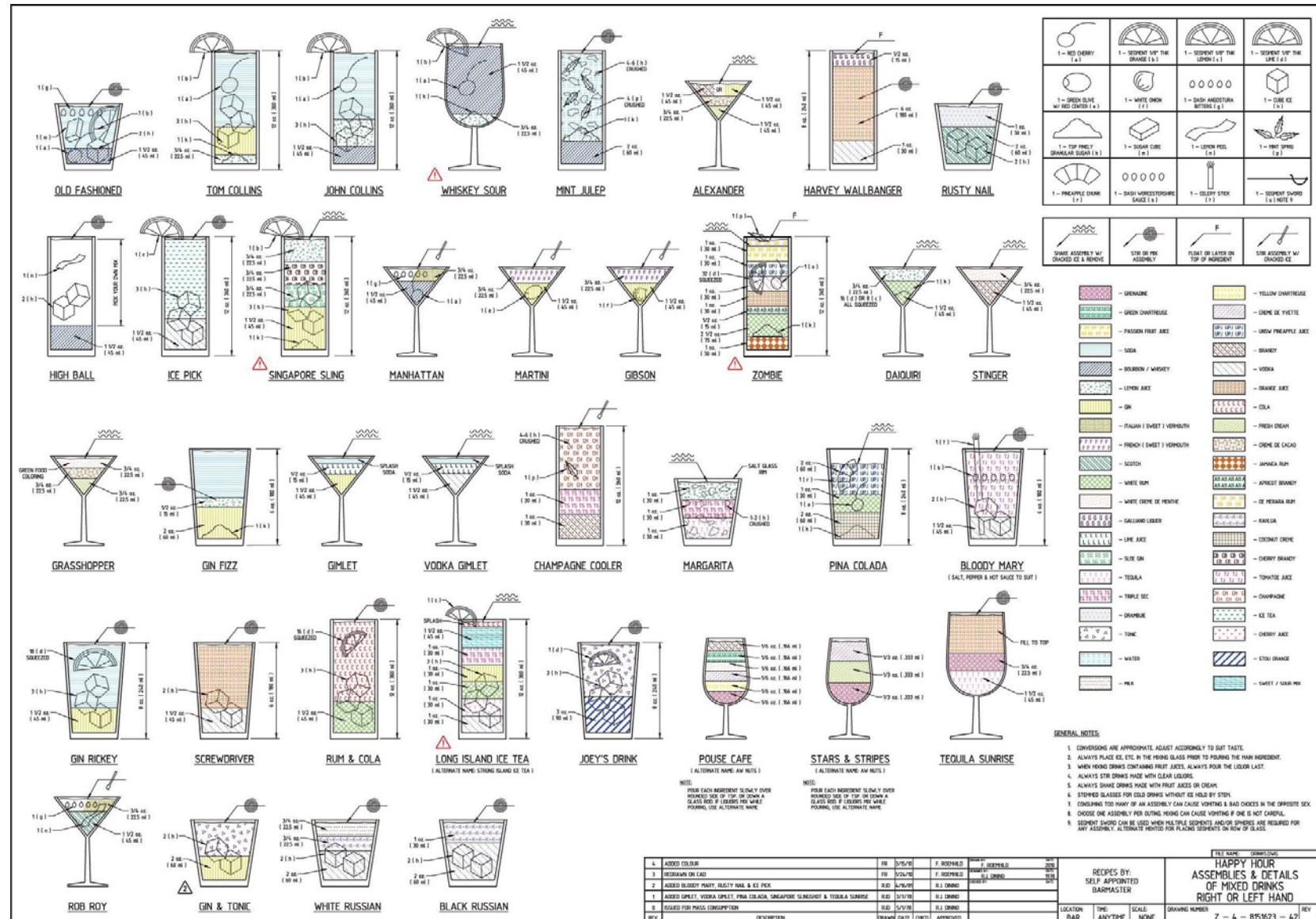




# Working with AutoCAD 2020



AUTODESK  
**AUTOCAD**  
**2020**



## Supplementary Reading List.

### Drawing:

Francis Ching (2015) *Architectural Graphics*

Chudley, Greeno, Merritt (2016) *Building Construction Handbook*

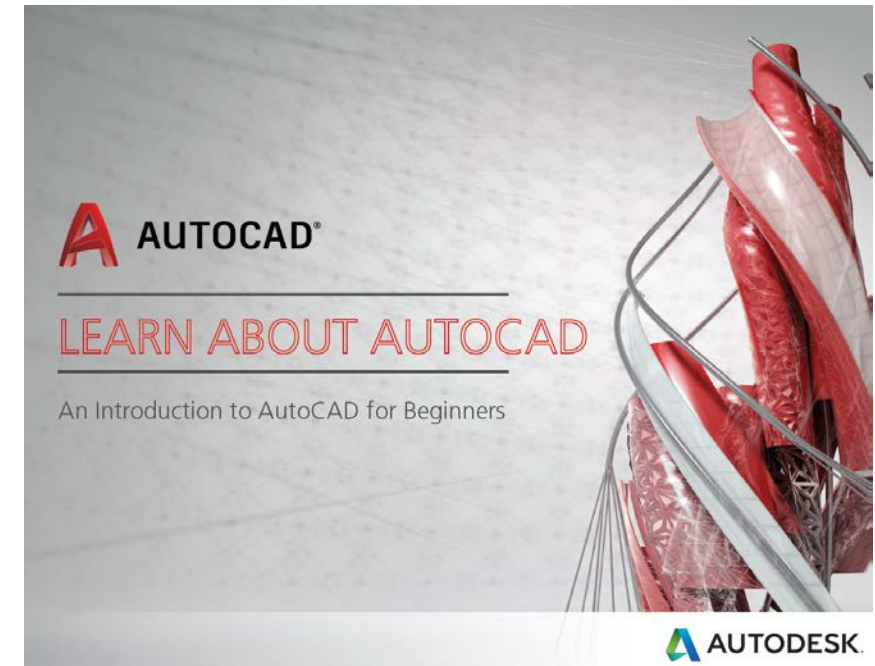
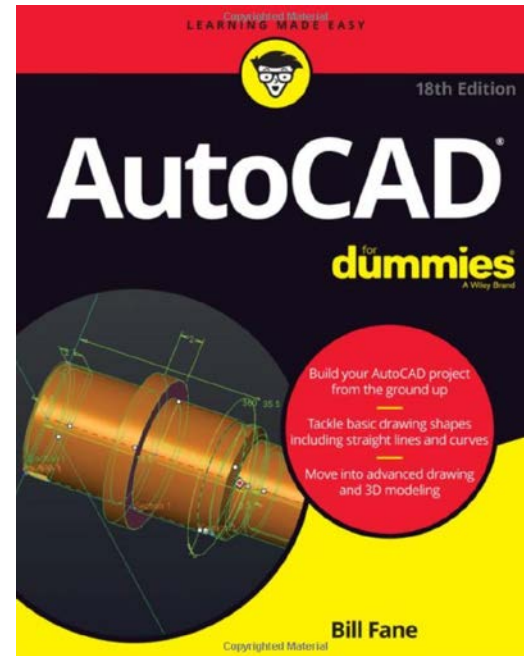
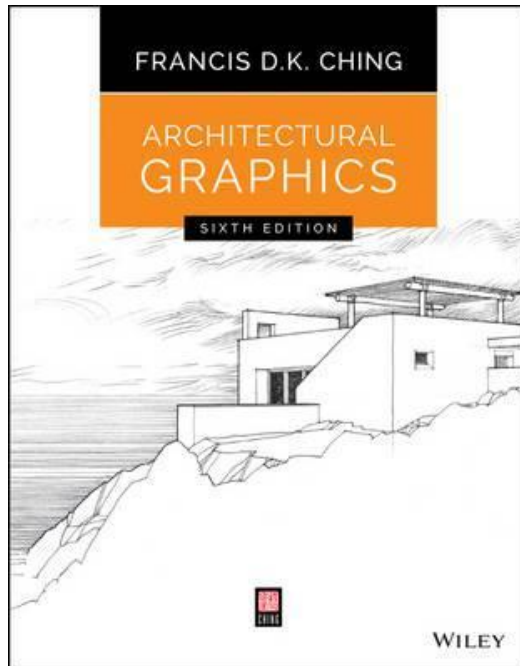
Reid, E (2016) *Understanding Buildings*

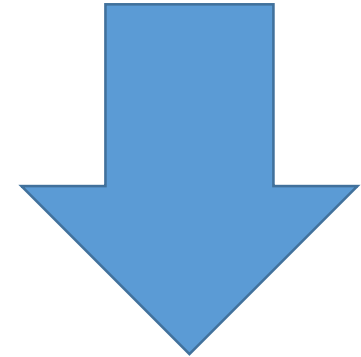
### 2D CAD:

Guide to AutoCAD (moodle)

AutoCAD for Dummies

<https://academy.autodesk.com/>





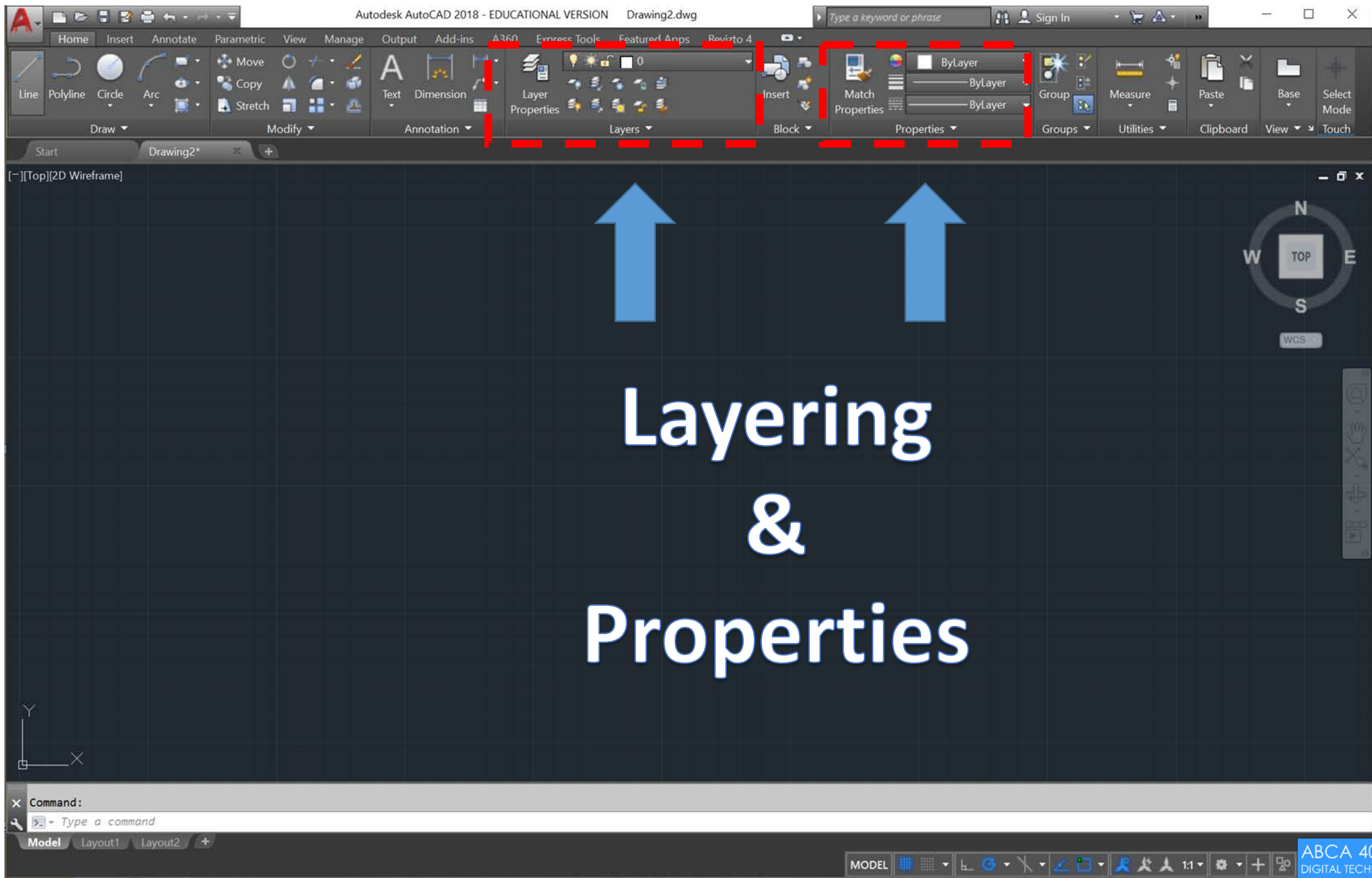
<https://www.autodesk.com/shortcuts/autocad>

- Q QSAVE / Saves the current drawing.
- A ARC / Creates an arc.
- Z ZOOM / Increases or decreases the magnification of the view in the current viewport.
- W WBLOCK / Writes objects or a block to a new drawing file.
- S STRETCH / Stretches objects crossed by a selection window or polygon.
- X EXPLODE / Breaks a compound object into its component objects.
- E ERASE / Removes objects from a drawing.
- D DIMSTYLE / Creates and modifies dimension styles.

