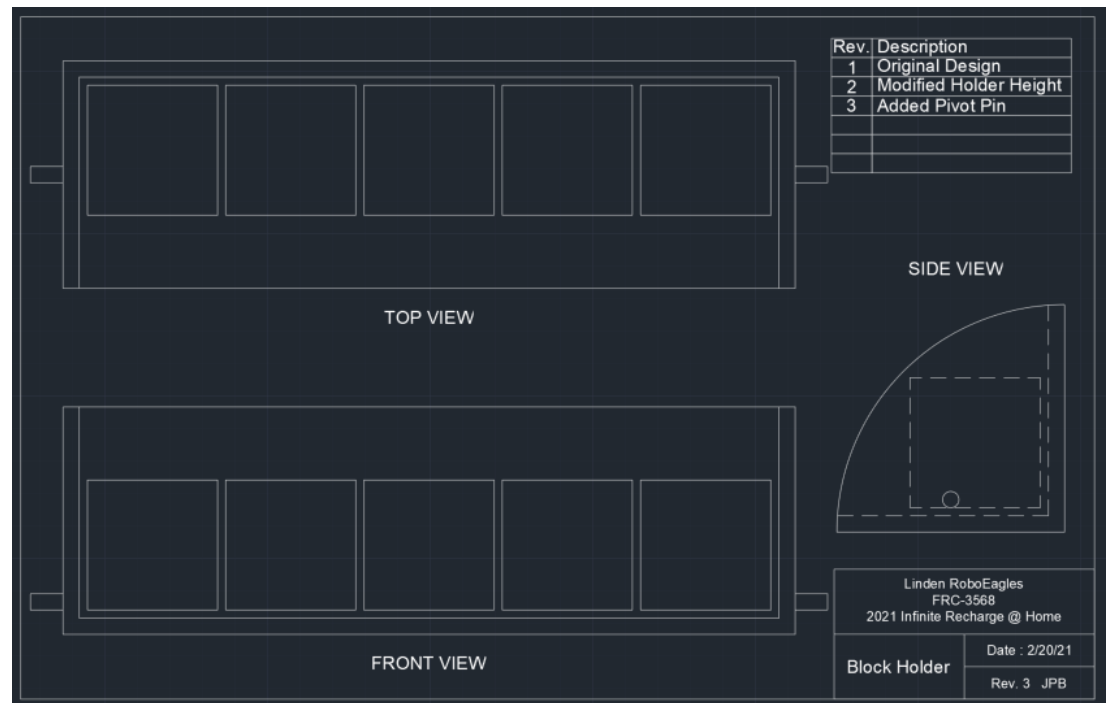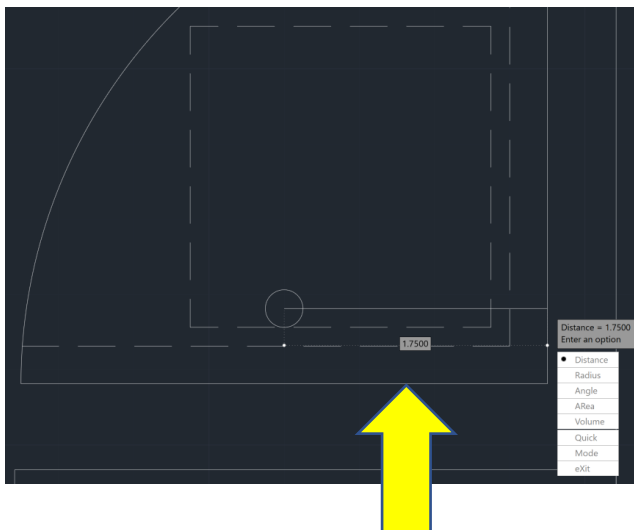65 – Save the drawing using the **Save As Tool** in the **Quick Access Toolbar**, save your drawing as **Block Holder rev3** to preserve the history of your part development.

Other Tools

66 – Copy the top view of the **Block Holder** to a new drawing. To do this click on the **+** on the **File Tab** and a new drawing will be created. Switch back to the **Cube Holder** drawing and select all the objects in the top view (if they are not in a **Group**). Use **Ctrl+C** to **Copy** the items and switch back to the new drawing. Use **Ctrl+V** to **Paste** the objects into the new drawing. Close, but do not save, the **Cube Holder** drawing.
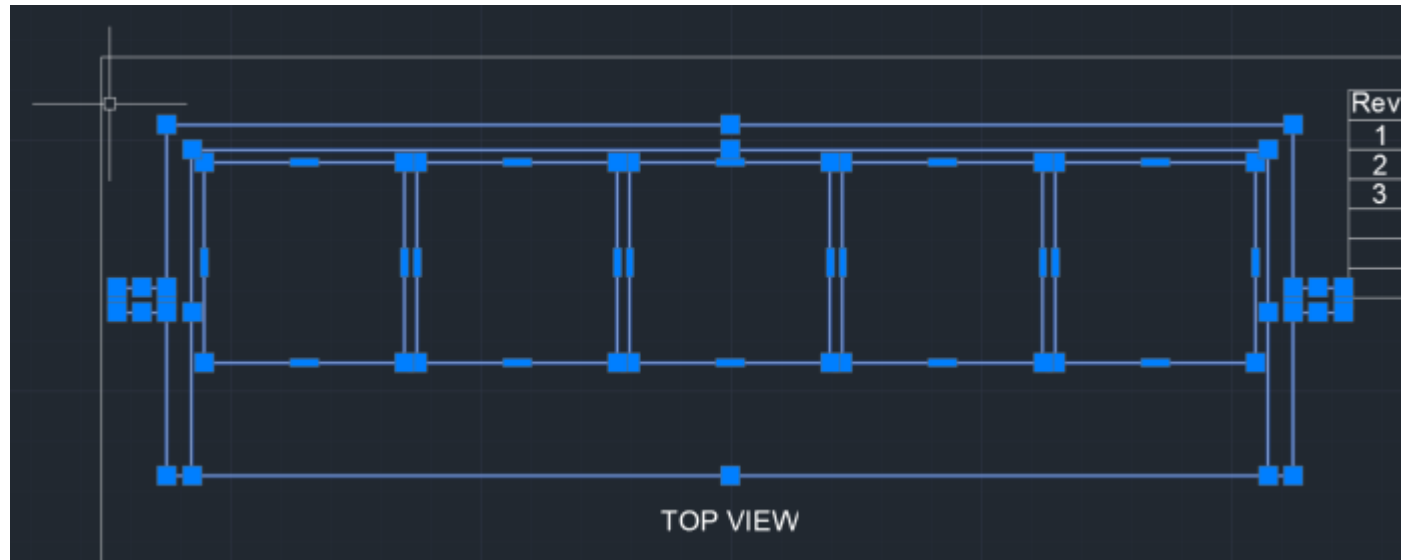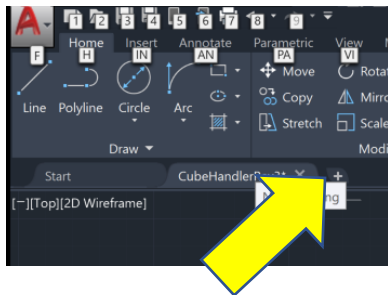
TOP VIEW

