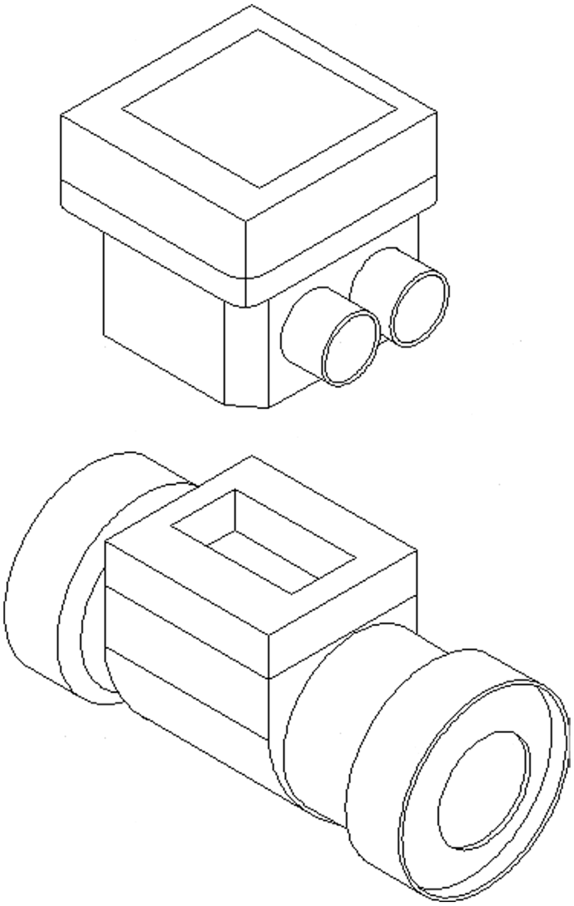
Chapter 20

Isometric Drawing



Learning Objectives

In this chapter, we introduce isometric perspective and how to use it. We cover

- What isometric perspective is
- When to use it
- When not to use it
- Setting isometric perspective
- Changing planes (F5)
- Ellipses in isometric
- Text in isometric

In the course of this chapter, you will create several isometric designs, including a computer desk and mechanical devices.

Estimated time for completion of this chapter: 1 hour.

Up and Running with AutoCAD 2017: 2D and 3D Drawing and Modeling. DOI: http://dx.doi.org/10.1016/B978-0-12-811058-4.00020-7

20.1 INTRODUCTION TO ISOMETRIC PERSPECTIVE

By strict definition, *isometric perspective* means representing a three-dimensional object in two dimensions. As applied to AutoCAD, it means we draw a 3D object without resorting to the complexities of 3D space, sort of "faking it" in 2D, by angling horizontal lines 30°, the accepted isometric drafting standard (although there is also Axonometric, which is 45°). This creates the illusion of 3D and is good enough to get an idea across; indeed, that is how it is done with paper and pencil. In our case, we sometimes leave the horizontal lines flat, as with the box in Fig. 20.1, and sometimes angle all of them 30°, as with the computer table exercise at the end of this chapter.

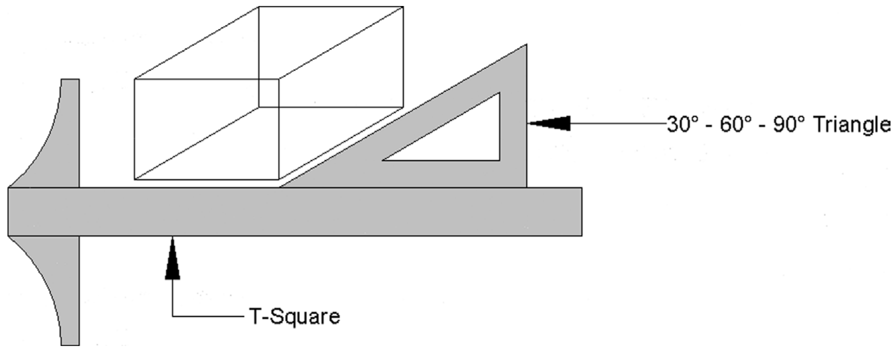


FIGURE 20.1 T-square and triangle.

Why Use Isometric Perspective Instead of 3D?

There are a few reasons. One is that it is much easier to learn isometric drawing than to develop proficiency in real 3D. So, for someone who needs only a quick 3D sketch once in a while, just to accent an otherwise excellent 2D presentation, this perfectly fits the bill. Another reason is that 3D takes up more time and computing resources, something that is not always available, and there is also some difficulty in combining 2D and 3D drawings on one sheet. Many students do not go on to take AutoCAD 3D right away (nor should they), and isometric fills that temporary void quite well. For those who do go on, isometric drawing serves as an excellent introduction to 3D and should be reviewed before starting the 3D instruction.

When *Not* to Use Isometric Perspective

Isometric drawing is inappropriate when precision 3D drawings are required for design, testing, and manufacture. Remember, isometric perspective is only for visualization. These are *not* true 3D objects and have no real depth, only the illusion of depth. As a result, true measurements and the use of the offset command are not possible in the traditional sense.

20.2 BASIC TECHNIQUE

Nothing is inherently special about drawing an isometric design. Draw a straight (Ortho) horizontal line, then rotate it 30° counterclockwise. Next, attach a perfectly straight line to one of the tips using ENDpoint. Copy the original horizontal line from where it meets the vertical to the other end (using ENDpoint as well). You are on your way to drawing an isometric box. It is the same as taking a T-square in hand drafting and putting a 30° –60° – 90° triangle on it, as illustrated in Fig. 20.1.

That was not hard, but it was tedious. There is a way to have AutoCAD preset the crosshairs so you are always drawing in isometric mode, of course. To explain it, we need to introduce the idea of planes, so here is a short introduction to the plane concept.

In isometric drawing, you are always drawing in one of three available planes: top, right, or left (see Fig. 20.2). Because you are using a 2D pointing device (a mouse), which exists only in a 2D world, you need to be able to easily move from one plane to the other to be able to draw on it. To toggle between planes, press the F5 key. Your crosshairs line up accordingly, and now you just draw using the line command. Here is one final rule: You almost always have Ortho on while in isometric mode; otherwise, the lines are not straight and rotating them 30° is meaningless. Let us put it all together and draw an isometric box. After you are able to do this, more advanced isometric drawings are surprisingly easy.

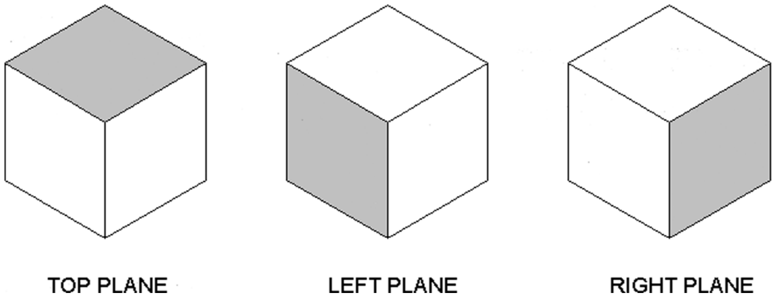


FIGURE 20.2 Isometric planes.

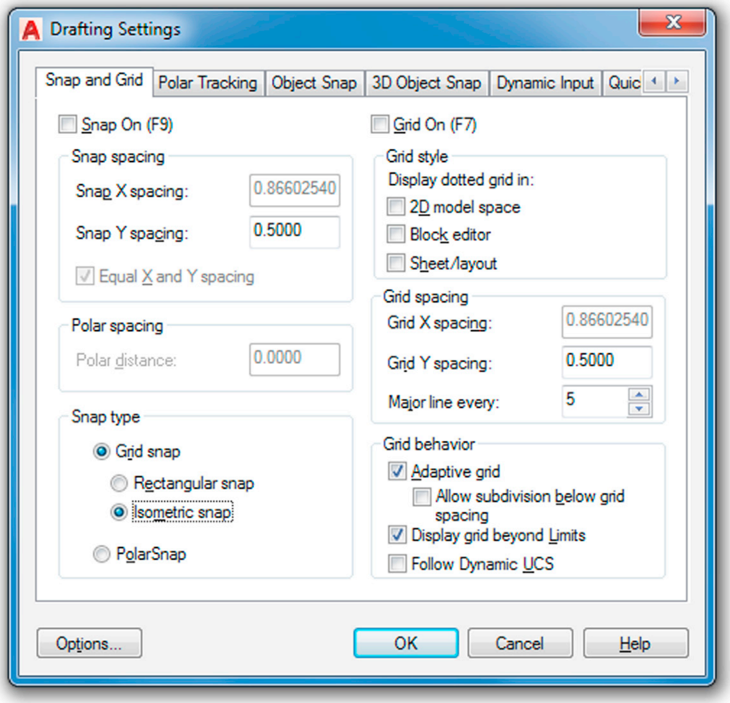


FIGURE 20.3 Drafting Settings with Isometric snap selected.