- C CIRCLE / Creates a circle.
- R REDRAW / Refreshes the display in the current viewport.
- F FILLET / Rounds and fillets the edges of objects.
- V VIEW / Saves and restores named views, camera views, layout views, and preset views.
- T MTEXT / Creates a multiline text object.
- G GROUP / Creates and manages saved sets of objects called groups.
- B BLOCK / Creates a block definition from selected objects.
- N NEW / Create a new drawing

- H HATCH / Fills an enclosed area or selected objects with a hatch pattern, solid fill, or gradient fill.
- J JOIN / Joins similar objects to form a single, unbroken object.
- M MOVE / Moves objects a specified distance in a specified direction.
- I INSERT / Inserts a block or drawing into the current drawing.
- O OFFSET / Creates concentric circles, parallel lines, and parallel curves.
- L LINE / Creates straight line segments.
- P PAN / Adds a parameter with grips to a dynamic block definition.

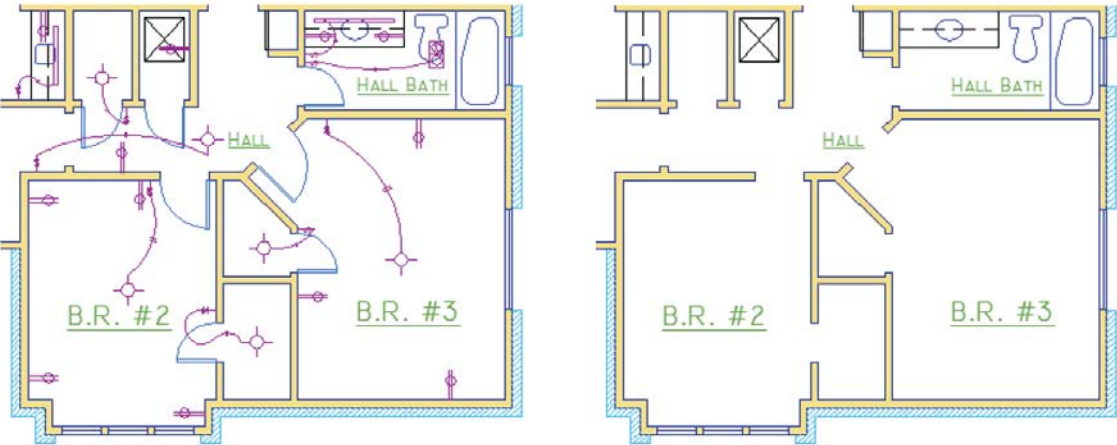
PL Polyline  
CO Copy  
REC Rectangle  
MO/PR Modify Properties  
Pallet  
LA Layer Pallet



# Layers

Organize your drawing by assigning objects to layers.

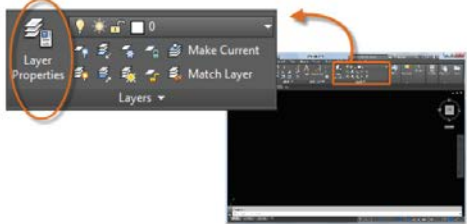
When a drawing becomes visually complex, you can hide objects that you currently do not need to see.



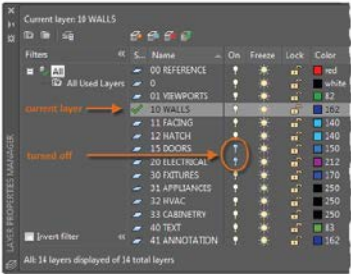
In the drawing below, the doors and electrical wiring were temporarily hidden by hiding their layers.

## Layer Controls

To see how a drawing is organized, use the **LAYER** command to open the Layer Properties Manager. You can either enter **LAYER** or **LA** in the Command window, or you can click the Layer Properties tool on the ribbon.



Here's what the Layer Properties Manager displays for this drawing.



As indicated, layer 10 WALLS is the *current layer*. All new objects are automatically placed on that layer. In the list of layers, the green check next to layer 10 WALLS indicates that it is the current layer.

In the column labeled On, notice that the light bulb icons for two layers are dark. This indicates that these layers were turned off to hide the doors and electrical wiring in the floor plan.

Notice that each layer name starts with a two-digit number. This convention makes it easy to control the order of the layers because their order does not depend on the alphabet.

## Layer Settings

The following are the most commonly used layer settings in the Layer Properties Manager. Click the icon to turn the setting on and off.

COMMONLY USED LAYER SETTINGS

Turn Off Layers: This will help reduce the visual complexity of your drawing while you work.

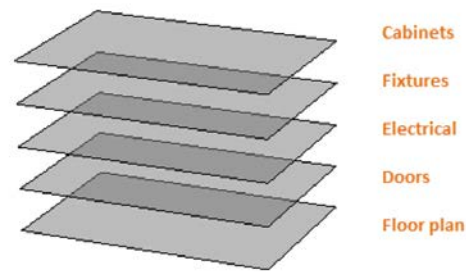
Freeze Layers: Freeze layers that you do not need to access for a while. Freezing layers is similar to turning them off, but improves performance in very large drawings.

Lock Layers: Locking layers prevents accidental changes to the objects on those layers. Also, the objects on locked layers appear faded, which helps reduce the visual complexity of your drawing.

Set Default Properties: You can set the default properties for each layer, including color, linetype, line weight, and transparency. New objects that you create will use these properties unless you override them. Overriding layer properties is explained later in this topic.

## Layers (continued)

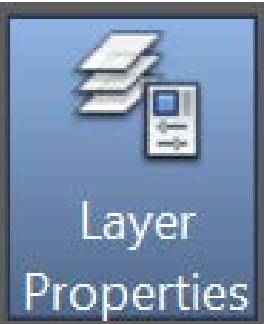
You gain this level of control by organizing the objects in your drawing on layers that are associated with a specific function or purpose. It might be helpful to think of layers as clear plastic sheets:

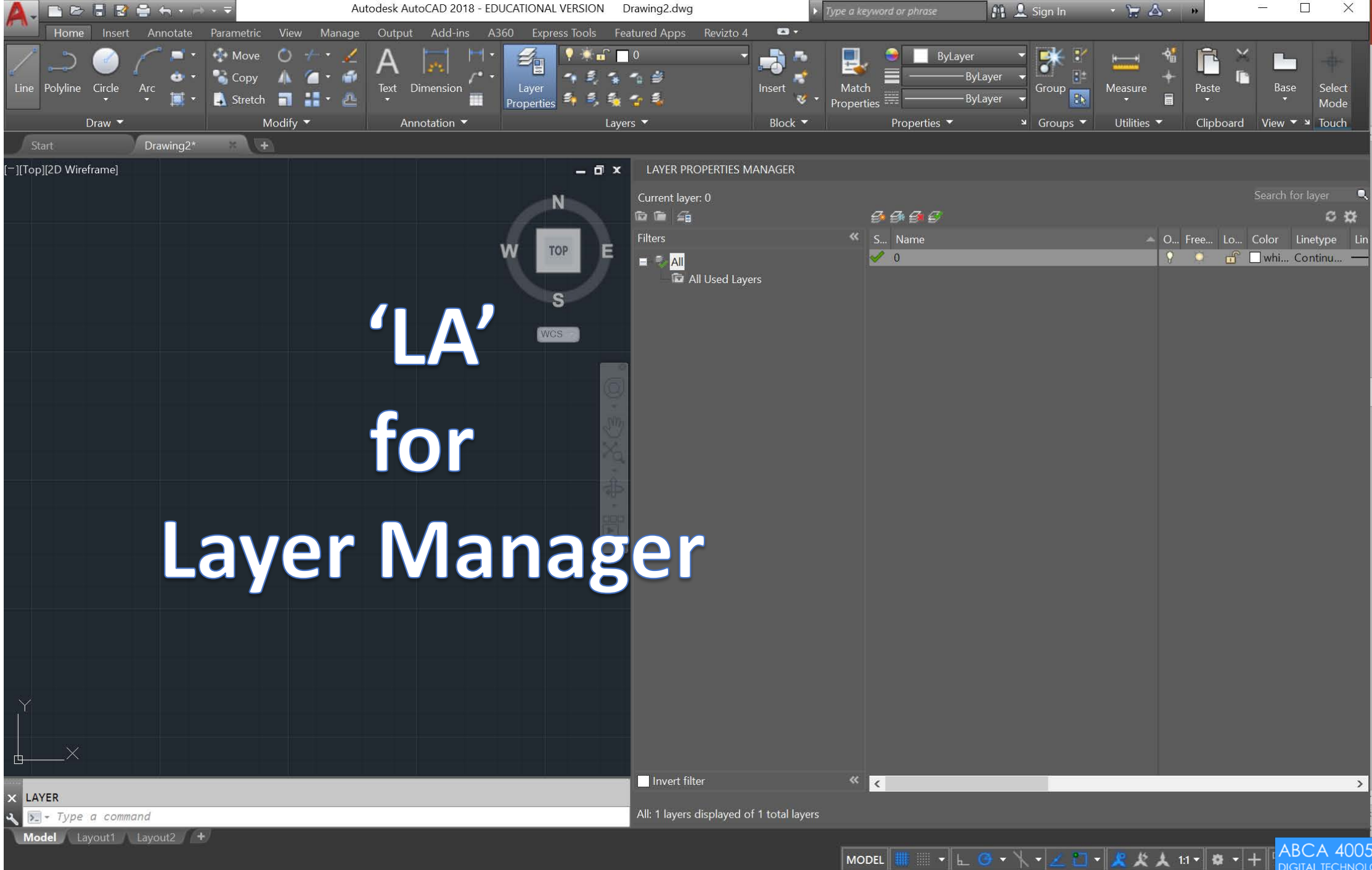


- With layers, you can:
- Associate objects by their function or location
  - Display or hide all objects related to a single operation
  - Enforce linetype, color, and other property standards for each layer

### Important:

Resist the temptation to create everything on one layer. Layers are the most important organizing feature available in AutoCAD drawings.