Other Tools

67 – Switch the **View Control** from **Top** to **SW Isometric** (located just below the drawing tabs at the top left of the drawing). The **TOP VIEW** will rotate into an **Isometric View** looking down from above. Switch the **Visual Style** from **2D Wireframe** to **Realistic**.
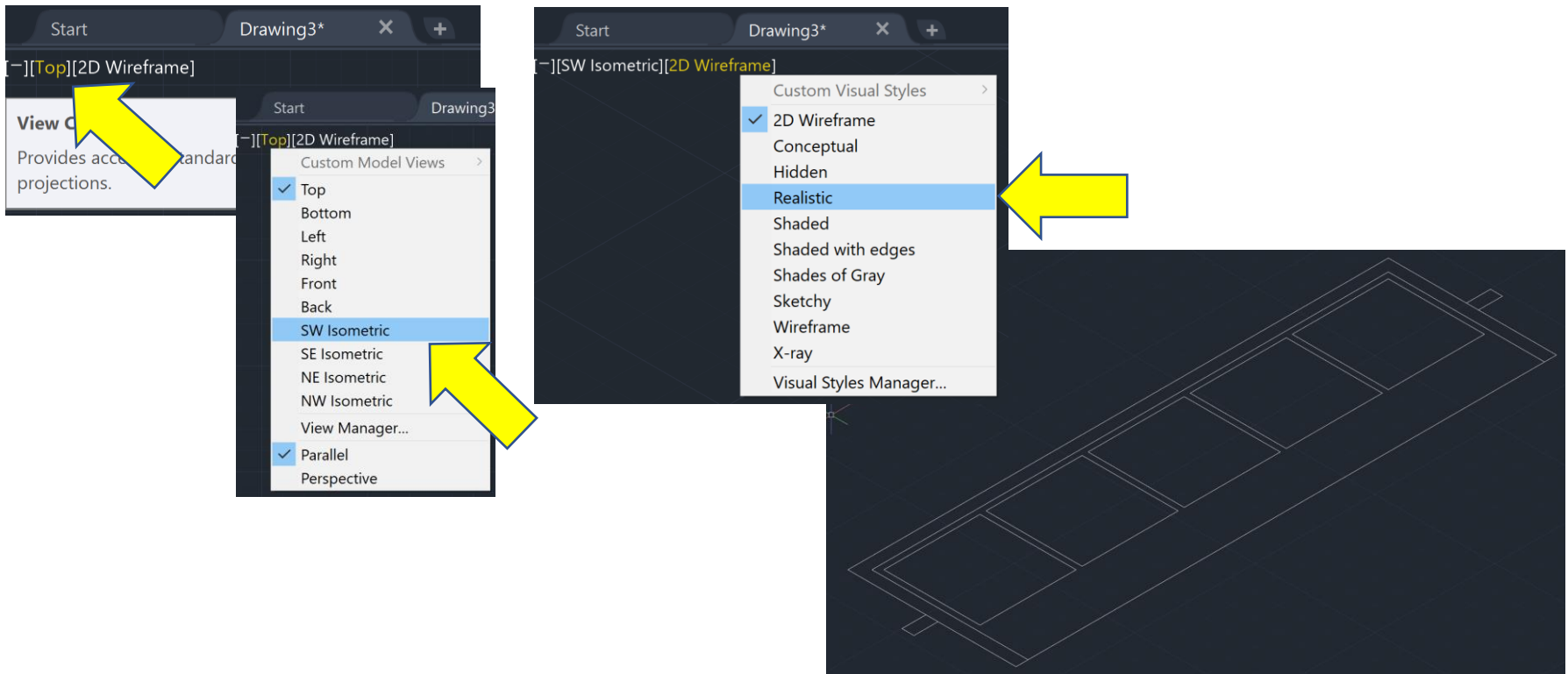
Other Tools

68 – Type **PRESS** and press **Enter**. Select the first block outline and **Pull** the surface up **2"**. Repeat for all five blocks. (Just like in Fusion 360.)