Step 1. Open a blank file.

Step 2. From the cascading menu select Tools→Drafting Settings…, and the dialog box seen in Fig. 20.3 appears.

Step 3. Pick the Snap and Grid tab, go to the Snap type category (lower left), pick Isometric snap, and press OK. Fig. 20.3 is a screen shot of the Drafting Settings dialog box with Isometric snap selected.

Step 4. Make sure Ortho is activated and the crosshairs are set at 100% for easier visualization of planes. Notice also how the crosshairs are positioned now that you are in isometric mode.

Step 5. Draw straight lines (as they should be with Ortho) of any size and continue drawing until you have the front face of a box. Very important: Do not try to connect the final line to the first line; you will never get it exactly right. Instead overshoot and click after passing it by, as shown in Fig. 20.4.

Step 6. Now, use the fillet command to fillet the line between Clicks 4 and 5 and Clicks 1 and 2. Fig. 20.5 shows the result.

Step 7. Now, press F5. The crosshairs shift to another plane and you can draw another surface.

Step 8. You can press F5 again for the final surface or use the copy command. Be sure to use the ENDpoint OSNAP to cleanly connect lines. Fig. 20.6 shows what you get after a few lines.

Step 9. And the final result, after a few more lines, is seen in Fig. 20.7.

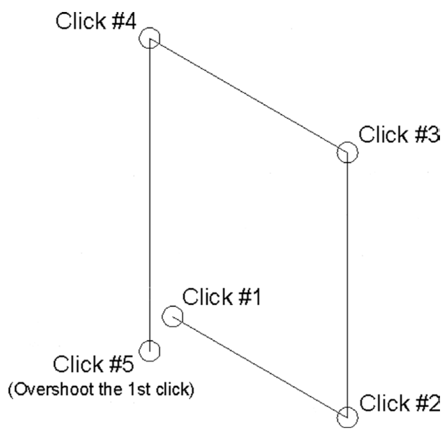


FIGURE 20.4 Isometric drawing, Step 5.

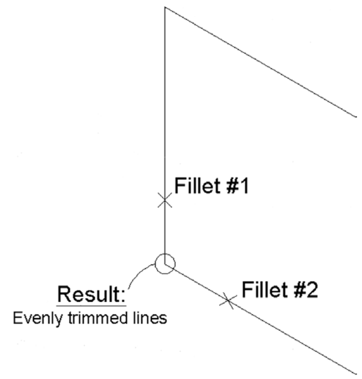


FIGURE 20.5 Isometric drawing, Step 6.

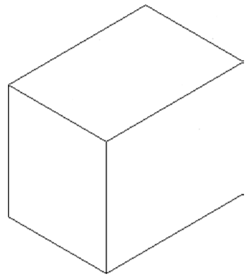


FIGURE 20.6 Isometric drawing, Step 8.

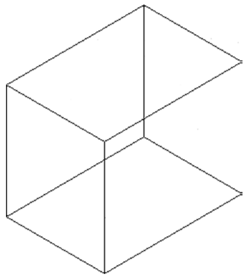


FIGURE 20.7 Isometric drawing, Step 9.

What makes isometric drawing easy is that the techniques do not change for more complex objects. There may be more lines, but it is the same thing over and over.

Here are some additional pointers:

- To draw circles in isometric perspective use ellipses. This command is introduced in Chapter 2, AutoCAD Fundamentals—Part II and used to make the bathtub in the apartment drawing at the end of Chapter 4, Text, Mtext, Editing, and Style. We say a few more words about using ellipses in isometric design next.
- Always stay in Ortho mode unless you need to deliberately angle a line at some odd angle (see Exercise 3 at the end of this chapter for an example of this.)
- Text can be angled up or down by 30° to align with the Isoplanes. We discuss this shortly.
- Have fun with this. Isometric drawing is a semi-artistic endeavor and not as rigid as drafting. Eyeball distances but try to make the drawing look good. Do not be afraid to throw in some hatch patterns, as is done in some of the practice exercises in this chapter. Remember though, if you need more precision, you have to go to the real 3D in Chapter 21, 3D Basics.

20.3 ELLIPSES IN ISOMETRIC DRAWING

A circle angled away from you is an ellipse. These shapes find wide application in isometric drawing, and you will need to use them often in the end-of-chapter exercises.

There is no surefire way to create the perfect ellipse; it always requires a bit of adjusting to get right and a bit of a creative eye to do so. Reproducing what was first shown in Chapter 2, AutoCAD Fundamentals—Part II, we have Fig. 20.8.

Once the ellipse is positioned and is the right size, you can rotate it until it looks correct and in the same plane as the rest of the isometric geometry. Fig. 20.9 is an example of some ellipses in an isometric box.

20.4 TEXT AND DIMENSIONS IN ISOMETRIC DRAWING

Text can easily be physically aligned with Isoplanes by rotating it plus or minus 30°, or other values depending on the plane, as shown in Fig. 20.10. There is, however, another, arguably better, way to create isometric text for two of those three planes, by applying an oblique angle to it as described next.

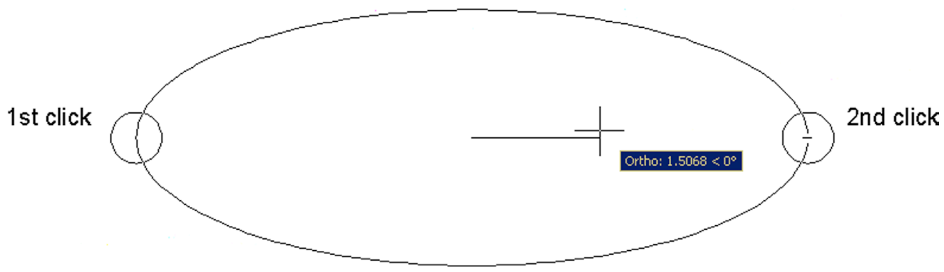


FIGURE 20.8 Basic ellipse.

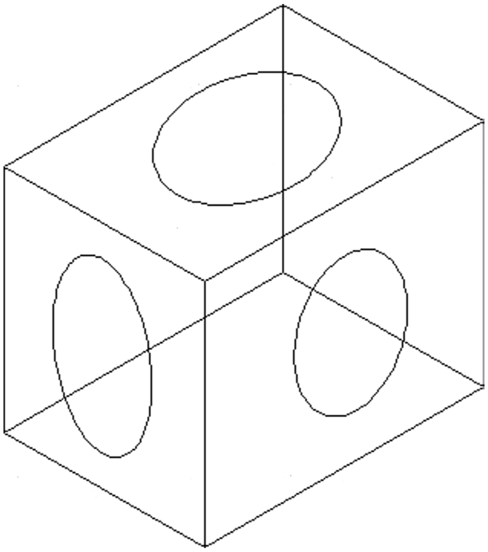


FIGURE 20.9 Isometric box with ellipse.

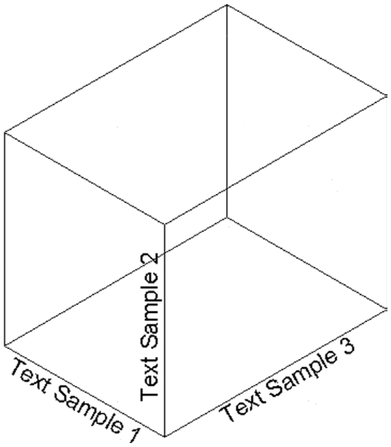


FIGURE 20.10 Text in isometric drawing—rotation.

Go to the Text Style dialog box and create a new style, called `Oblique-Right`, with an oblique angle of 30°, as seen in Fig. 20.11. Size your text height as needed for your particular isometric design. When done, press Apply, Set Current, and Close.