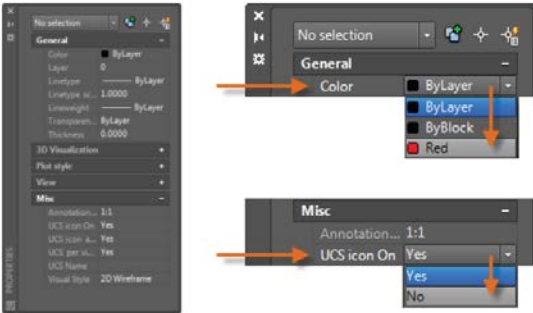


### The Properties Palette

The Properties palette is an essential tool. You can open it with the **PROPERTIES** command (enter **PR** in the Command window), you can press **Ctrl + 1**, or you can click the tiny arrow in the Properties panel on the Home tab—whichever you prefer.

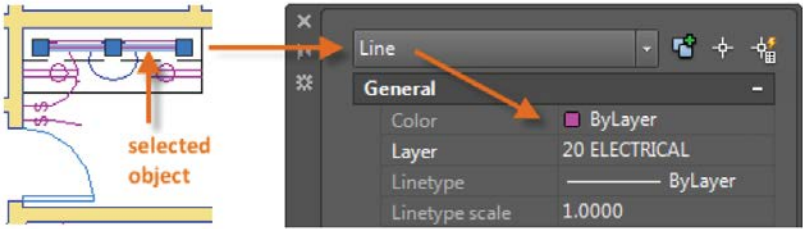


The Properties palette displays a list of all the important property settings. You can click any of the available fields to change the current settings. In the following example, if no objects are selected, the current color will be changed from ByLayer to Red and the UCS icon will be turned off.



### Verify and Change Object Properties

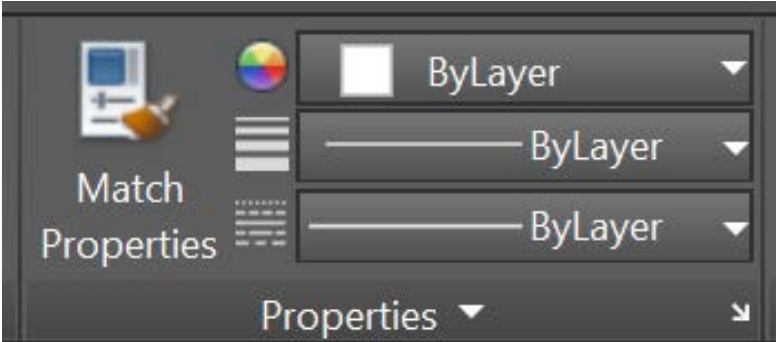
You can use the Properties palette to verify and change property settings for selected objects. If you click an object in your drawing to select it, here is what you might see in the Properties palette.

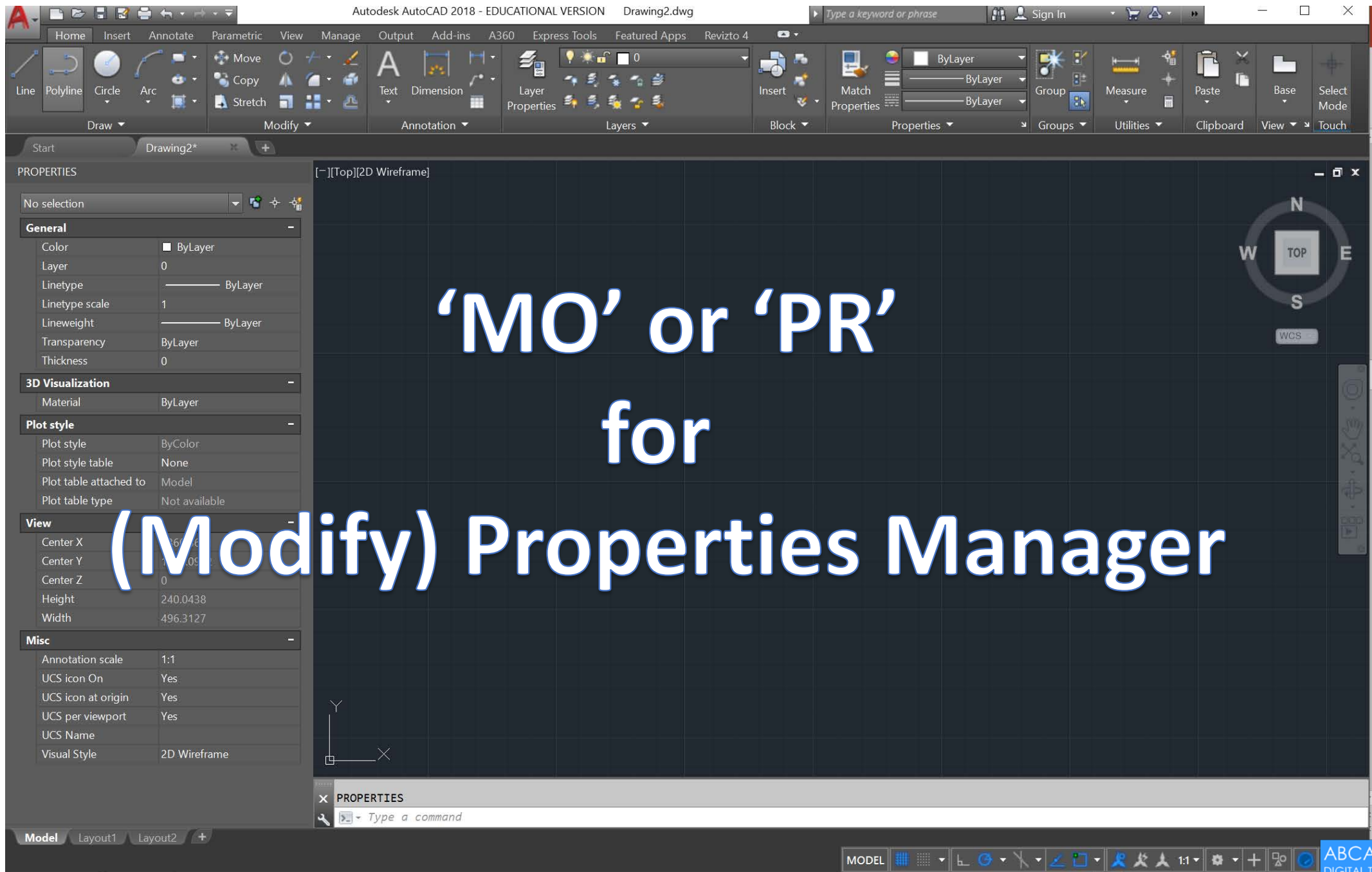


Notice that the current properties for the selected object are displayed in the palette. You can change any of these properties by clicking and changing the setting.

A property that is set to "ByLayer" inherits its setting from the layer. In the previous example, the objects that were created on the 20 ELECTRICAL layer are purple because that is the default color of the objects on that layer.

If you select several objects, only their common properties are listed in the Properties palette. If you change one of these properties, all the selected objects will change in one operation. Selecting objects is covered in more detail in the Modifying topic.





# Exercise 1

## Creating Layers

Walls - Cyan

Doors - Magenta

Text - White

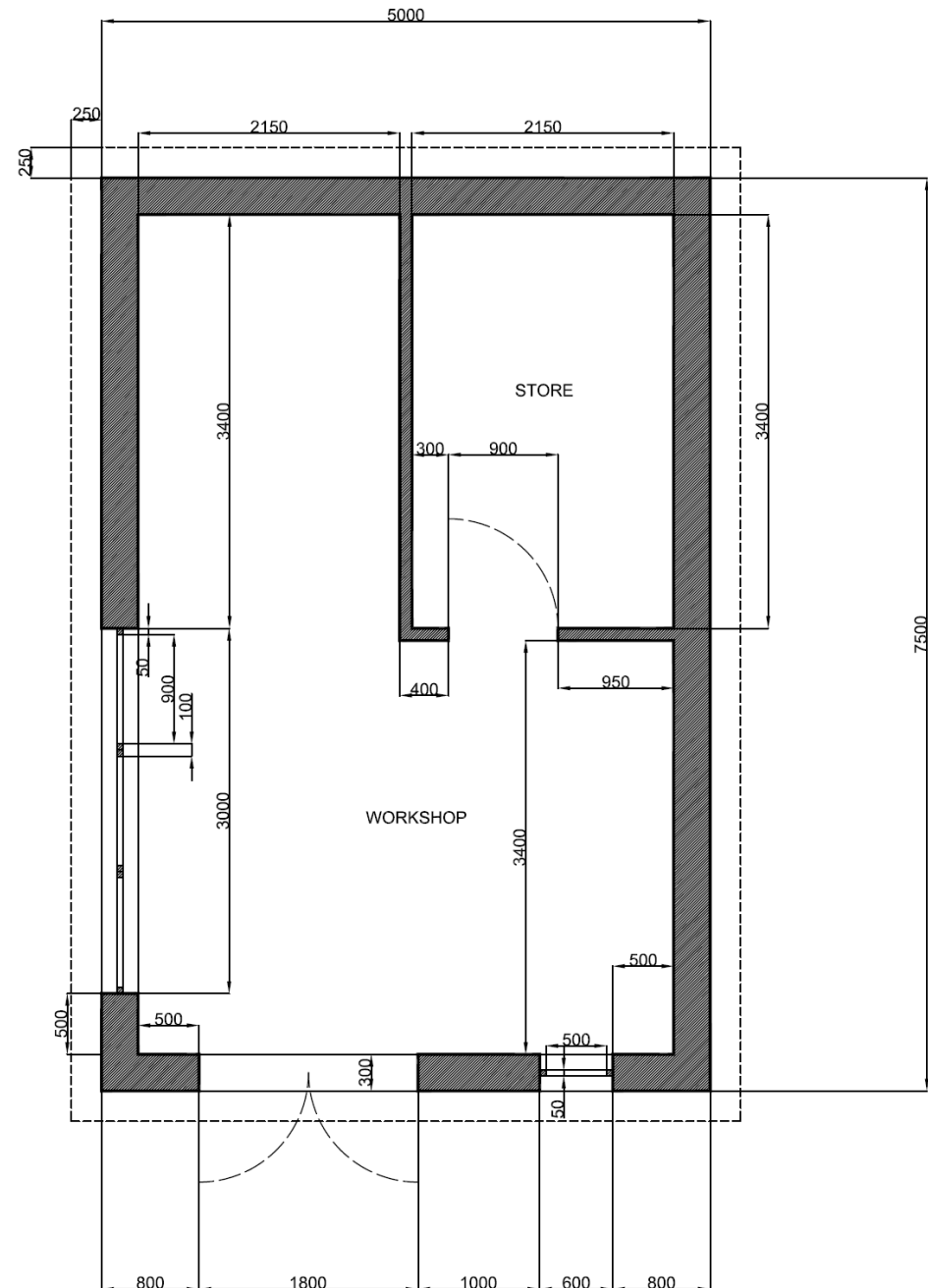
Hatching - Red

Draw it the building plan opposite, drawing the walls as a Polyline

Modify the thickness of the walls to show the cut plane.

Draw 6 no 200 x 2000mm rack shelving units in the workshop

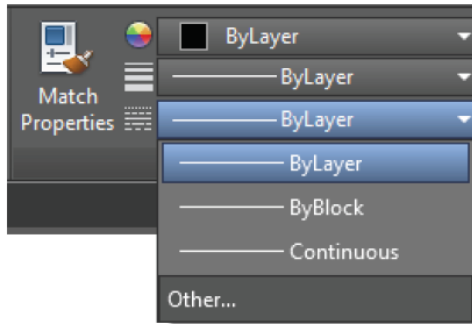
Create a new layer called Furniture and relocate to the layer.