69 – Type **PROP** and press **Enter**. The **Properties Window** will open. Select each block and change its **Color** to **Yellow**.
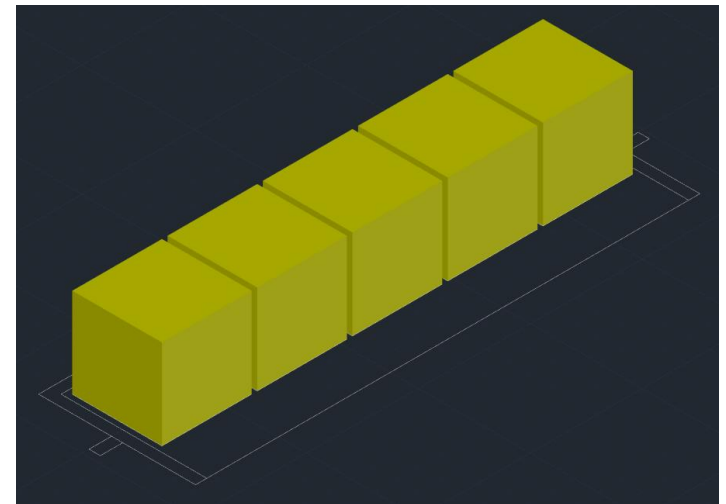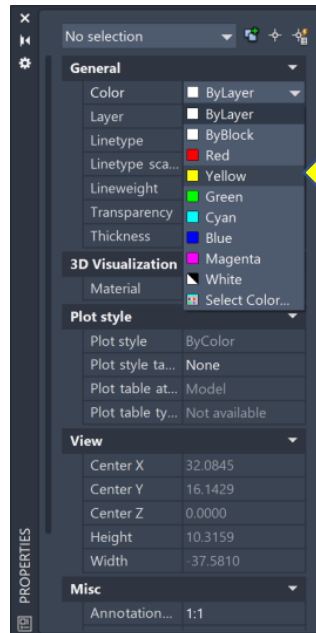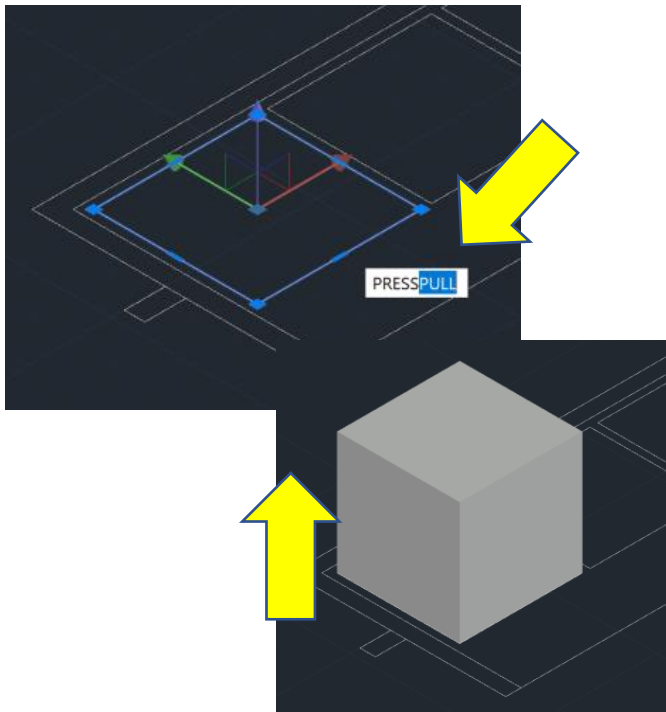
Other Tools

70 – You can create 3D Models from 2D but it's much easier the other way around. Start by **Exporting** the **Bracket** we made in Fusion 360 as a **DWG** file and opening it in Autocad.

71 – **Zoom Extents** and delete the **Link Arm**. You should be left with just the **Bracket**.

72 – Make sure drawing is set for **3D Modeling** by clicking on the **Gear** in the **Status Bar** (bottom right corner). Choose the **Flatshot Tool** from the **Section Menu**.
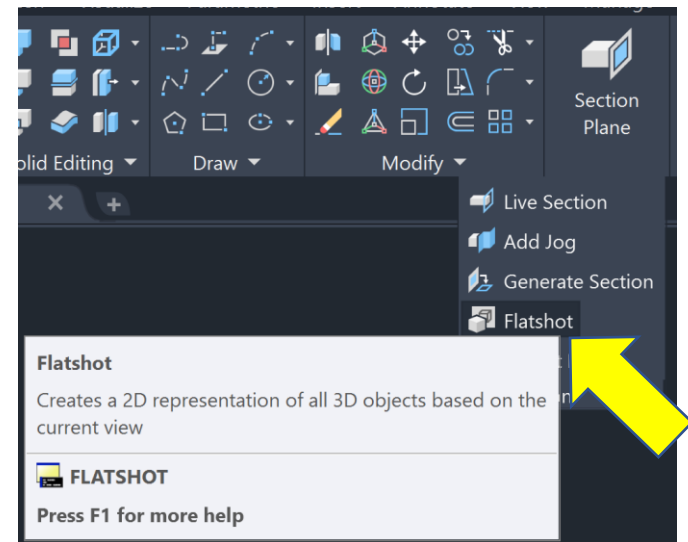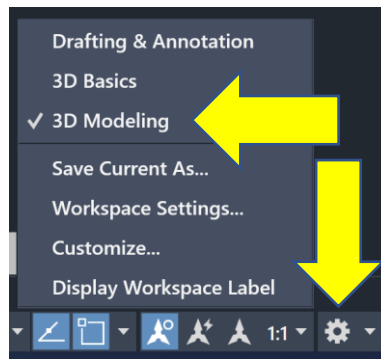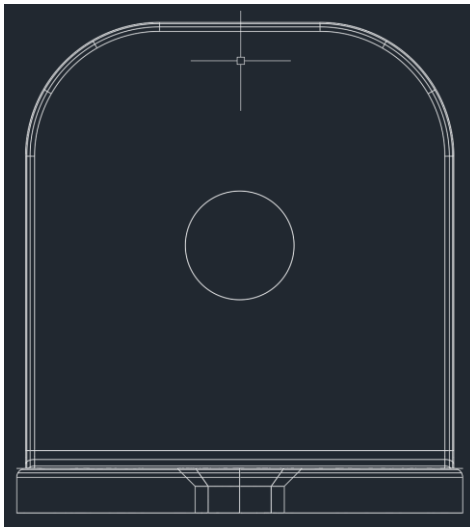
Other Tools

73 – In the **Flatshot Window** make sure the **Insert as New Block** is selected, and select the drop down for the **Obscured Lines** section at the bottom of the window. Load the **Hidden Line Type** and select it. Click on **Create**.