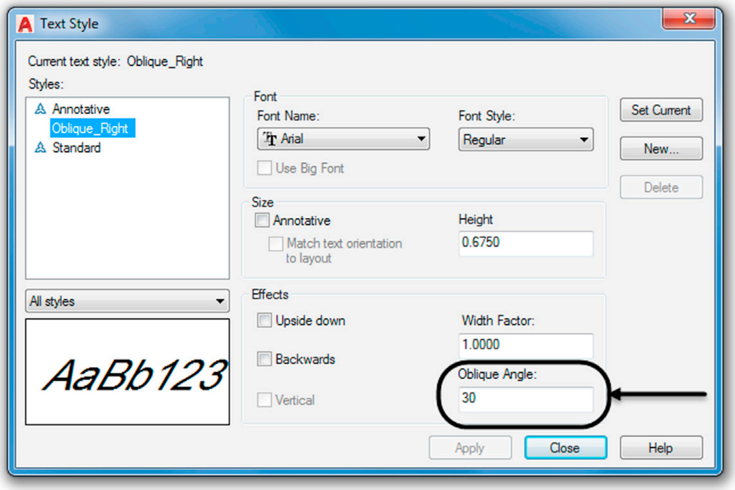


FIGURE 20.11 Setting the `Oblique-Right` text style.

Go ahead now and rewrite the same text at the bottom of the isometric box as seen in Fig. 20.12. Just as before, make sure its rotated 30°. Notice now how the new oblique text leans "in plane" with the box. A lot of designers prefer this approach as opposed to just pure rotation.

You can also do this with the opposite plane by creating an `Oblique-Left` text font and leaning it negative 30°. The final result is seen in Fig. 20.13. For the straight vertical text (`Text Sample 2` in Fig. 20.10), no obliqueness is needed of course, as it is pointing straight up and can be left as is.

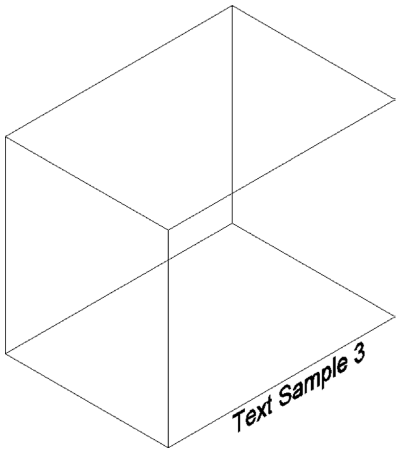


FIGURE 20.12 `Oblique-Right` text style.

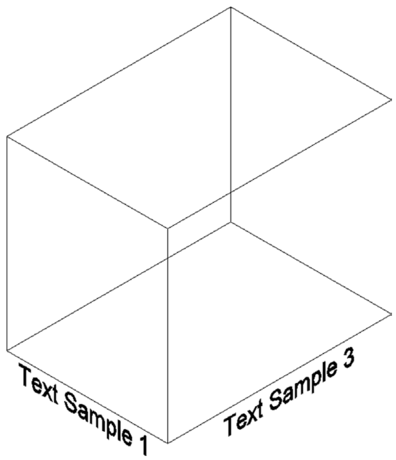


FIGURE 20.13 `Oblique-Left` text style added.

You can also easily dimension an isometric drawing, using Aligned and Vertical dimensions, as seen in Fig. 20.14. There is unfortunately no way to oblique extension lines to match the design (unless you explode the dimensions and do it manually—never a good idea). You can oblique the dimension text inside the dimension via the previously described methods if needed.

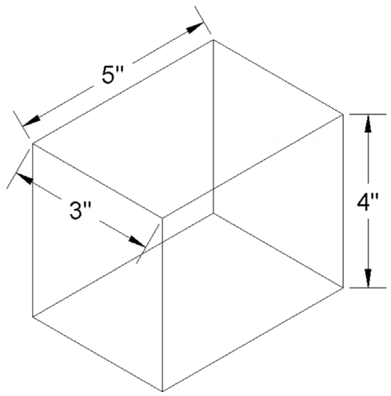


FIGURE 20.14 Dimensions in isometric drawing.

20.5 LEVEL 2 DRAWING PROJECT (10 OF 10): ARCHITECTURAL FLOOR PLAN

For Part 10 of the drawing project, you completely finish the design by adding the Paper Space layouts. You need to put together a lot of techniques you learned in Levels 1 and 2.

Step 1. In Paper Space, create the following seven layouts:

- Architectural layout.
- Furniture layout.
- Carpeting layout.
- Electrical Layout.
- RCP_HVAC layout.
- Landscaping layout.
- Elevations.

Step 2. Insert a title block into each Paper Space layout. Label the title block as appropriate for that layout. Make sure all the attribute fields are filled in and page numbers are incremented.

Step 3. Create an mview window for each layout (VP layer, color: white), centering and zooming each layout to the proper scale using the techniques you learned in Chapter 10, Advanced Output—Paper Space. The scale will be either ¼″, ⅜″, or not to scale. Freeze the VP layer when you are done with each of the layouts.

Step 4. In each layout, use advanced layer settings to freeze all layers that are not necessary for that particular view. You will likely need to create as many layer settings as there are Paper Space layouts, as each one shows something different.

Step 5. Add labels and any other title block information you may need.

Step 6. If your computer is connected to a printer or plotter, plot out all of the layouts on D-sized paper. Make sure all of the following are addressed:

- Paper Space layouts are correct.
- Proper scale is used in each mview window.
- Proper layers show in each mview window.
- The title block is correct for each layout.
- The CTB file is correct and there are varying lineweights.

All the layout plans are shown in Figs. 20.15–20.21.

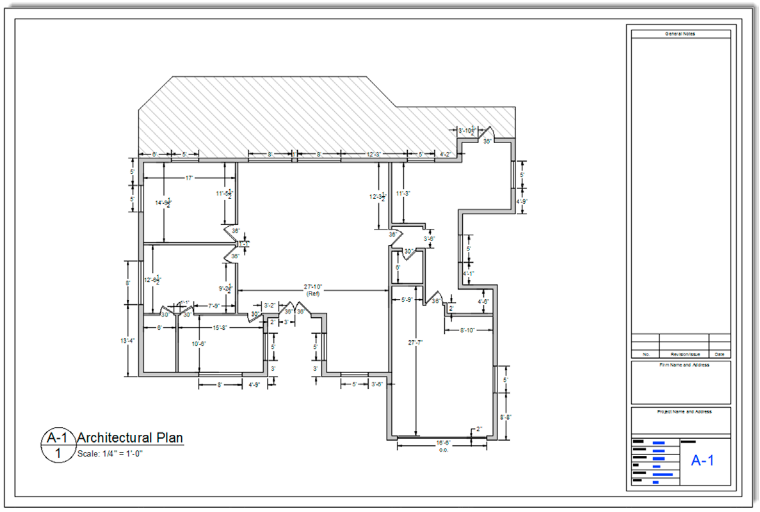


FIGURE 20.15 Architectural plan.

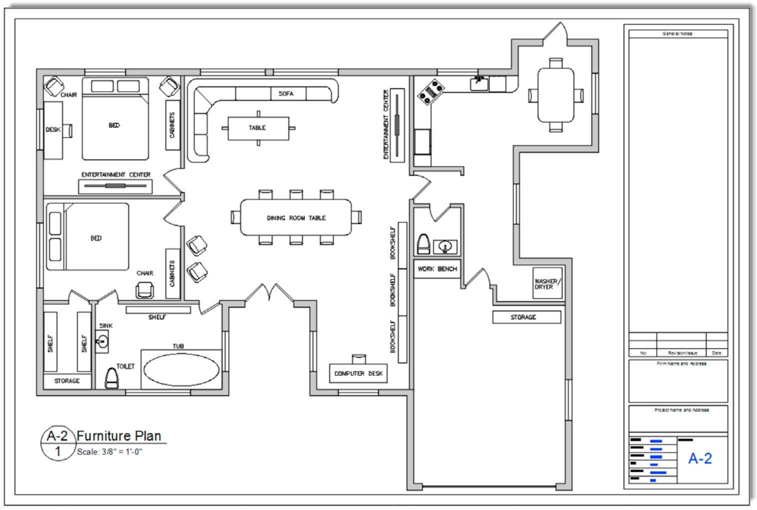


FIGURE 20.16 Furniture plan.