## Linetypes

Dashed and other non-continuous linetypes are assigned from the Properties panel. You must first load a lincype before you can assign it.

In the Lincype drop-down list, click Other.

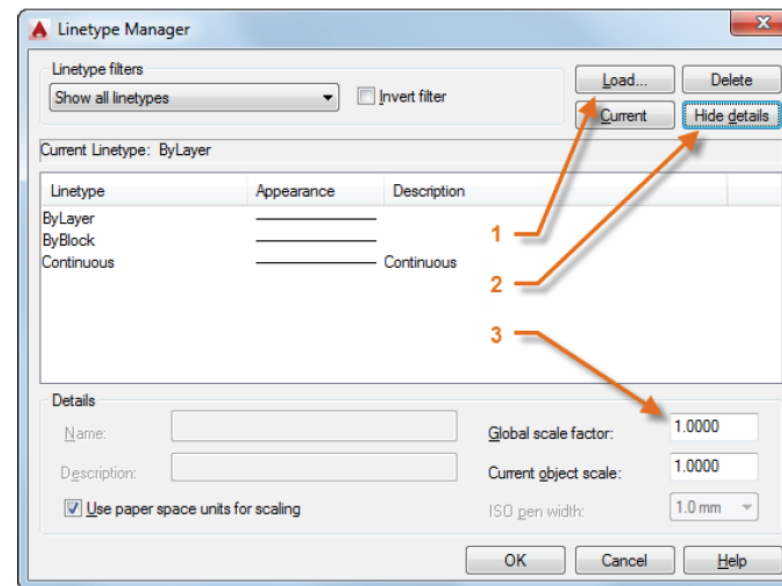


This action displays the Linetype Manager dialog box.

Perform the following steps in order:

1. Click Load. Choose one or more linetypes that you want to use. Notice that dashed (non-continuous) linetypes come in several preset sizes.
2. Click Show/Hide details to display additional settings.
3. Specify a different "global scale factor" for all linetypes—the larger the value, the longer the dashes and spaces. Click OK.

4. Once you've loaded the linetypes that you plan to use, you can select any object and specify a lincype from the Properties panel or the Properties palette. Alternatively, you can specify a default lincype for any layer in the Layer Properties Manager.



# Exercise 2

Using Orthographic Projection

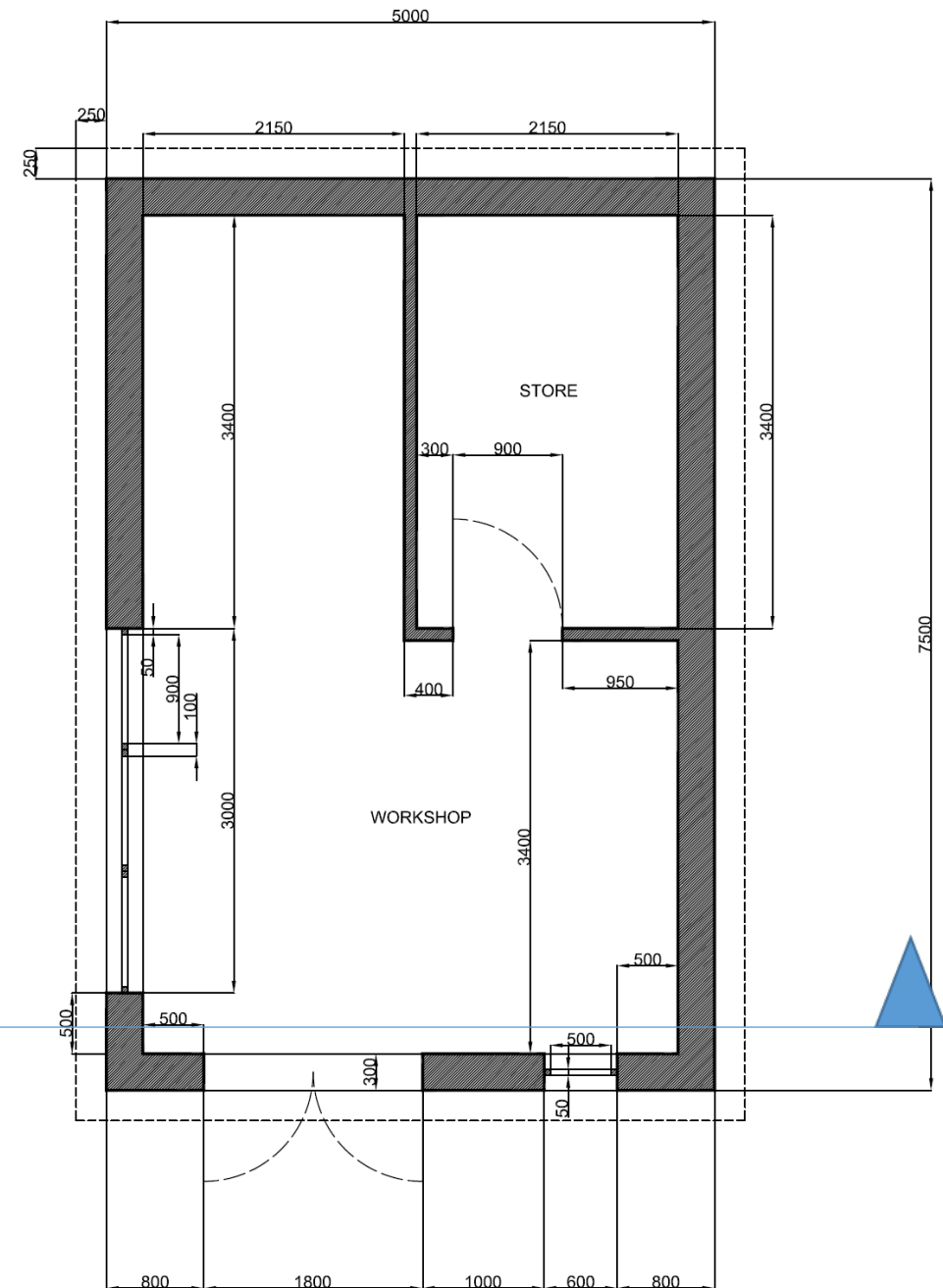
Prepare an Elevation and Section of the proposed building.

You will need to create a 'UCS'

Assume the following:

- High to Apex of roof is 5m
- Floor to ceiling height is 2.5m
- Floor slab is 300mm,
- Roof is 300mm thick
- Cill heights are 900mm

Create appropriate layers



User Coordinate System UCS can assist you to reorientation your drawing for orthographic projection.

Type UCS

'3' for New 3 point UCS

Click a positive point on the X axis

Click a positive point on the Y axis

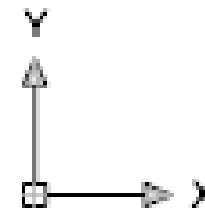
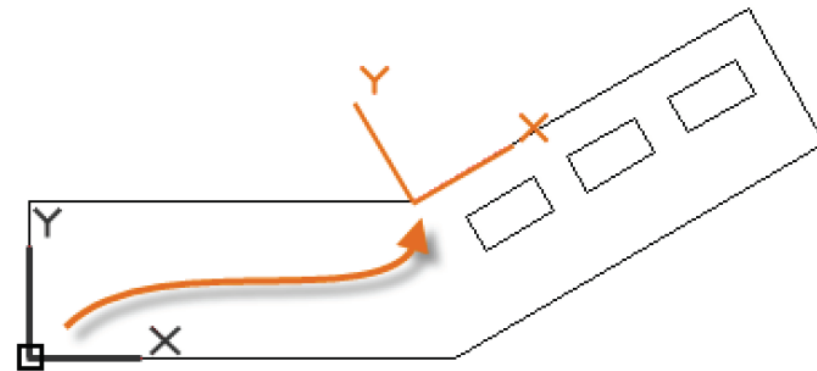
Select '0' for Z axis

TYPE 'Plan' for reorientation your view to the new UCS

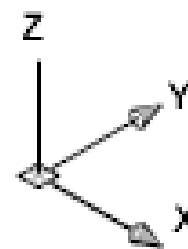
Save your USC – USC – Save – Name it

## The User Coordinate System

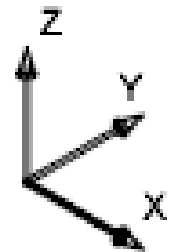
The user coordinate system (UCS) icon indicates the direction of the positive X and Y axis for any coordinates that you enter, and it also defines the horizontal and vertical directions in a drawing. In some 2D drawings, it can be convenient to click, drag, and rotate the UCS to change the origin point, and the horizontal and vertical directions.



2D UCS icon



3D UCS icon



shaded UCS icon

# Exercise 3

Using Orthographic Projection

Prepare the remaining Elevations and Sections of the proposed building.

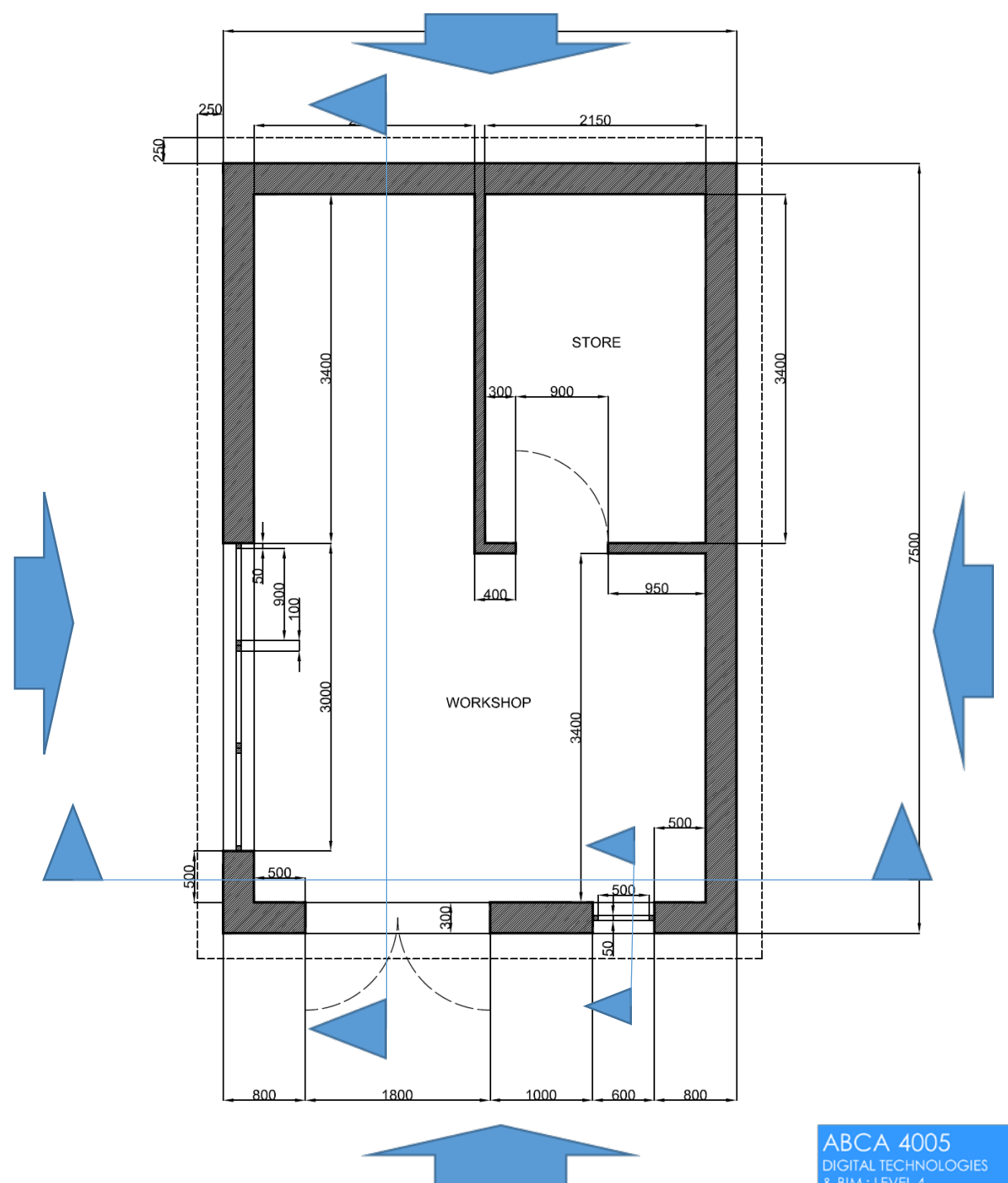
You will need to create a 'UCS' for each