74 – A 2-Dimensional image will be created of the **Bracket**. Place it in the drawing by clicking on an open area in the drawing. Press **Enter** for a **X-Scale Factor** of **1**, and again for a **Y-Scale Factor** of **1**, and again for a **Rotation Angle** of **0**.
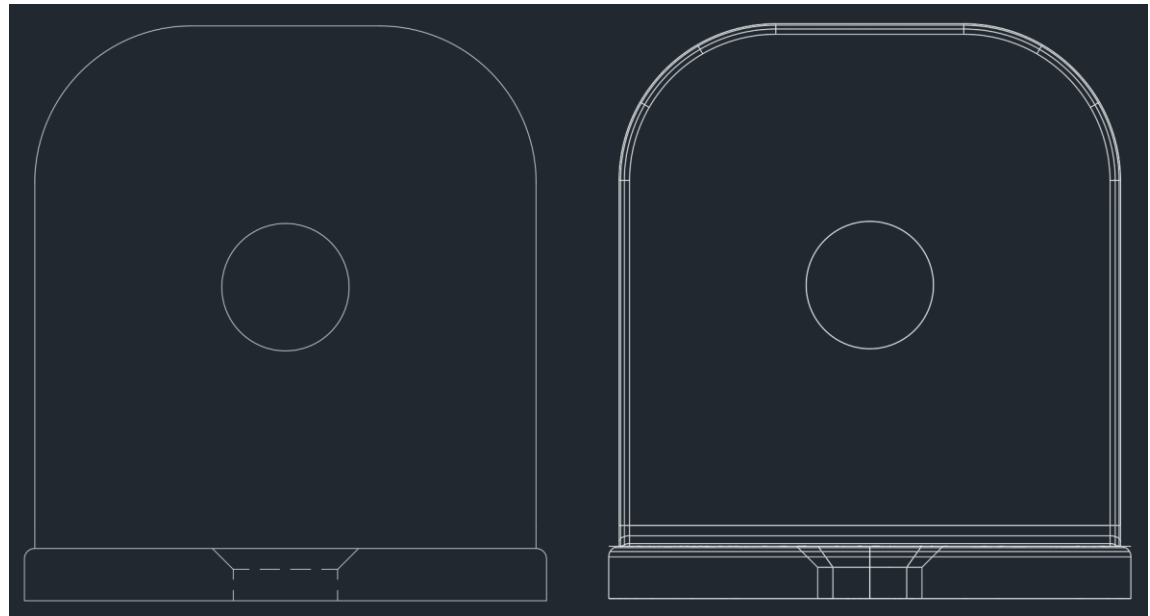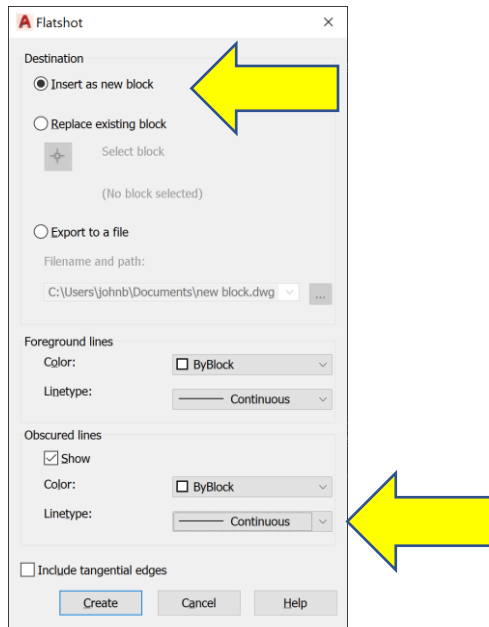
Other Tools

75 – Use the **View Cube** to tilt the drawing forward and see that the **Bracket** is indeed 3-Dimensional and the **Flatshot** image is 2-Dimensional.

76 – Create a new drawing by clicking on the **+** on the **File Tab**. Close the **Bracket** drawing.
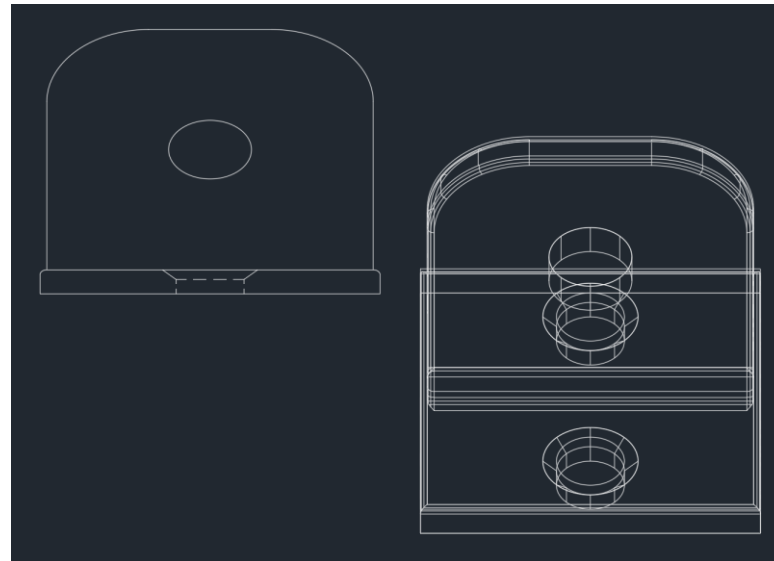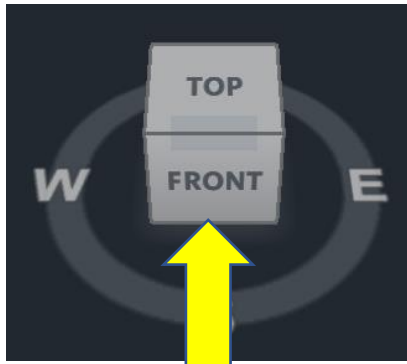
Other Tools

77 – The **Spline Tool** interpolates a curve between points. Verify the new drawing is set for 2D Drafting by clicking on the **Gear** in the **Status Bar**. If **Drafting & Annotation** is not selected then do so. Select the **Spline Fit Tool** from the **Draw Menu**. Start drawing a Spline by clicking multiple points to make the shape desired.

78 – The **Fillet Tool** will round over edges. Start by drawing a **Rectangle** and choosing the **Fillet Tool** from the **Modify Menu**. Type **R** for **Radius** and press **Enter**, enter **1**" for the radius size and press **Enter**. Select the two lines that create the corner of the **Rectangle**.