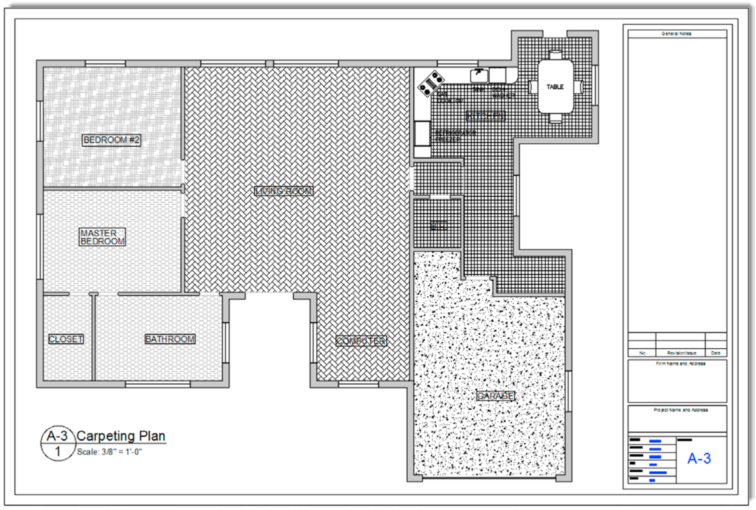


FIGURE 20.17 Carpeting plan.

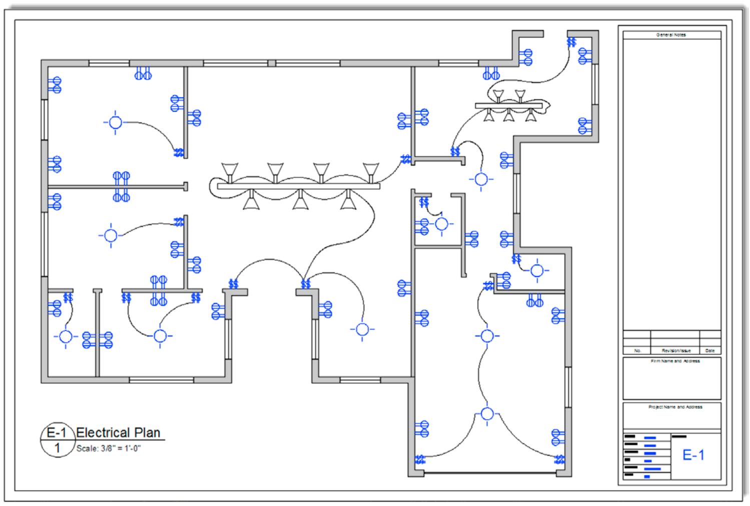


FIGURE 20.18 Electrical plan.

FIGURE 20.19 RCP_HVAC plan.

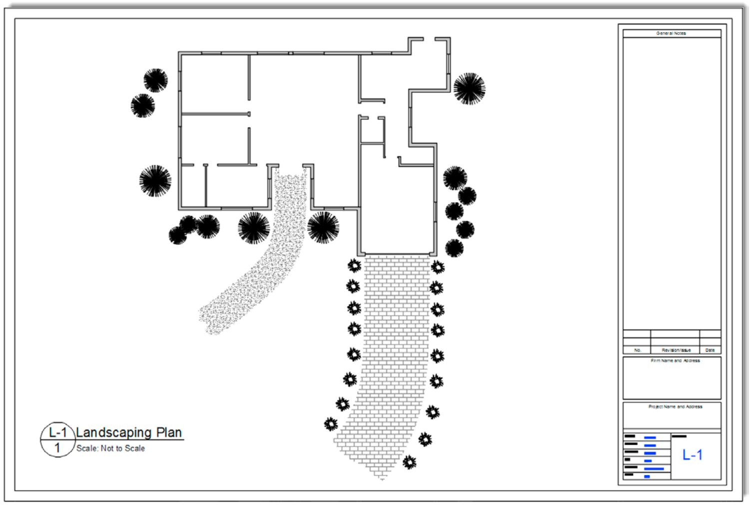


FIGURE 20.20 Landscaping plan.

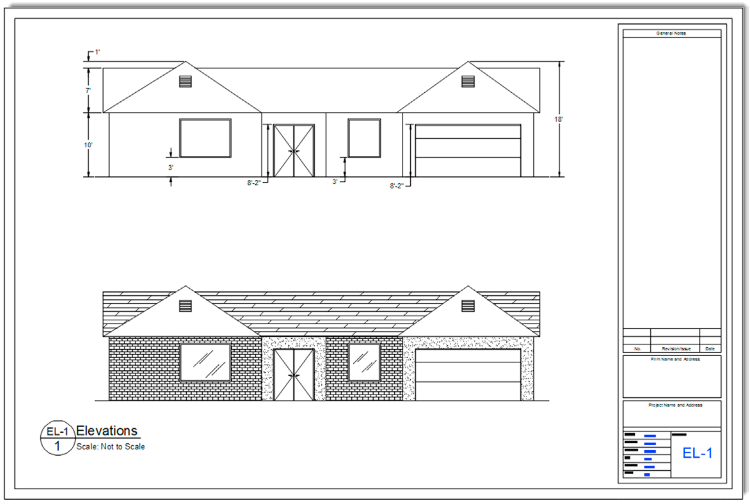


FIGURE 20.21 Elevations.

20.6 SUMMARY

You should understand and know how to use the following concepts at the conclusion of this chapter:

- Isometric drawing
  - What is it?
  - When to use it
  - When not to use it
  - Isometric settings
- Planes
  - What are the three planes?
  - Switching between them (F5)
- Ellipses in isometric drawing
- Text and dimensions in isometric drawing

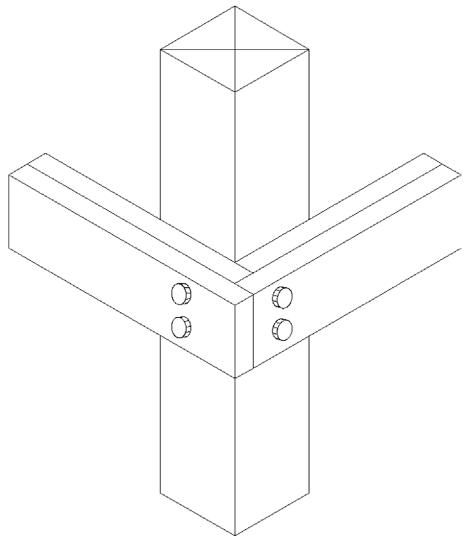
Review Questions

Answer the following based on what you learned in this chapter:

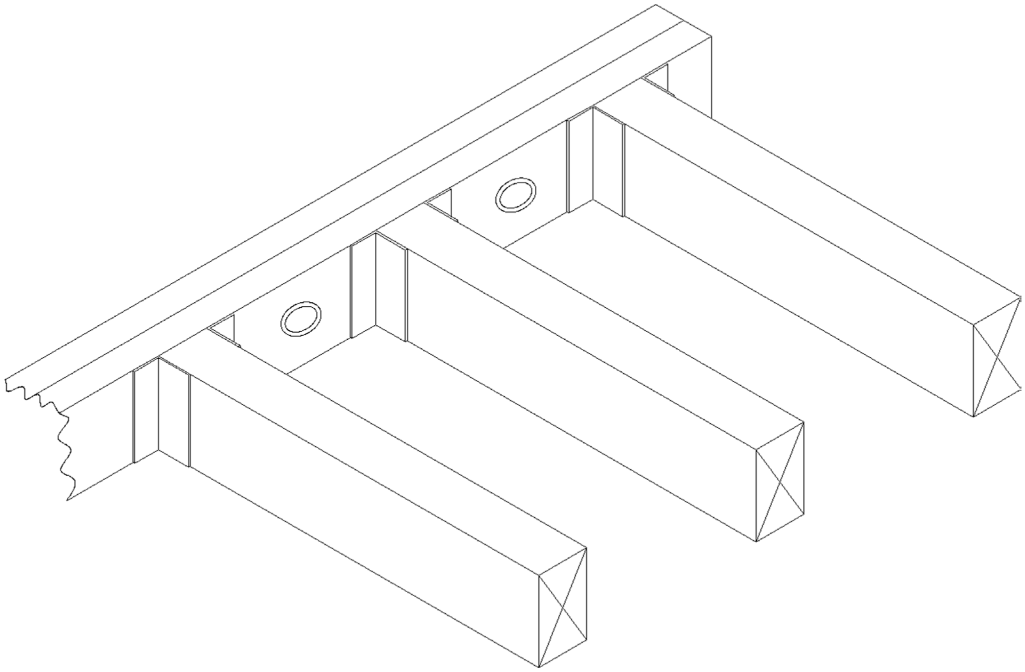
1. List some instances when isometric drawing is appropriate.
2. List some instances where 3D would be better than isometric drawing.
3. Name the three planes that exist in isometric perspective.
4. In what dialog box is Isometric snap found?
5. What F-key switches the cursor from plane to plane?
6. What is almost always on when drawing in isometric?
7. What is the equivalent of a circle in isometric drawing?