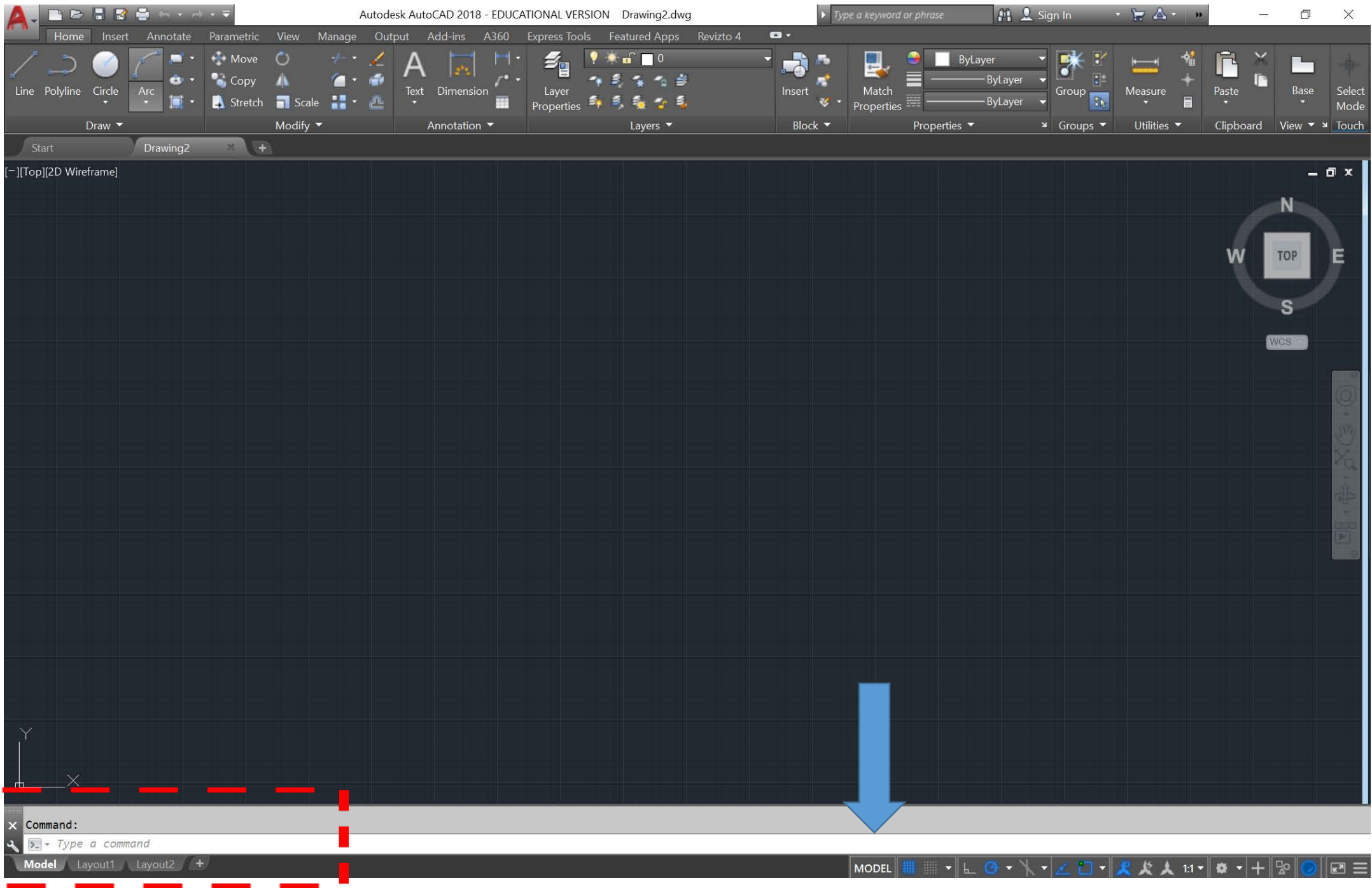
Create appropriate layers

Prepare the detailed section through the window.

Wall construction:

- 100mm Brickwork
- 100mm cavity
- 80mm insulation
- 100mm blockwork
- 12mm plaster





# Model Space and Paper Space – Layout and Scale

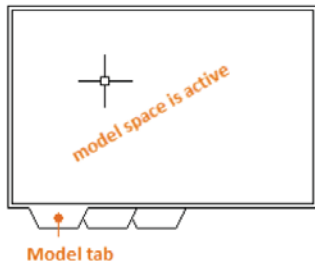
## Layouts

Display one or more scaled views of your design on a standard-size drawing sheet called a layout.

After you finish creating a model at full size, you can switch to a *paper space layout* to create scaled views of the model, and to add notes, labels, and dimensions. You can also specify different linetypes and line widths for display in paper space.

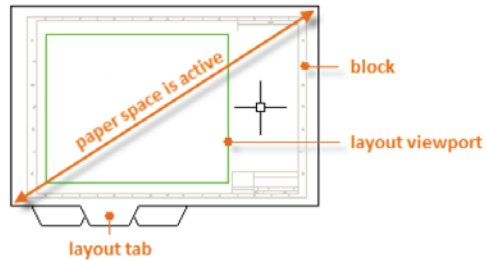
## Model Space and Paper Space

As you know, you create the geometry of your model in *model space*.



Originally, this was the only space available in AutoCAD. All notes, labels, dimensions, and the drawing border and title block were also created and scaled in the model space.

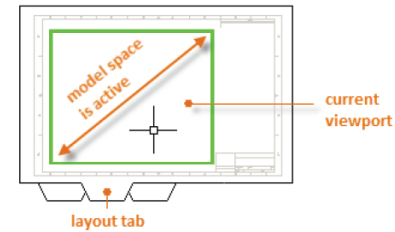
After *paper space* was introduced, you could click a layout tab to access a space designed specifically for layouts and scaling. In the following illustration, paper space is active. There are currently only two objects in paper space: a drawing border block, and a single *layout viewport*, which displays a view of model space.



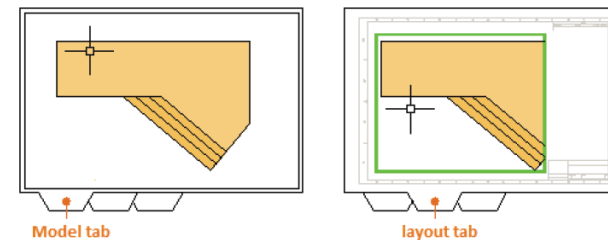
Working with layout viewports is described in more detail later in this topic.

## Layout Viewports

A layout viewport is an object that is created in paper space to display a scaled view of model space. You can think of it as a closed-circuit TV monitor that displays part of model space. In the illustration, model space is active and accessible from within the current layout viewport.



In a layout, when model space is active, you can pan and zoom, and anything else that you could do on the Model tab. For example, let's say that you created a backyard deck design in model space, and now you want to lay out and print your design from a layout tab.

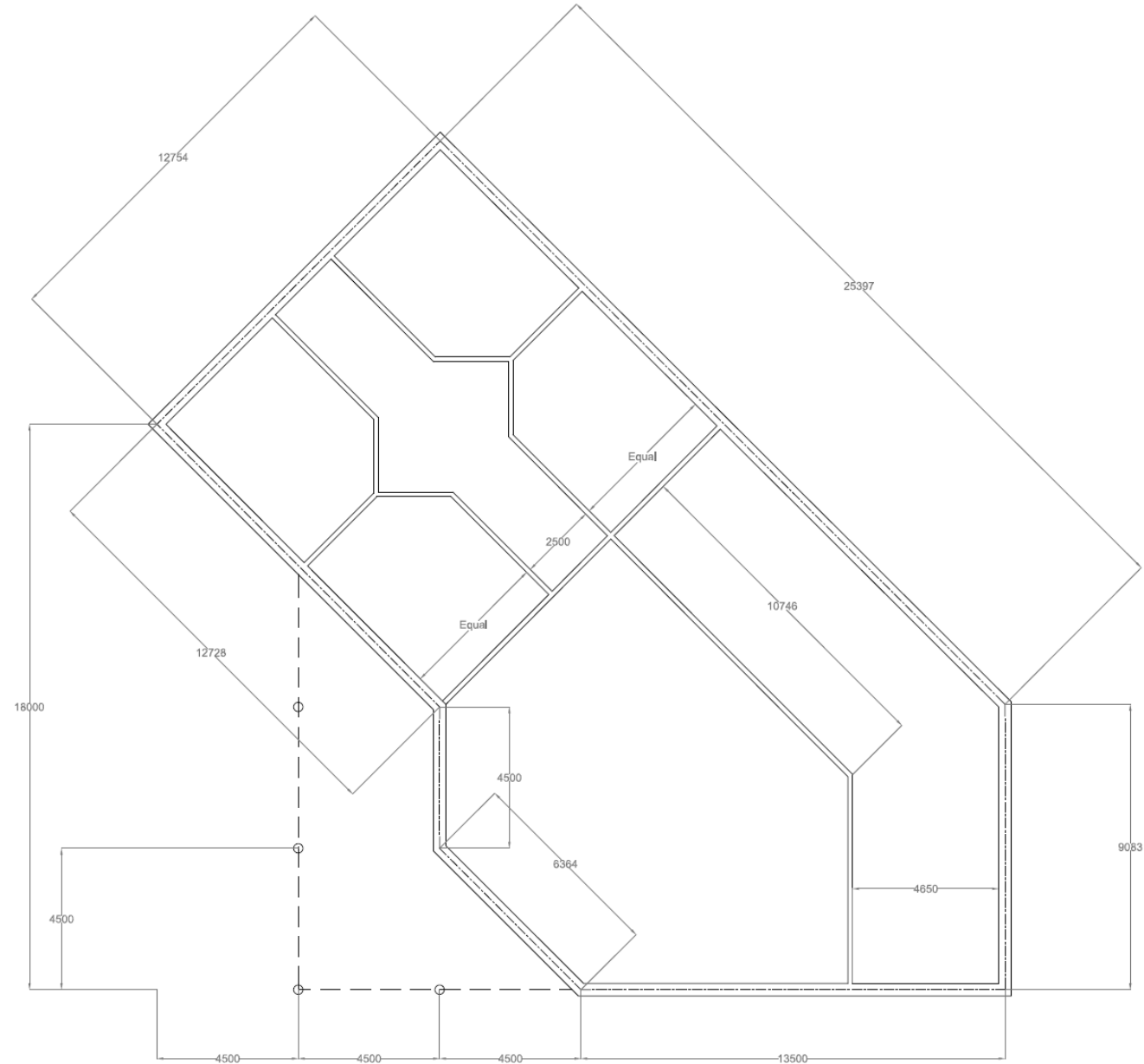


The view in the layout viewport is not yet set to the correct scale.