79 – The **Chamfer Tool** will trim the corner edges. Start by again drawing a **Rectangle** and choosing the **Chamfer Tool** from the **Modify Menu**. Type **D** for **Distance** and press **Enter**, enter **1**" for the first distance and press **Enter**, again enter **1**" for the second distance and press **Enter**, and now select the two lines that create the corner of the **Rectangle**.
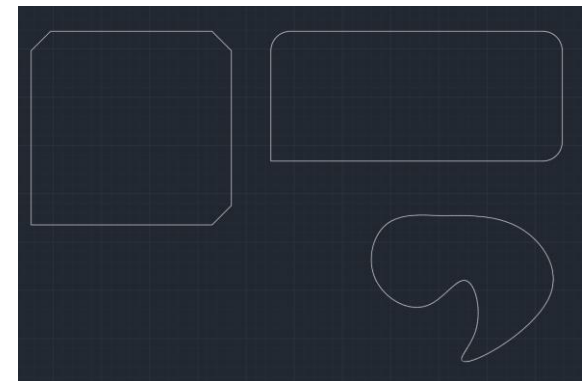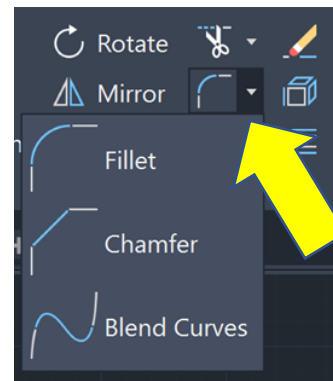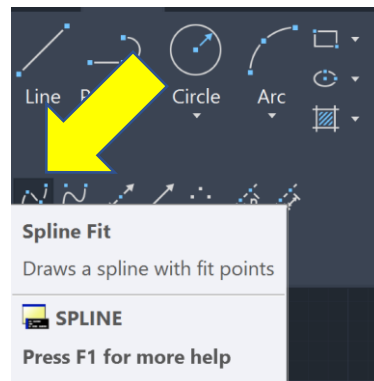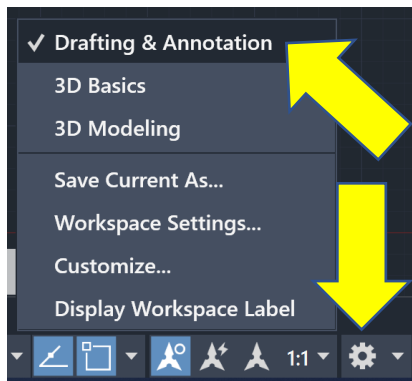
Other Tools

80 – The **Blend Curves Tool** can be used to create a curve between two points. To start draw several lines using the **Line Tool** and chose the **Blend Curves Tool**. Select the two lines to be connected and the **Blend Curves Tool** with create a spline connection.

81 – The **Line Tool** has several options beyond entering a length. One option is to enter a length at a certain angle. To do this select the **Line Tool** and start the line by creating the first point on the drawing. Type **2 < 0** and press **Enter**, type **1 < 45** and press **Enter**, type **1< 135** and press **Enter**, type **2 < 180** and press **Enter**, type **Close** and press **Enter**.
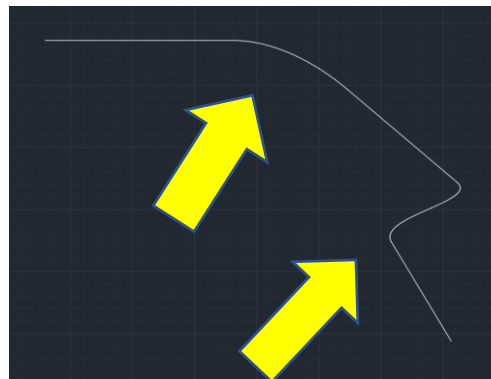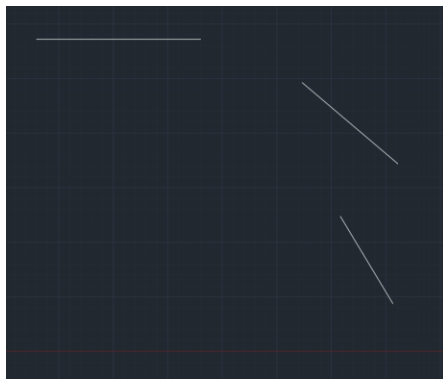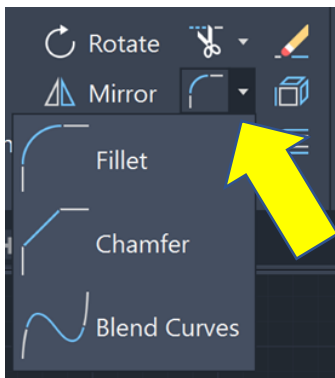
Other Tools

82 – Annotations are a way to display dimensions of your designs, let's add dimensions to the shape created in Step 81. To start select the **Dimension Tool** from the **Annotation Menu**. Select the top left corner of the shape and then the point to the right of it. The dimension will appear above the shape and can be moved up and down. Drag the dimension to where you want it and click to place it. Repeat these steps for the next line segment. You may notice that there are three dimensions for the line; X, Y, and Length.
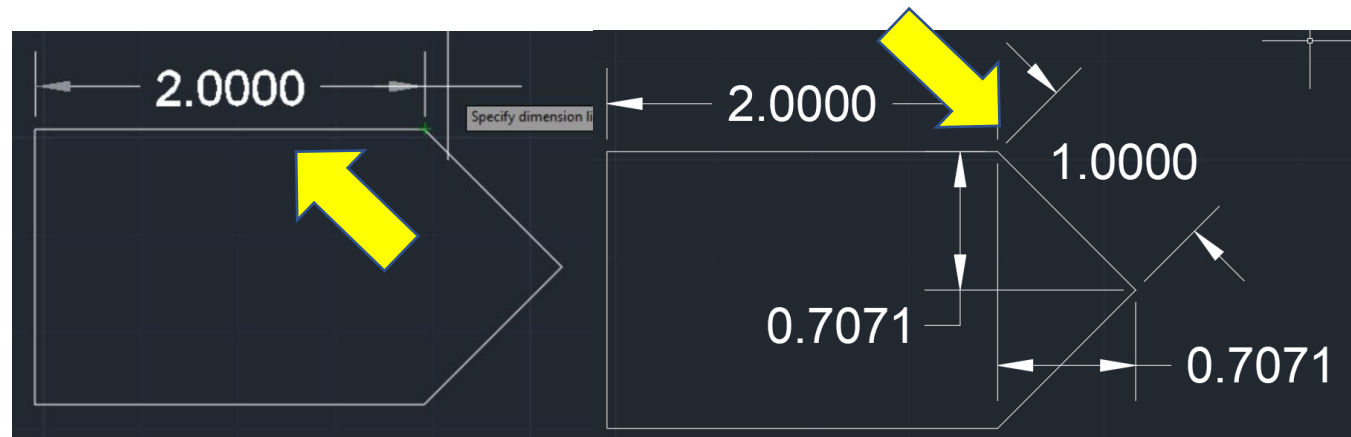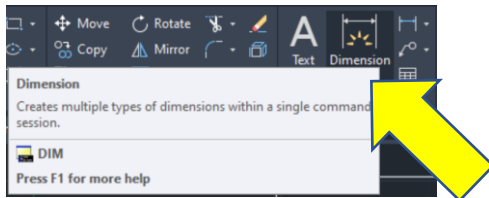
Other Tools