Exercises

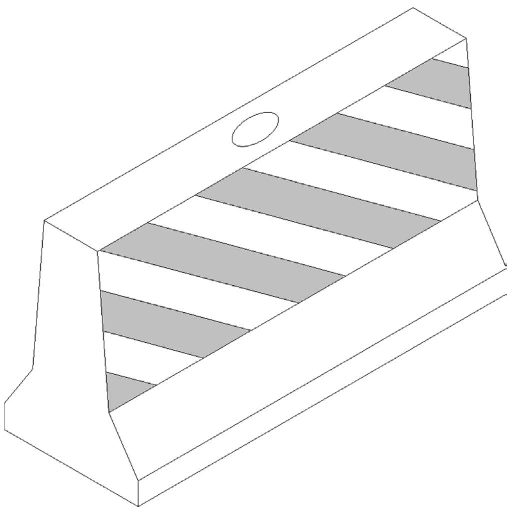
1. Draw the following architectural detail. All sizes are approximate and may be estimated. You will need to cycle through all three Isoplanes for the main structure, and use ellipses for the fasteners. (Difficulty level: Easy; Time to completion: 10–15 minutes.)



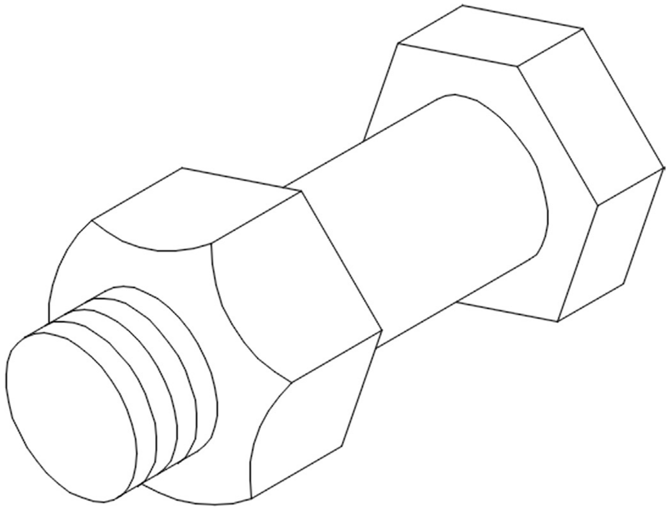
2. Draw the following architectural detail. All sizes are approximate and may be estimated. You will need to cycle through all three Isoplanes for the main structure, use ellipses for the fasteners and a spline for the cutaway. (Difficulty level: Easy; Time to completion: 10–15 minutes.)



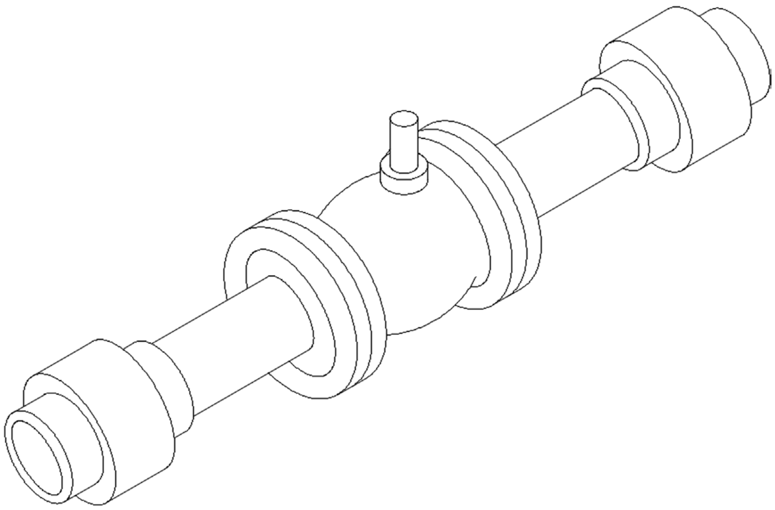
3. Draw the following detail of a concrete barrier. All sizes are approximate and may be estimated. You will need to cycle through all three Isoplanes for the main structure, and use one ellipse. Be aware also that, for certain lines, you will break from the Isoplanes and draw freehand. As a final step, add solid hatching as shown. (Difficulty level: Easy; Time to completion: 10–15 minutes.)



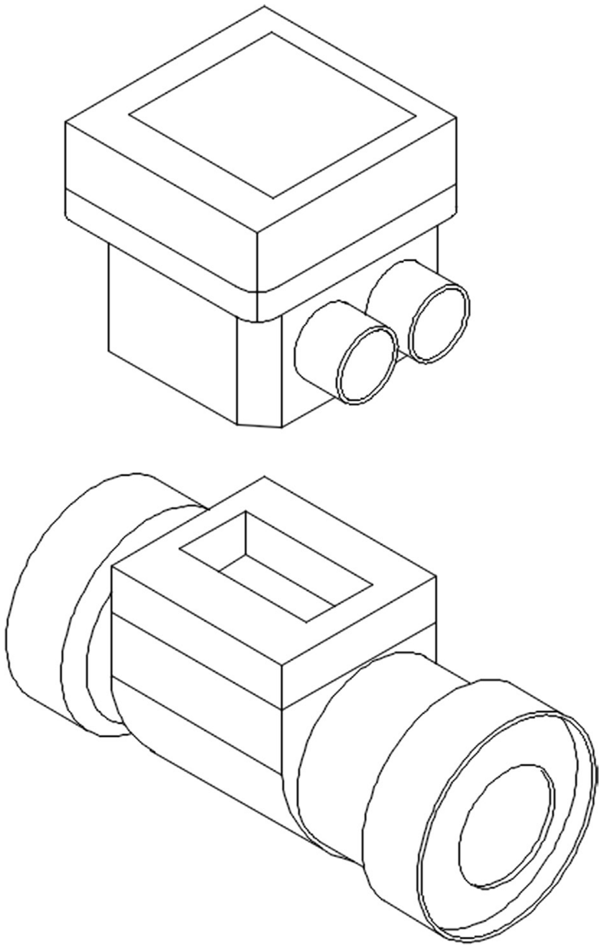
4. Draw the following detail of a nut and bolt. All sizes are approximate and may be estimated. There is more emphasis here on freehand drawing (including using arcs) after some basic Isoplanes linework is established. There is also more usage of ellipses and partial ellipses, which need to be trimmed as necessary. (Difficulty level: Easy; Time to completion: 10–15 minutes.)