# Exercise 4

Some sketch plans need to be drawn for a new office block. General dimensions are give opposite.

Download the file from Moodle and add the data required.



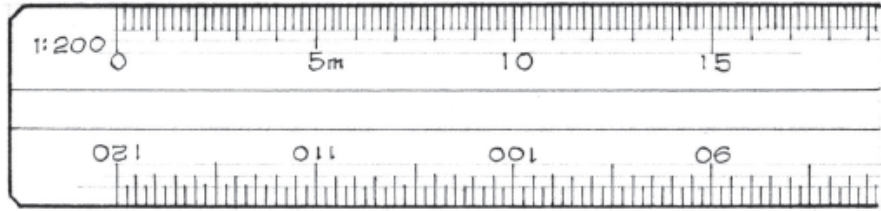
External walls 400mm thick  
Internal Walls 150mm thick

Columns 300mm Ø

Create Layers,

Add Windows to external walls  
Add internal 900mm wide single doors  
Add external 2000mm wide double doors

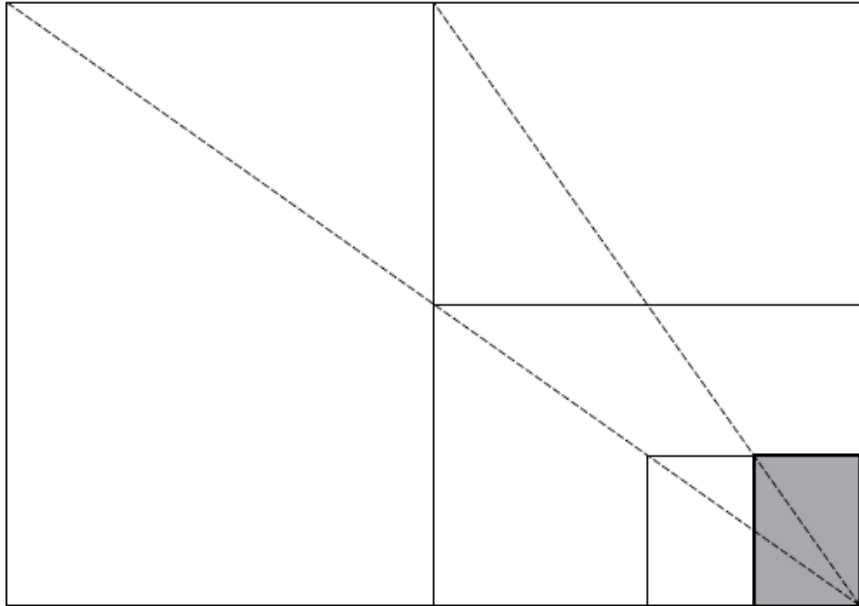
## Appropriate Scale Drawings



### Metric Scales

Metric scales consist of one or more sets of graduated and numbered spaces, each set establishing a proportion of one millimeter to a specified number of millimeters.

- Common metric scales include the following: 1:5, 1:50, 1:500, 1:10, 1:100, 1:1000, 1:20, and 1:200.



### Digital Scale

In traditional drawing, we think in real-world units and use scale to reduce the drawing to a manageable size. In digital drawing, we actually input information in real-world units, but we should be careful to distinguish between the size of the image viewed on a monitor, which can be reduced and enlarged independent of its real-world size, and the scale of the output from a printer or plotter.

When hand drawing, scales are prescribed to the appropriate scale for the drawing.

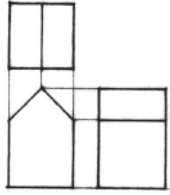
Eg. 1:1250 site plan for a Planning Application

When digitally drawing, software packages allow the designers to prepare information at 1:1 scale - real life dimensions. However, you should always consider the appropriate output scale each time you draw.

# Conventions

## Projection Systems

### Orthographic Projection



When we study how each projection system represents the same subject, we can see how different pictorial effects result. We categorize these pictorial systems into multiview drawings, paraline drawings, and perspective drawings.

### Pictorial Systems

#### Multiview Drawings

- Multiview drawings consist of plans, sections, and elevations.
- The principal face in each view is oriented parallel to the picture plane.

#### Paraline Drawings

Isometrics: The three major axes make equal angles with the picture plane.

Dimetrics: Two of the three major axes make equal angles with the picture plane.

Trimetrics: All three major axes make different angles with the picture plane.

### Axometric Projection

### Oblique Projection

Elevation obliques: A principal vertical face is oriented parallel to the picture plane.

Plan obliques: A principal horizontal face is oriented parallel to the picture plane.

### Perspective Projection

#### Perspective Drawings

1-point perspectives: One horizontal axis is perpendicular to the picture plane while the other horizontal axis and the vertical axis are parallel with the picture plane.

2-point perspectives: Both horizontal axes are oblique to the picture plane and the vertical axis remains parallel with the picture plane.

3-point perspectives: Both horizontal axes as well as the vertical axis are oblique to the picture plane.

These pictorial views are available in most 3D CAD and modeling programs. The terminology, however, may differ from what is presented here.

## Orthographic Projection

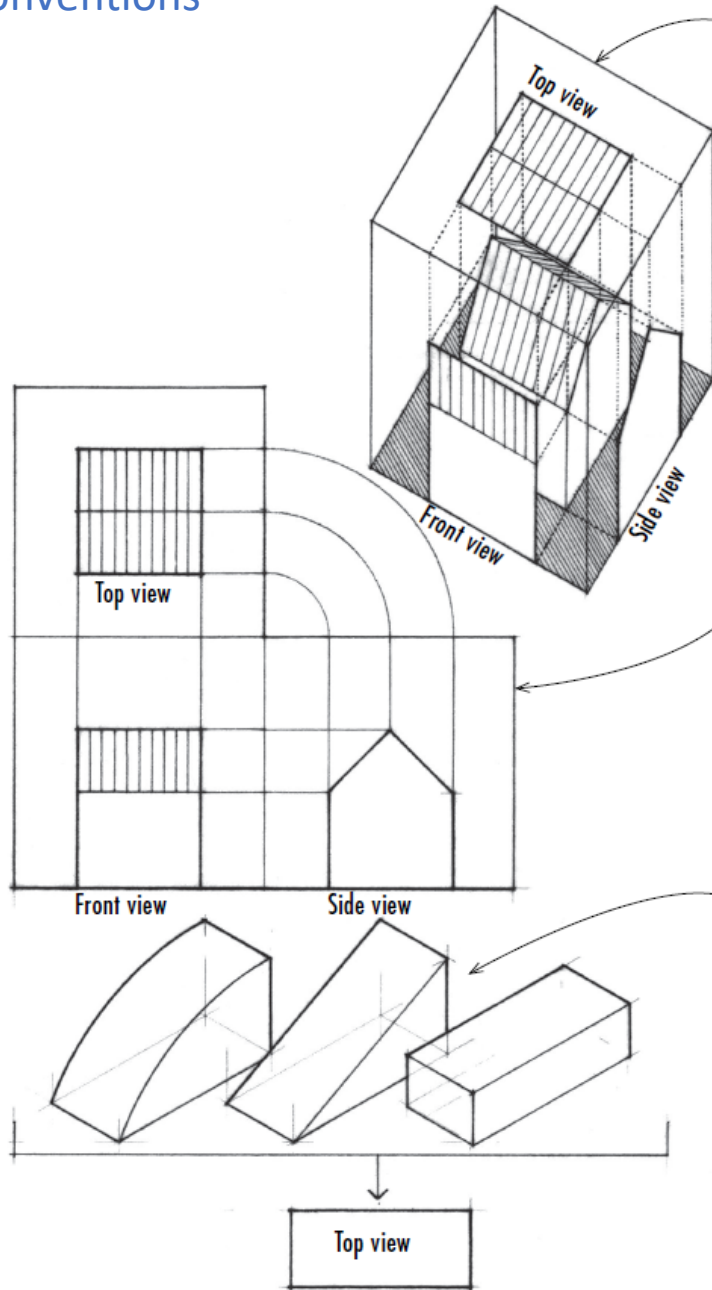
Drawings that can be prepared through orthographic projection to produce **WHAT?**:

PLANS

SECTIONS

ELEVATIONS

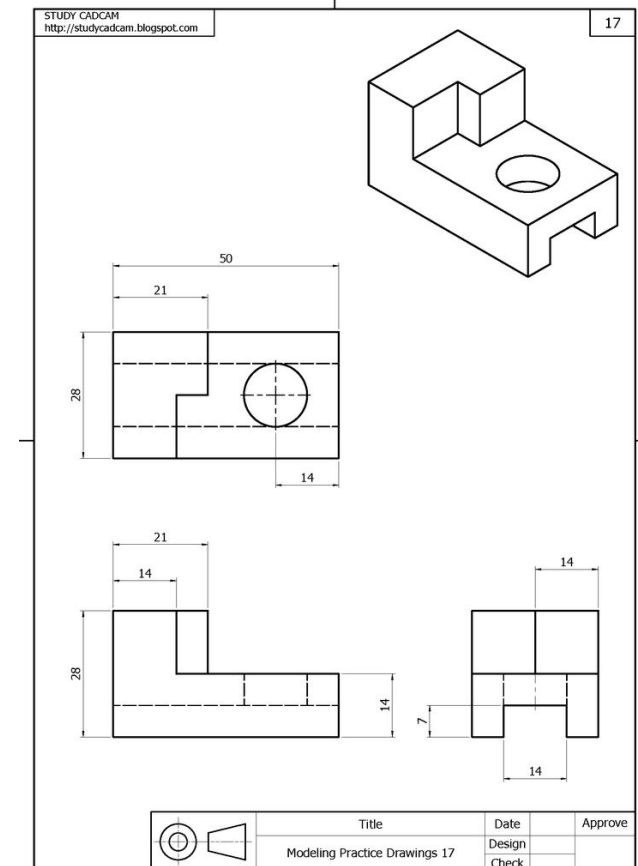
## Conventions



- If we enclose an object within a transparent picture-plane box, we can name the images projected orthographically onto the principal picture planes.
- Top views are orthographic projections cast onto the horizontal picture plane. In architectural drawing, top views are called plans.
- Front and side views are orthographic projections cast onto the vertical picture planes. In architectural drawing, front and side views are called elevations.
- See Chapter 4 for floor plans and sections, which are orthographic projections of cuts made through a building.
- To make it easier to read and interpret how a series of orthographic projections describe a three-dimensional whole, we arrange the views in an orderly and logical fashion.
- The most common layout results when we unfold the transparent picture-plane box into a single plane represented by the drawing surface. The top or plan view revolves upward to a position directly above and vertically aligned with the front or elevation view, while the side view revolves to align horizontally with the front view. The result is a coherent set of related orthographic views.
- Although these three objects have different forms, their top views appear to be identical. Only by looking at related orthographic projections are we able to understand the three-dimensional form of each object. We should therefore study and represent three-dimensional forms and constructions through a series of related orthographic projections.
- The mind must be able to read and assemble a set of multiview drawings to fully understand the nature of the three-dimensional subject.