83 – By selecting the two points to create a **Dimension** there is a relationship made and it makes the **Dimension** dynamic. To show this select the point on the right side by clicking on the **End Point Handle** and bring the cursor to the left slightly. Type **.5**" to shorten the line length and press **Enter**. Notice that any dimension tied to that point is updated. Press the **Undo Tool** at the top left corner of the screen to restore the drawing.
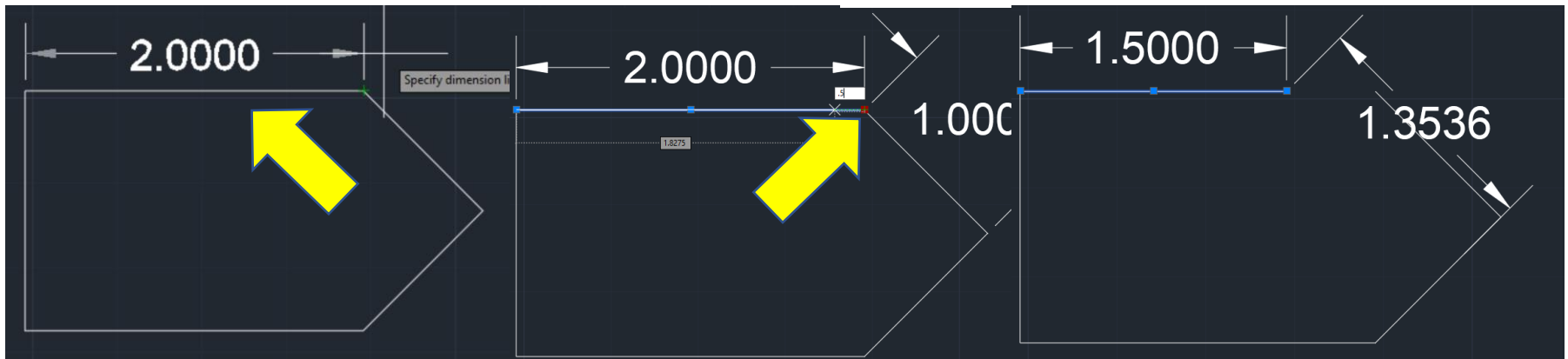
Other Tools

84 – Double click on the 2.0000 dimension and type **2.00** and press **Enter**. Try to shorten the line by **.5"** like in Step 83. You will see that by **Overriding** the **Dimension** we have destroyed the relationship to the line (it is now just text). Also notice that the second dimension's relationship remains intact. Again press the **Undo Tool** to restore the drawing.
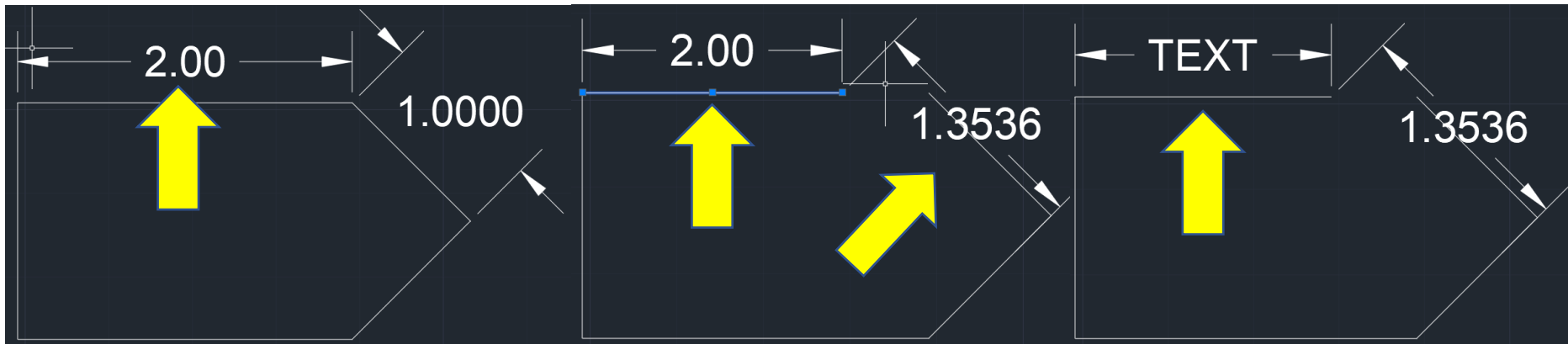
Other Tools