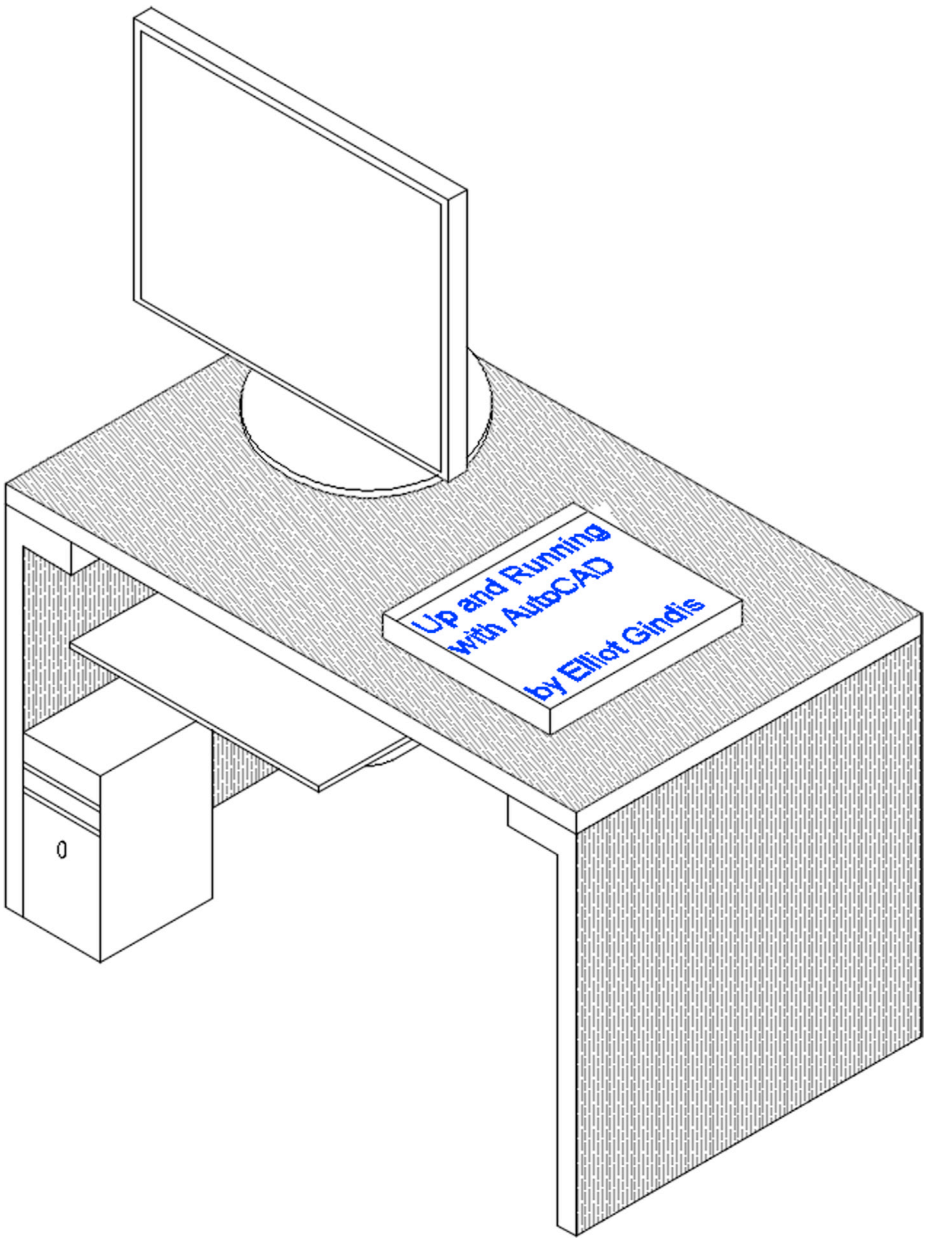
5. Draw the following valve/piping detail. All sizes are approximate and may be estimated. There is more usage of ellipses and partial ellipses, which need to be trimmed as necessary. (Difficulty level: Intermediate; Time to completion: 15–20 minutes.)



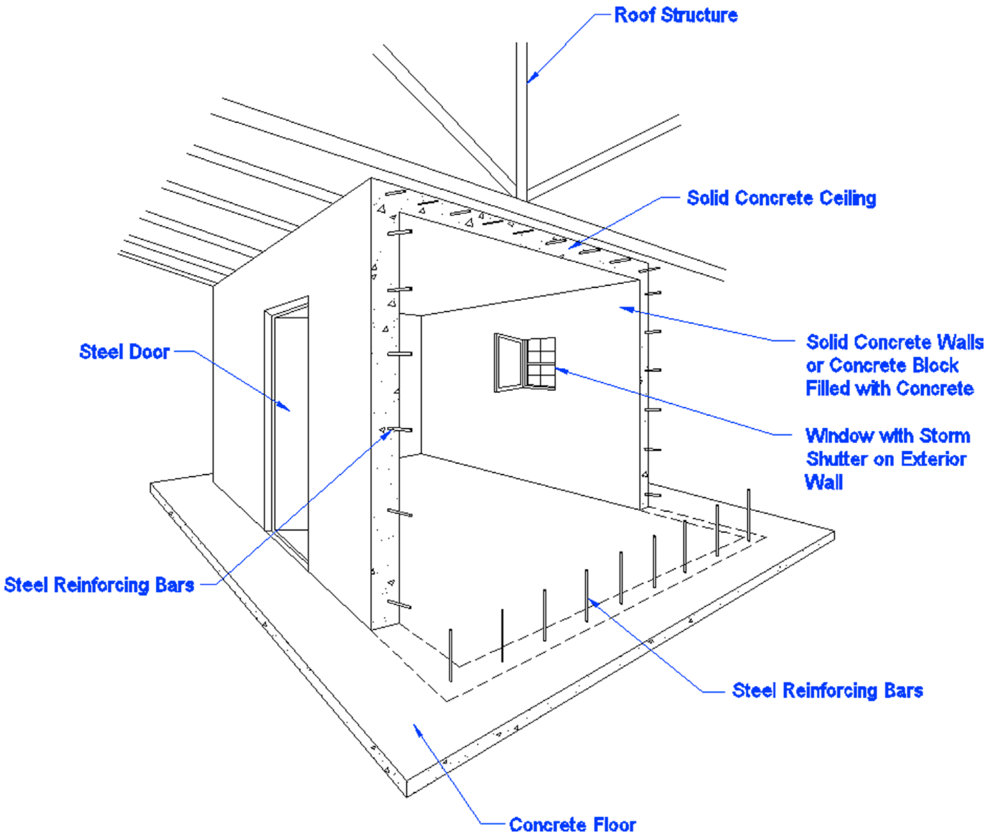
6. Draw the following piping detail. All sizes are approximate and may be estimated. This exercise is similar to the previous two in its usage of ellipses and partial ellipses, which need to be trimmed as necessary. (Difficulty level: Intermediate; Time to completion: 15–20 minutes.)



7. Draw the following computer desk. All sizes are approximate and may be estimated. You will need to cycle through all three Isoplanes for the main structure and use ellipses for a few elements. Add text and hatching as shown. (Difficulty level: Moderate; Time to completion: 20–25 minutes.)



8. Draw the following architectural room detail. This exercise features not only isometric but also a perspective view, where the design converges to a "vanishing point" toward the back. Here, there is little Isoplanes work and quite a bit of improvising and freehand drawing, as isometric does not allow for perspective views. These types of layouts are not very common but still can be encountered in design work. They offer a very dynamic and interesting way to present an idea. A certain amount of artistic license is allowed, so do improvise. Note the various nuances in the design, such as slight rotation of the steel reinforcing bars in the side walls. Add in hatch and text as shown for the final step. (Difficulty level: Advanced; Time to completion: 60–90 minutes.)



Level 2

Answers to Review Questions

CHAPTER 11 REVIEW QUESTIONS

1. What are the two major properties a *pline* has and a line does not?
   Property 1: A pline's segments are joined together. Property 2: A pline can have thickness.
2. What is the key command to add *thickness* to a pline?
   Pedit.
3. What is the key command to create a *pline* out of regular lines?
   Pedit.
4. What option gives the pline *curvature*? What option undoes the curvature?
   Spline option. Decurve option.
5. What two major things happen when you *explode* a pline?
   It loses its thickness and is split into segments.
6. What other *options* for pline were mentioned?
   Making a pline with variable thickness, adding an arc, and various other vertex options.
7. What is the bpoly command?
   Bpoly creates a pline border on top of a group of ordinary lines forming a closed area. You need to select a point in the enclosed area to accomplish this.
8. Define an *xline* and specify a unique property it has.
   An xline is a continuous line that has no beginning or end.
9. How is a ray the same and how is it different from an xline?
   A ray has no end, just like an xline, but it does have a beginning, unlike an xline.
10. Describe a *spline* and list its advantages.
    A spline is a NURBS curve and is used to create organic curvature, something that cannot be done any other way.
11. List some uses for a spline in a drawing situation.
    Gradient lines, cables, electrical wires, pathways, landscaping, for example.
12. What is an mline? List some uses.
    An mline is a multiline. It can be used for everything from architectural walls to highway design.
13. What are some of the items likely to be changed using *mlstyle*?
    Number of lines making up the mline, distances between those lines, linetypes making up the lines, colors of the lines and fills, end caps, and other details.
14. What are some of the uses of *mledit*?
    Mainly to edit intersections that are made using mlines; also to create vertexes and make cuts in mlines.
15. Describe the s*ketch* command. What is a *record increment*? What size is best?
    The sketch command allows you to draw freehand. A record increment is the smallest size piece of line that makes up the sketch pathway; .01 is an optimal size.
16. Describe the basic function of a Geometric Center OSNAP point
    The Geometric Center OSNAP allows you to snap from/to the center (centroid) of complex closed shapes.

CHAPTER 12 REVIEW QUESTIONS

1. Describe what is meant by *layer management*. Why is it needed?
Layer management describes a set of tools and concepts that, taken together, manage a large amount of layers, so they can be grouped together under some common theme and controlled as one unit (frozen, locked, etc.).
2. Describe the basic premise of a *script*.
A script automates a series of input commands and saves the process under a name so it can be recalled and put to use automating a repetitive task.
3. What can a *script file* do for layer management?
A script file can freeze and thaw a large amount of layers by simply executing the script. This was the original way to do layer management.
4. Describe what *Layer State Manager* does.
It saves layer settings under a descriptive name, so this setting can be recalled to easily freeze and thaw (among other actions) large amounts of layers all at once.
5. What are the fundamental steps in using *Layer State Manager*?
Once the layers are set up as desired, the setting is saved in the LSM.
6. What is *layer filtering*? What are the two types?
Layer filtering sorts layers based on common traits (such as color or names), so they can all be worked with at once. Property filter and Group filter.