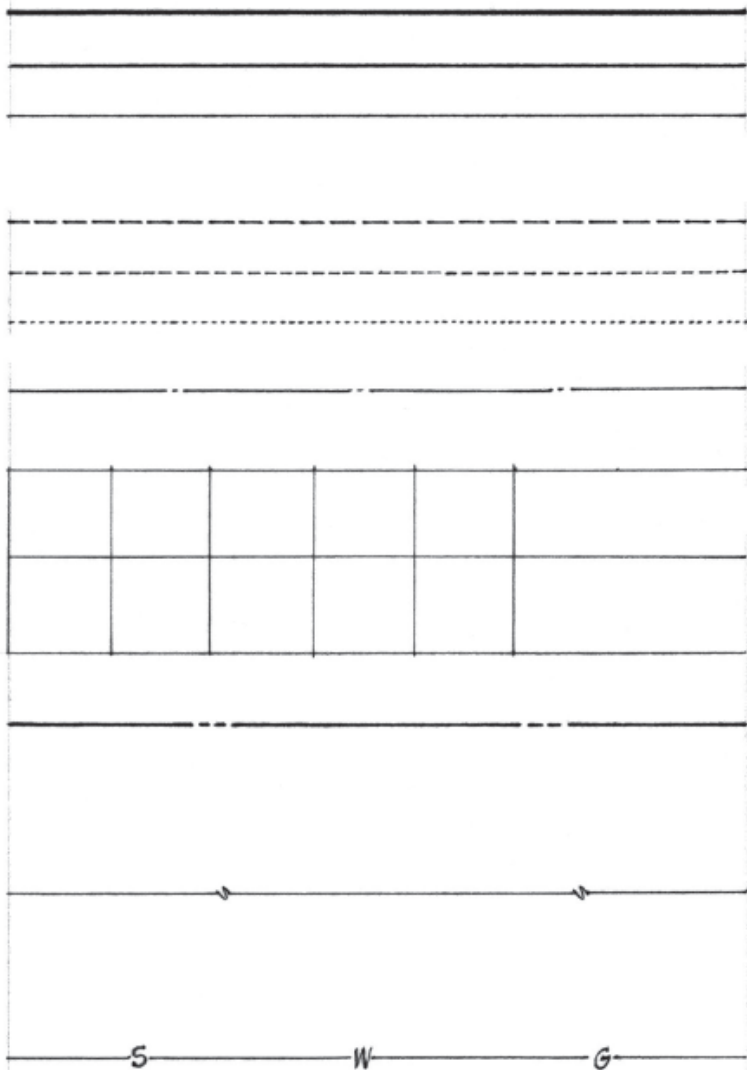
## Orthographic Projection

CAD Packages can assist us to create multiple view of the same object through projection



<https://free-clipart-pictures.com/images/orthographic-drawing-mug-5.jpg>

## Conventions - Lines



- Solid lines delineate the form of objects, such as the edge of a plane or the intersection of two planes. The relative weight of a solid line varies according to its role in conveying depth.
- Dashed lines, consisting of short, closely spaced strokes, indicate elements hidden or removed from our view.
- Centerlines, consisting of thin, relatively long segments separated by single dashes or dots, represent the axis of a symmetrical object or composition.
- Grid lines are a rectangular or radial system of light solid lines or centerlines for locating and regulating the elements of a plan.
- Property lines, consisting of relatively long segments separated by two dashes or dots, indicate the legally defined and recorded boundaries of a parcel of land.
- Break lines, consisting of relatively long segments joined by short zigzag strokes, are used to cut off a portion of a drawing.
- Utility lines consist of relatively long segments separated by a letter indicating the type of utility.

Line type conventions assist in the legibility of drawn information. The quality, thickness, scale and type of line can help communicate the importance of the line.

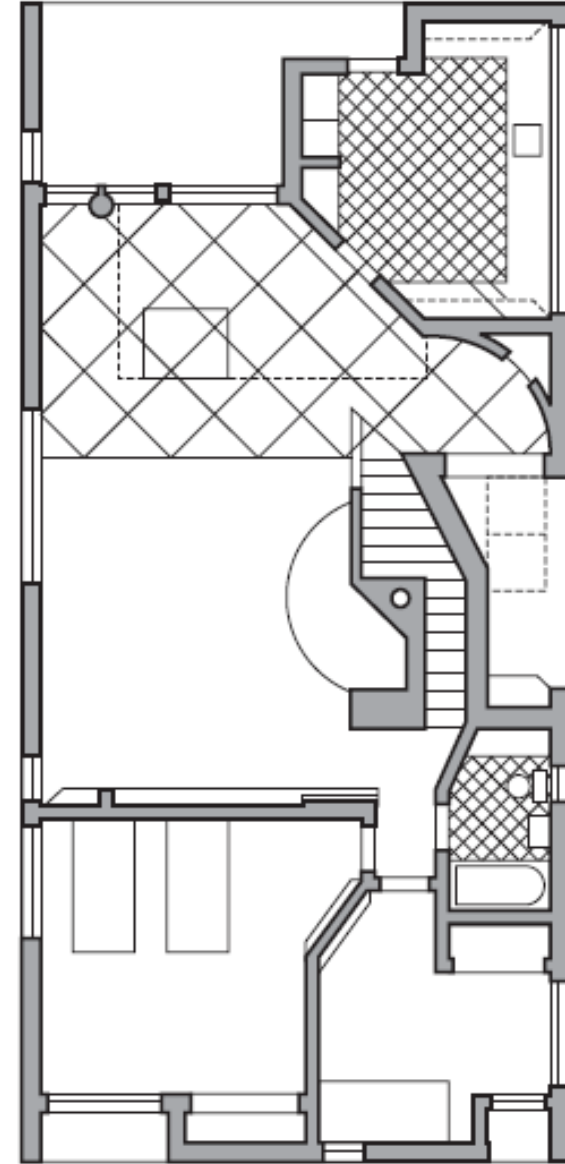
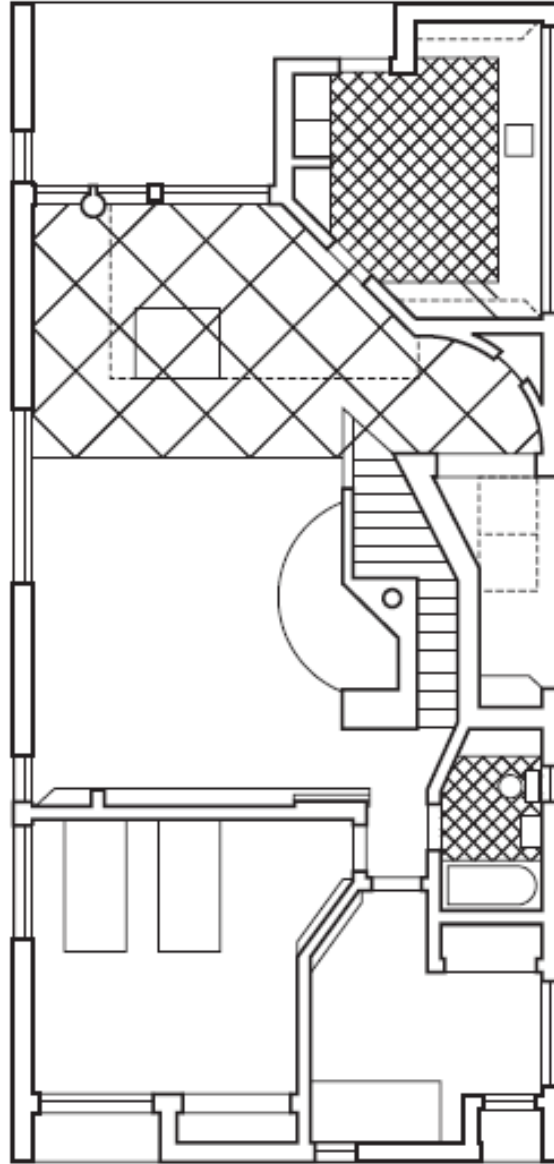
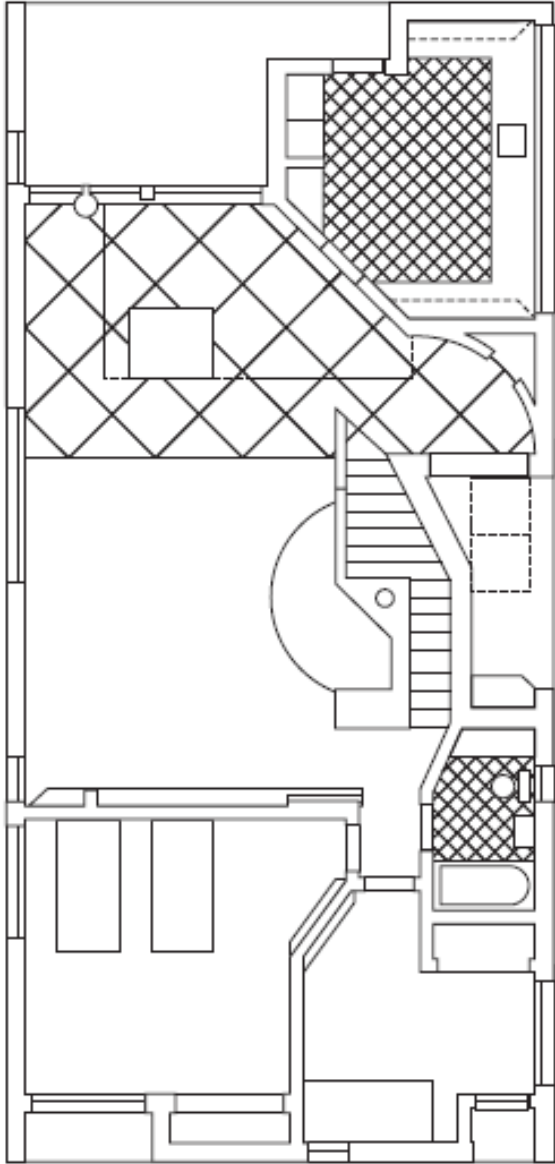
E.G

Thick Solid line depicting a section cut.

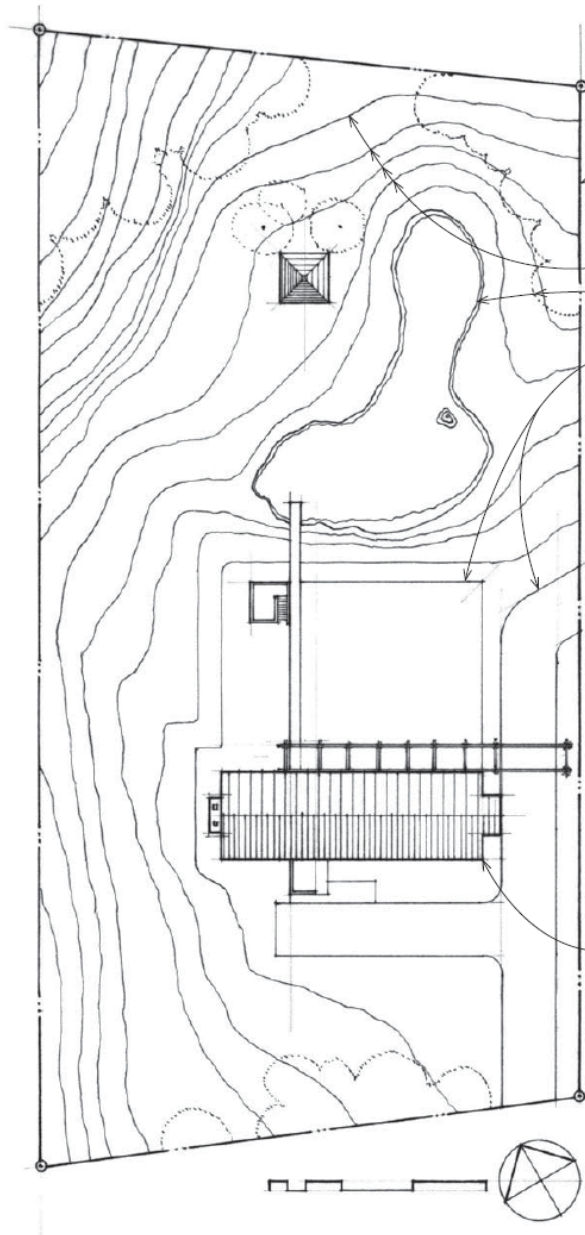
Dashed lines depicting something hidden from view.