85 – You can modify the **Annotation Text** by typing **DIMSTY** to open the **Dimension Style Manager** window. Choose **Standard** and **Override...** to open the **Modify Dimension Style: Standard** window. There are too many things to explain within this window but an important feature would be the precision of the dimensions. To **Modify** the **Dimension** precision select the **Primary Units** tab and choose **0.00** from the **Precision** drop down menu and click **OK**. Click on the **Close** button to close the window. Dimension the bottom line in the drawing. To edit the existing dimensions you can left click and then right click and choose **0.00** from the **Precision** menu.
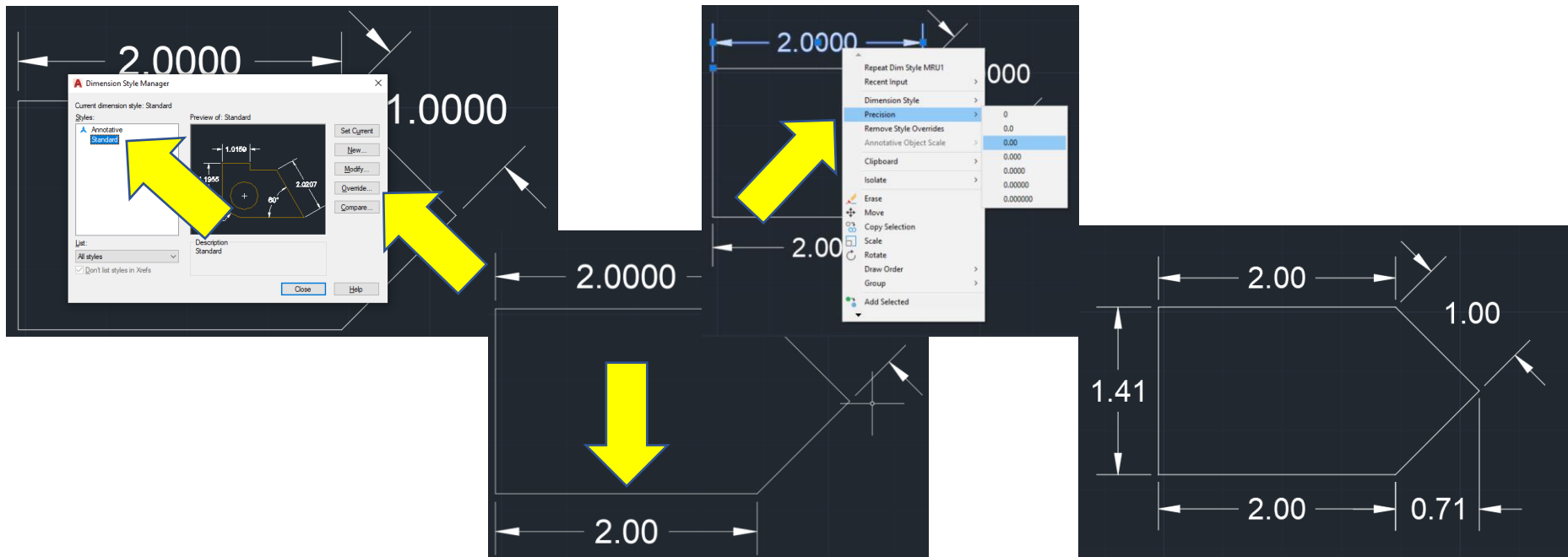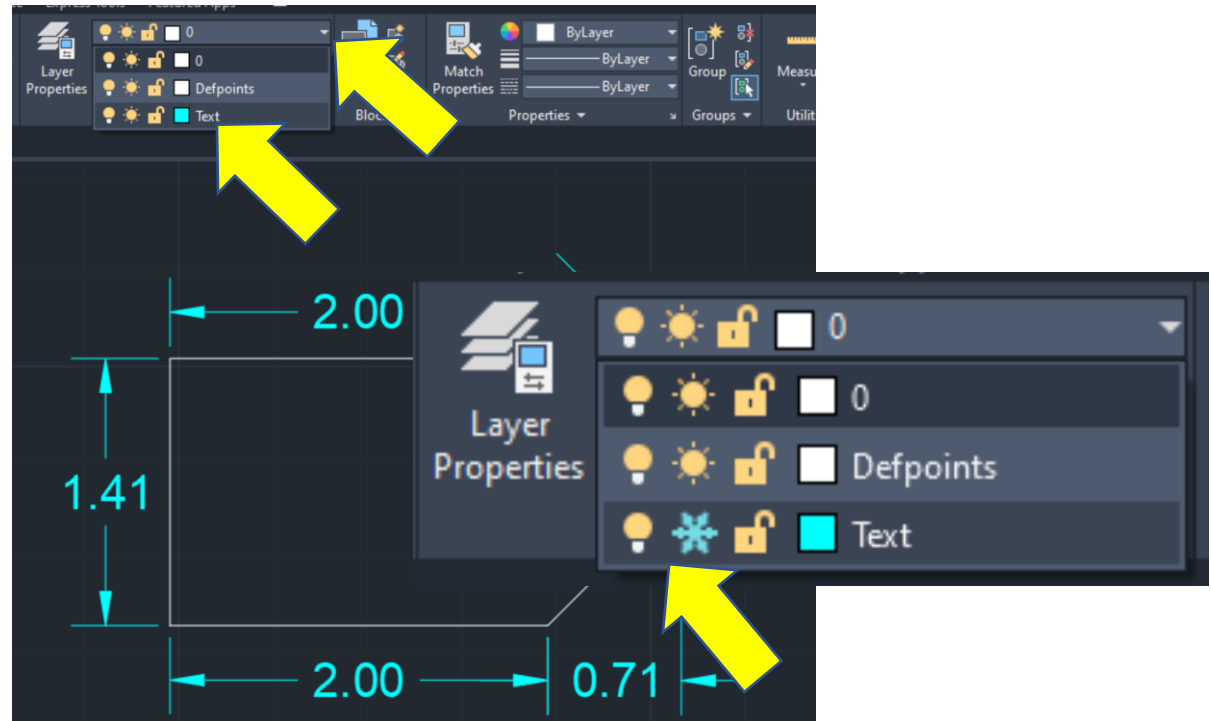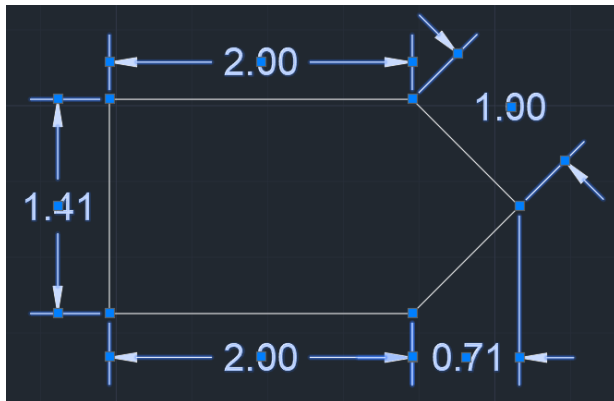
Layers