CHAPTER 13 REVIEW QUESTIONS

1. Describe the important features found under the *Lines* tab.
Nothing critical is found here, but the colors of the dimension and extension lines are changed.
2. Describe the important features found under the *Symbols and Arrows* tab.
Here, the arrowheads are changed to an architectural tick.
3. Describe the important features found under the *Text* tab.
Here, the text style and color are changed, with a box added around the text.
4. Describe the important features found under the *Fit* tab.
Here, the most important feature is the setting of the overall scale.
5. Describe the important features found under the *Primary Units* tab.
Here, everything under Linear dimensions, Zero suppression, and Angular dimensions is discussed.
6. Describe the important features found under the *Alternate Units* tab.
Here, the approach to setting alternate units is discussed, including Zero suppression and placement.
7. Describe the important features found under the *Tolerances* tab.
The types of tolerances are covered.
8. Describe the purpose of *geometric constraints*.
To constrain the positioning of drawn geometry.
9. What seven *geometric constraints* are discussed?
Perpendicular, parallel, horizontal, vertical, concentric, tangent, and coincident.
10. Describe the purpose of *dimensional constraints*.
To constrain the sizing of drawn dimensions and the geometry they represent.
11. What six *dimensional constraints* are discussed?
Horizontal, vertical, aligned, radius, diameter, and angle.

CHAPTER 14 REVIEW QUESTIONS

1. What is important under the *Files* tab?
It is recommended that nothing be changed under this tab.
2. What is important under the *Display* tab?
Here, you can turn off some unnecessary screen tools like scroll bars; change the background colors of the screen, command line, and other features; clean up the Paper Space layouts; and change the crosshair size.
3. What is important under the *Open and Save* tab?
Here, you can save a drawing down to an older release of AutoCAD, delete Automatic save and backup files, and set security options.

4. What is important under the *Plot and Publish* tab?
   Here, you can set and modify plot stamp settings.
5. What is important under the *System* tab?
   It is recommended that nothing be changed under this tab.
6. What is important under the *User Preferences* tab?
   Here, you can set right-click customization.
7. What is important under the *Drafting* tab?
   Here, you can modify the look of the AutoSnap and Aperture boxes.
8. What is important under the *Selection* tab?
   Here, you can modify the pickbox and grip size as well as set the visual effects settings.
9. What is important under the *Profiles* tab?
   Here, you can save your settings and preferences under a name for future recall.
10. What is the `pgp` file? How do you access it?
    The `pgp` file holds AutoCAD shortcuts. It can be accessed via Tools→Customize→Edit Program Parameters (acad.pgp) in the drop-down menus.
11. Describe the overall purpose of the *CUI*.
    The Customize User Interface is used to modify the AutoCAD environment with changes to toolbars, palettes, shortcuts, macros, and much more.
12. Describe the purpose of the *Design Center*.
    The Design Center is useful for bringing entities such as layers and blocks into a drawing from another location as well as downloading symbol library blocks from the Autodesk Seek website.
13. Describe the important *Express Tools* that are covered.
    Some of the more useful Express Tools include Copy Nested Objects, Explode Attributes to Text, Convert Text to Mtext, Arc-Aligned Text, Enclose Text with Object, Delete Duplicate Objects, Flatten Objects, Break Line Symbol, Super Hatch, Convert PLT to DWG, and Layer Express Tools such as `layfrz`, `layiso`, and `laywalk`.

CHAPTER 15 REVIEW QUESTIONS

1. What are the purposes of the *audit* and *recover* commands? What is the difference?
   Both commands are used to check up on the integrity of an AutoCAD drawing in cases of errors or a drawing not opening. Audit is the lower-level check for a drawing that is already opened but not running right. Recover is a higher-level check and may be used to try to open a corrupted drawing.
2. For *join* to work, lines have to be what?
   They have to be coplanar.
3. The *Defpoints* layer appears when you create what?
   Dimensions.
4. Does the *divide* command actually cut an object into pieces?
   No, it only inserts points to create sections, but the object is still intact.
5. What is the idea behind *eTransmit*?
   The eTransmit command allows you to send a drawing via email along with all associated fonts, linetypes, xrefs, and so on.
6. To what can you attach a *hyperlink*? What can you call up using a hyperlink? How do you activate a hyperlink?
   To an object or text. Either a website or a document. Hold down Ctrl and click.
7. What is the idea behind *overkill*?
   Overkill allows you to remove multiple stacked lines.
8. Can you make a *revcloud* out of a rectangle? A circle?
   Yes, via the Object option.
9. What three new *selection methods* are discussed?
   Window polygon, Crossing polygon, and Fence.
10. Do you use a Crossing or a Window with the *stretch* command?
    A Crossing.
11. Name a system variable mentioned as an example.
    Mirrtext.
12. Explain the importance of the *wipeout* command. What does it add to the drawing?
    The wipeout command hides objects by covering them up. It can be used to add depth to a drawing.

CHAPTER 16 REVIEW QUESTIONS

1. What is the correct way to bring *Word* text into AutoCAD?
   Paste copied text from Word into mtext.
2. What is the procedure for bringing *AutoCAD* drawings into Word?
   For most applications, a Copy/Paste suffices. PrtScn can be used as well.
3. What is the correct way to bring *Excel* data into AutoCAD?
   Copy/Paste into an OLE.
4. What is the procedure for bringing AutoCAD drawings into *PowerPoint*?
   Copy/Paste or PrtScn works.
5. What is the procedure for importing JPGs and generating PDFs?
   The JPGs can be Copied/Pasted in, then adjusted. To generate a PDF, select it as the output printer or via the Ribbons output tab.

CHAPTER 17 REVIEW QUESTIONS

1. What are several *benefits* of xref?
   Reduce file size by attaching a core drawing to multiple files, critical file security, and automated design change updates to core drawings.
2. How is an xref different from a block?
   An xref is attached to a drawing and is never truly a part of it. A block is inserted into a drawing and becomes part of it.
3. How do you *attach* an xref?
   Xref command, browse for the xref file, specify insertion point, and then OK.
4. How do you *detach*, *reload*, and *bind* an xref?
   By opening up a menu via a right-click on the drawing name in the xref palette.
5. What do *layers* in an xrefed drawing look like?
   They are preceded by the name of the xref itself.
6. What do layers look like once you bind the xref?
   They contain a `$0$` in the name.
7. What are some *nesting* options for xref?
   One xref attached to another then to another (etc.) and then to the main drawing or all attached to one drawing simultaneously.

CHAPTER 18 REVIEW QUESTIONS

1. What is an *attribute* and how do you create one?
   An attribute is information inside of a block. To create one, you use the `attdef` command and fill in the required fields.
2. How do you *edit* attributes?
   Double-click on the attribute.
3. How do you *extract data* from attributes? Into what form?
   Data extraction is via the `eattext` command. It can be extracted into an Excel spreadsheet or an AutoCAD table.
4. How do you create an *invisible* attribute? Why can this be important?
   By checking off the invisible button during the initial creation of the attribute. This is important so that the information is not visible in the drawing but can still be used.

CHAPTER 19 REVIEW QUESTIONS

1. What is a CTB file?
   This is the file that stores information on line thickness and other settings.
2. Describe the process of *setting up* a CTB file.
   You do this through a multipage Add Plot Style dialog box.
3. What is *screening*?
   Screening fades the intensity of any color.
4. What is the effect of Lineweight Settings?
   All lines that are made thicker via this option will appear as such on the screen.

CHAPTER 20 REVIEW QUESTIONS

1. List some instances when isometric drawing is *appropriate*.
If you do not yet have 3D skills or need only a quick and simple 3D-looking model. Also, if computing resources are limited or you do not want to spend time combining 2D and 3D.

2. List some instances where 3D would be better than isometric drawing.
In any instances where a true 3D model is needed to convey the design intent, including for purposes of shading and rendering. Also when more accuracy is needed.