86 – **Layers** allow us to group like things and will enable us to add and remove information from our drawings as needed. Using the previous drawing let's create a **Text Layer** and move the text onto that **Layer**. Click on the **Layer Properties Tool** in the **Layers Menu** on the **Home Tab**. Choose the **New Layer Icon** or press **ALT+N** to create a **New Layer**. Label this layer as **Text** and change the **Layer Color** to the color of your choice. Click on the **X** in the top left corner to close the window.
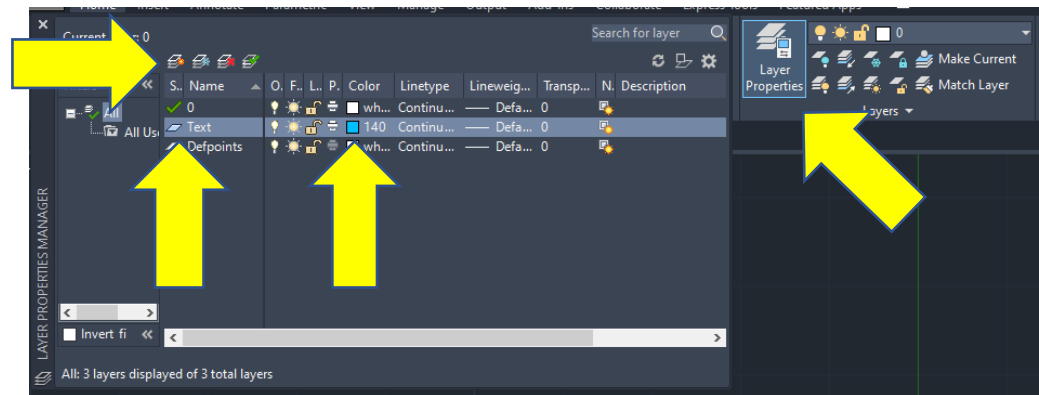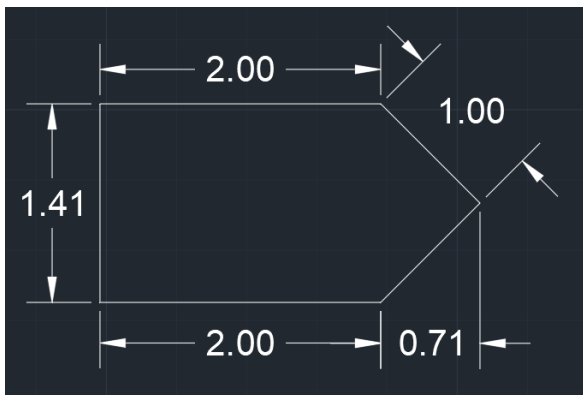
Layers

87 – Select all of the dimensions and, from the **Layers Menu**, click on the drop down and click on the new **Text Layer** we created. The text will change to whatever color you chose for the layer. The **Layer** can be **Turned ON** or **OFF** by selecting the **Light Bulb** symbol to the left of the **Layer Name**. Layers can also be **Frozen** or **Thawed** by clicking on the **Sun** or **Snow Flake** symbols. Both will remove the information from the drawing but the latter actually removes the information from memory to release system resources.
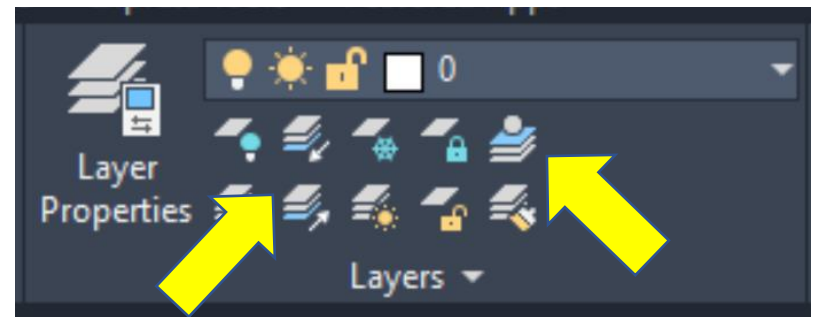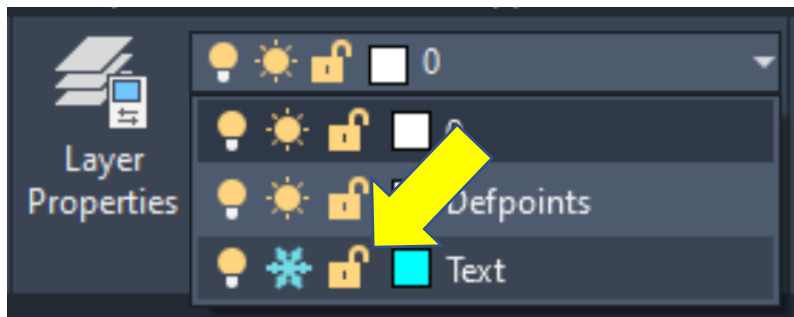
Layers

88 – **Locking** the **Layer** prevents any of the objects contained in the layer from being modified, preventing accidental changes from occurring.

89 – **Isolating** allows us to **Lock** anything not on the current selected item's Layer.

90 – We can also make the current selected item's layer the **Current Layer** by clicking on the **Current Layer Tool**.
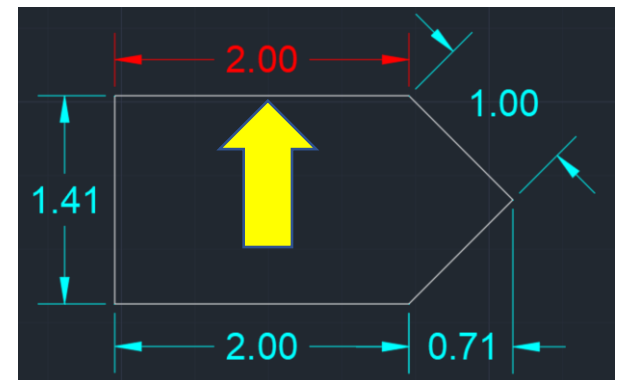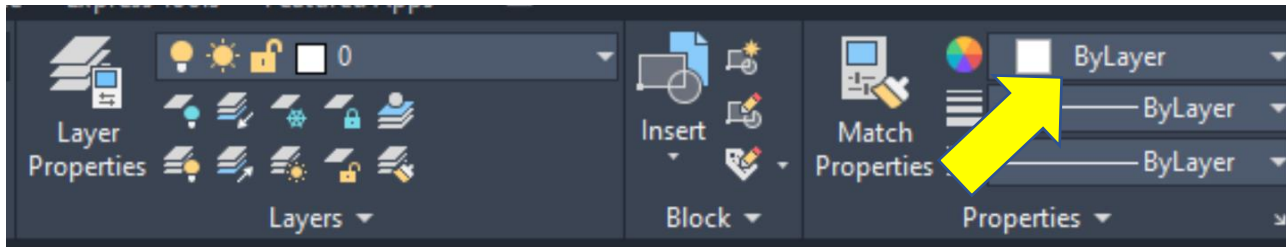
Finally...

91 – **ByLayer** refers to the **Properties** that are assigned to its **Layer**. For instance the **Text Layer** you created has a **Color Property** you assigned to it. Items created on that layer will be assigned that property unless the you **Override** it.

In Closing…

There are a lot of concepts covered in this training but it's only scratching the surface of the capabilities of Autocad. If you need more information ask your coaches and/or use YouTube and Google.