3. Name the three planes that exist in isometric perspective.
Top, left, and right.

4. In what dialog box is *Isometric snap* found?
`ddosnap`, Snap and Grid tab.

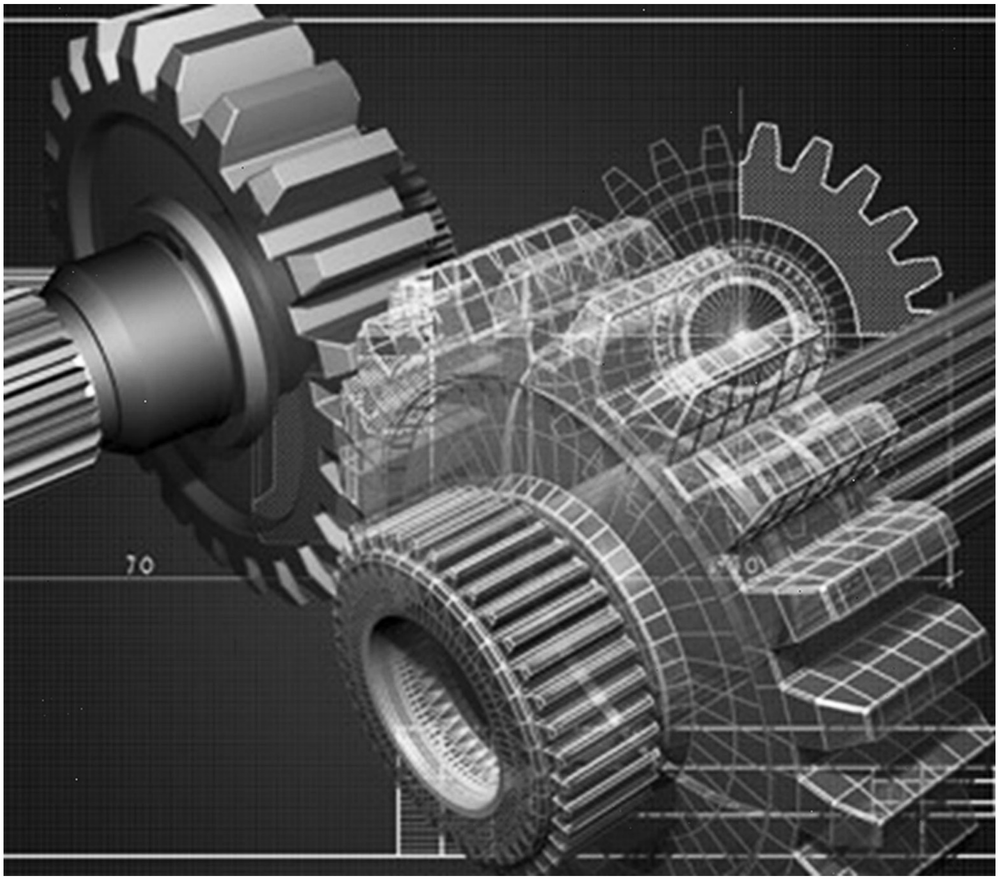
5. What *F key* switches the cursor from plane to plane?
F5.

6. What is almost always on when drawing in isometric?
Ortho.

7. What is the equivalent of a circle in isometric drawing?
Ellipse.

Level 3

Chapters 21–30



Welcome to the fascinating world of 3D computer-aided design. Ideally, you have completely mastered everything in Levels 1 and 2 and are ready to learn a new set of skills. Although 3D is a different world in AutoCAD, it builds on what you learned in 2D; really what we are doing is just adding another dimension (literally).

The world of 3D has come a long way in AutoCAD. From humble beginnings in the 1980s (which left users joking that it is not really 3D but 2.5D), through steady improvements in the 1990s, to a major retooling with release 2007, AutoCAD's 3D capabilities have grown exponentially, and it is now quite capable 3D software.

Note however that AutoCAD still does not do engineering modeling and analysis and cannot compete with CATIA, SolidWorks, SolidEdge, Pro/Engineer (Creo), NX, Inventor, and others, nor was it ever designed to. At its heart AutoCAD is still *drafting* software first and foremost and is *not* meant for complex modeling and simulation. Autodesk has other products, such as Inventor and Revit, which venture into the world of parametric modeling, while AutoCAD is firmly in the world of drafting and visualization. If you need to test a design for structural failure or send the geometry to a CNC mill for manufacturing, AutoCAD is not the software for this.

This, of course, is just fine for thousands of architects and engineers worldwide who use AutoCAD's 3D capabilities for visualization and create superb 3D designs. Some typical uses include 3D architectural models of residential and commercial interiors and exteriors, furniture design, small part design, electrical riser equipment diagrams, and other applications that require a 3D view of the object(s) to visualize, promote, display, and sell the design or concept. Often, these models are exported to specialized rendering software, such as 3ds Max, Form-Z, or Rhino, to obtain photorealistic images. Creating these underlying models is what we focus on here.

Our study of 3D is loosely broken into three major sections. The first part, which starts with Chapter 21, 3D Basics, is an introduction to the basics. We cover all the fundamental tools needed to create what can be referred to as *flat design*, meaning objects without major curvature. This broadly refers to architectural models, such as simple 3D floor plans that feature walls, door, windows, and furniture. For the most part, these are elements that feature essentially straight edges. We learn basic tools like Extrusion, 3D Rotate, 3D Mirror, and Booleans.

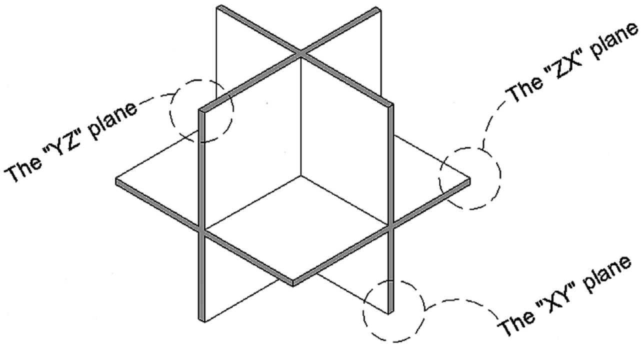
The second part is an extension of this knowledge into what can be thought of as *curved design*, meaning objects with curvature. This broadly refers to mechanical models, such as gears, shafts, bearings, springs, and shape-formed piping, to name a few examples. There is a great deal of overlap between architecture and mechanical design in terms of what is required of AutoCAD, of course, and you really need to learn everything regardless of what field you are in. Here, we cover tools such as Revolve, Loft, Shell, and Taper.

The third part is all about advanced tools, such as Sections, Vports, Meshes, Dynamic Views, Animations, Lighting, and Rendering, which round out your study of 3D and add realism in the form of lighting and shading as well as some rendering and backgrounds to your design.

A word of caution: Be sure to have truly mastered 2D before proceeding. All the 3D chapters are written with the assumption that you are an experienced 2D user, and few explanations are forthcoming when we use 2D tools to begin 3D projects, especially past Chapter 21, 3D Basics. Also, review isometric drawing (see chapter: Isometric Drawing). That seemingly unrelated topic is actually a precursor to 3D, as you will soon see, and you should go back and review it.

Chapter 21

3D Basics



Learning Objectives

In this chapter, we introduce the basics of 3D theory and operating in 3D space. Specific topics include the following:

- Axes, planes, and faces
- 3D workspace—Ribbon, toolbars, and options
- Entering and exiting 3D
- Projecting into 3D
- 3D dynamic views
- Extrude
- Visual styles—Hide, Realistic Shade, and Conceptual Shade
- ViewCube and Navigation Bar

By the end of this chapter, you will understand basic 3D theory and be able to navigate in and out of 3D, navigate inside 3D, as well as extrude, hide, and shade your designs.

Estimated time for completion of this chapter: 1.5 hours.

21.1 AXES, PLANES, AND FACES

So, what exactly does *drawing in 3D* mean? It is the ability to give depth to objects or to expand them into the "third dimension" from a flat plane. This concept should be intuitively obvious—after all, we live in a 3D world. Everything has not just a length and width but also a depth (or height).

It turns out that, as you were learning AutoCAD in Levels 1 and 2, you were in 3D all along. It is just that you did not see or use this vertical third dimension; therefore, everything appeared flat, similar to not seeing the height of a tall building if you are flying directly above it. All this changes as we discuss this hidden dimension and learn how to project into it. For this, we need to start at the very beginning and learn about axes, planes, and faces, because by definition, using the third dimension involves using a third, and previously ignored, Z axis.

Up and Running with AutoCAD 2017: 2D and 3D Drawing and Modeling. DOI: http://dx.doi.org/10.1016/B978-0-12-811058-4.00021-9