Centre lines through steelwork allowing accuracy between column positions.

## Conventions - Lines



## Conventions - Plans



A site plan describes the location and orientation of a building or building complex on a plot of land and in relation to its context. Whether this environment is urban or rural, the site plan should describe the following:

- Legally recorded boundaries of the site, indicated by a broken line consisting of relatively long segments separated by two short dashes or dots
- Physical topography of the terrain with contour lines
- Natural site features, such as trees, landscaping, and watercourses
- Existing or proposed site constructions, such as walks, courts, and roadways
- Architectural structures in the immediate setting that impact the proposed building

In addition, a site plan may include:

- Legal constraints, such as zoning setbacks and rights-of-way
- Existing or proposed site utilities
- Pedestrian and vehicular entry points and paths
- Significant environmental forces and features

### Roof Plans

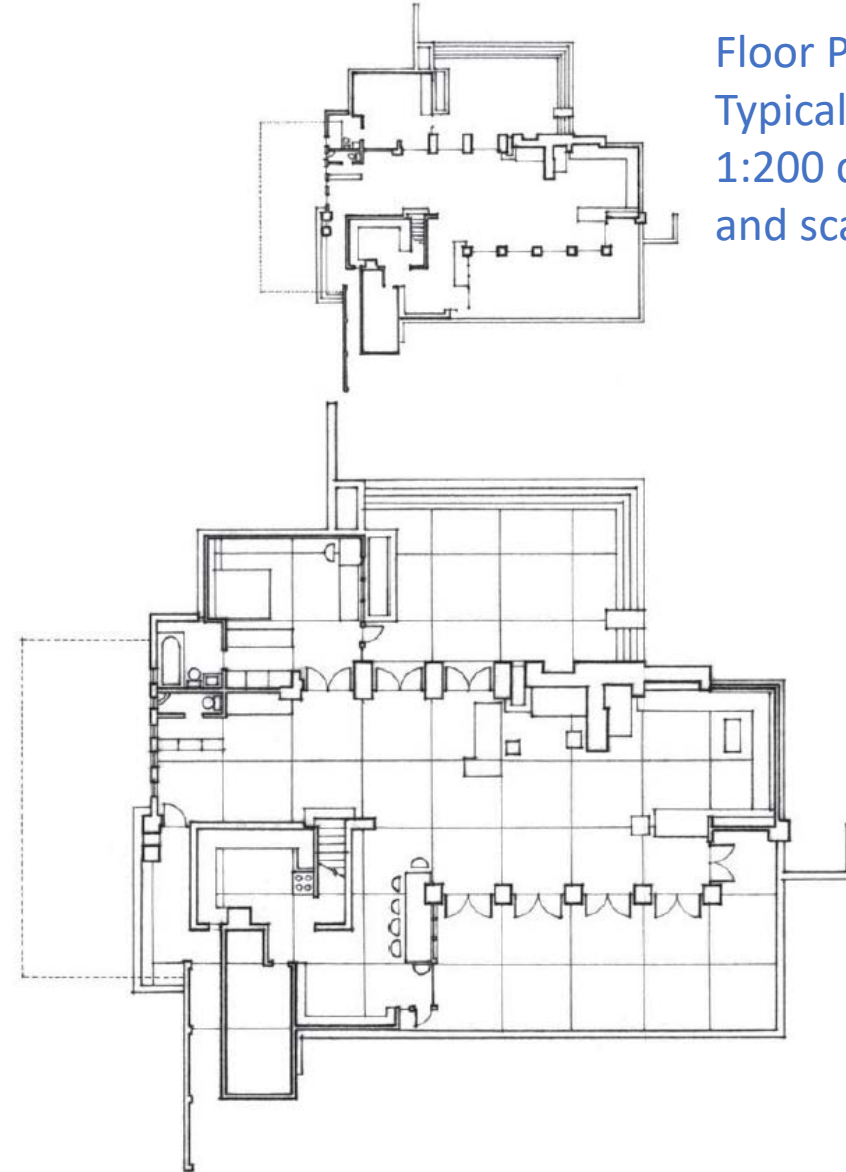
A roof plan is a top view describing the form, massing, and material of a roof or the layout of such rooftop features as skylights, decks, and mechanical housings.

- Roof plans are typically included in the site plan for a proposed building or building complex.

## Site Plans

Typical scale 1:1250 / 1:500

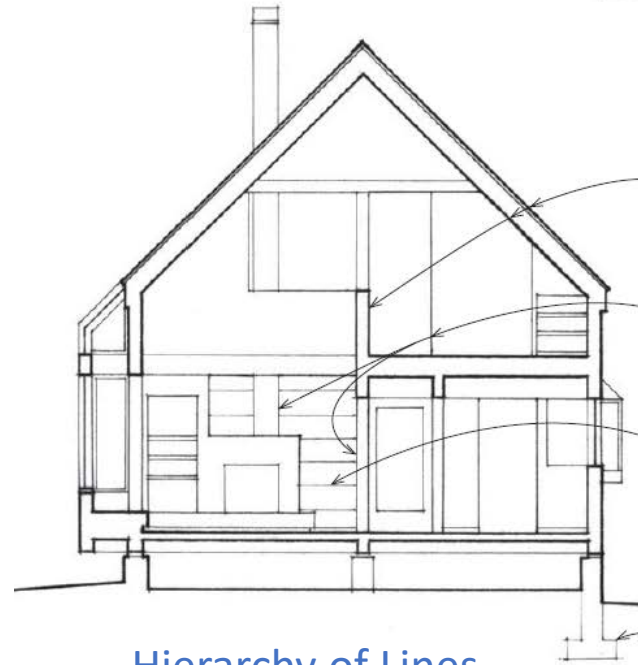
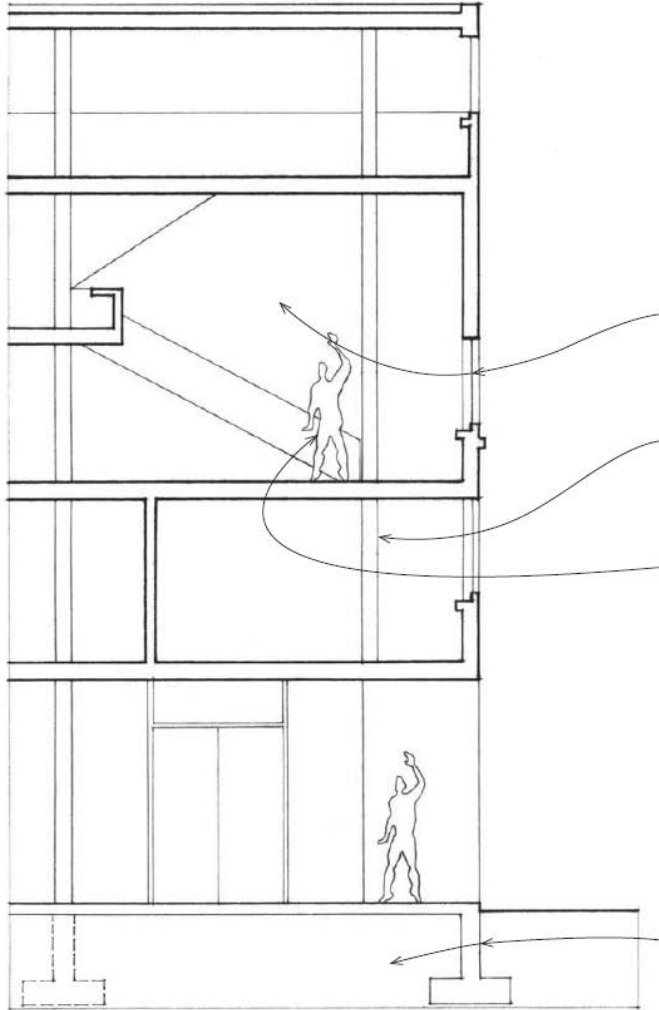
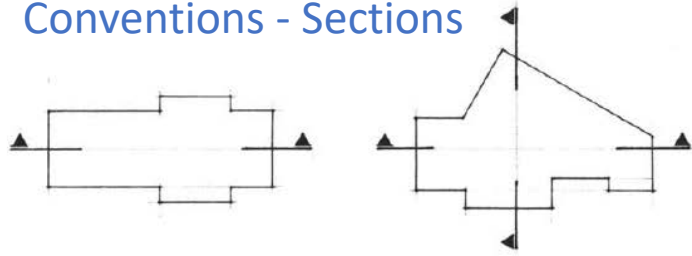
- Graphic scale designates the scale of the site plan and a north arrow indicates the orientation of the site.



## Floor Plans

Typical scales 1:100 / 1:200 depending on size and scale of the building.

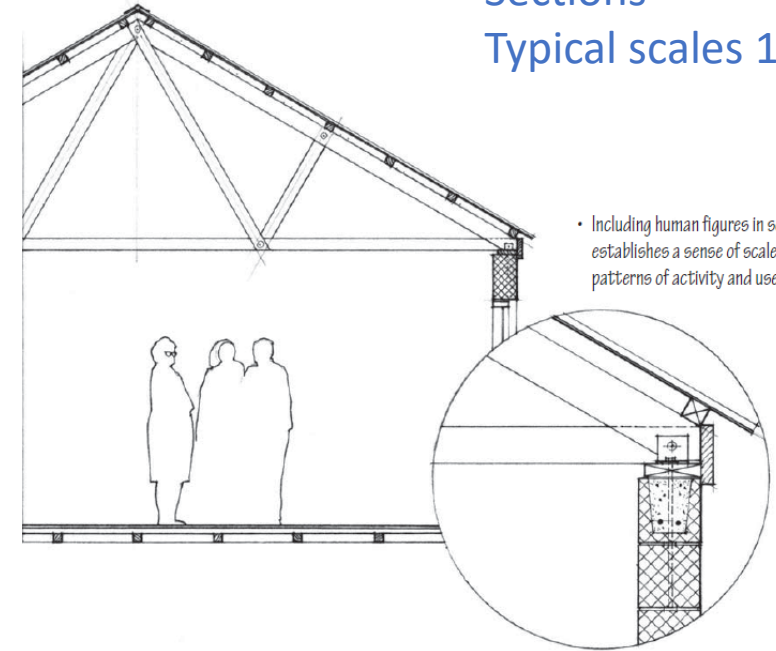
## Conventions - Sections



Hierarchy of Lines

## Sections

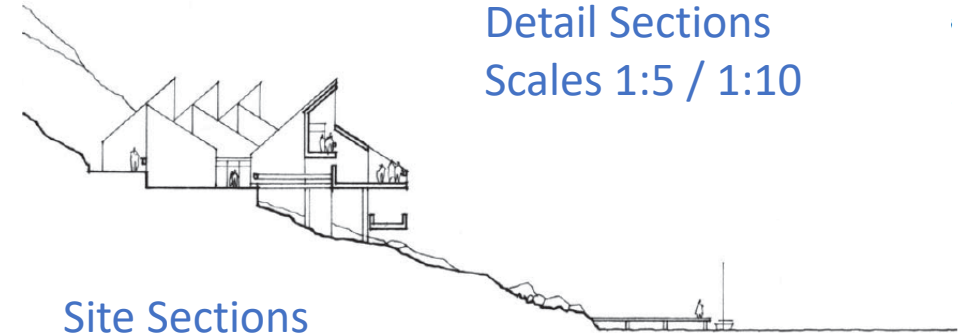
Typical scales 1:20 / 1:50



- Including human figures in section drawings establishes a sense of scale and reminds us of patterns of activity and use.

## Detail Sections

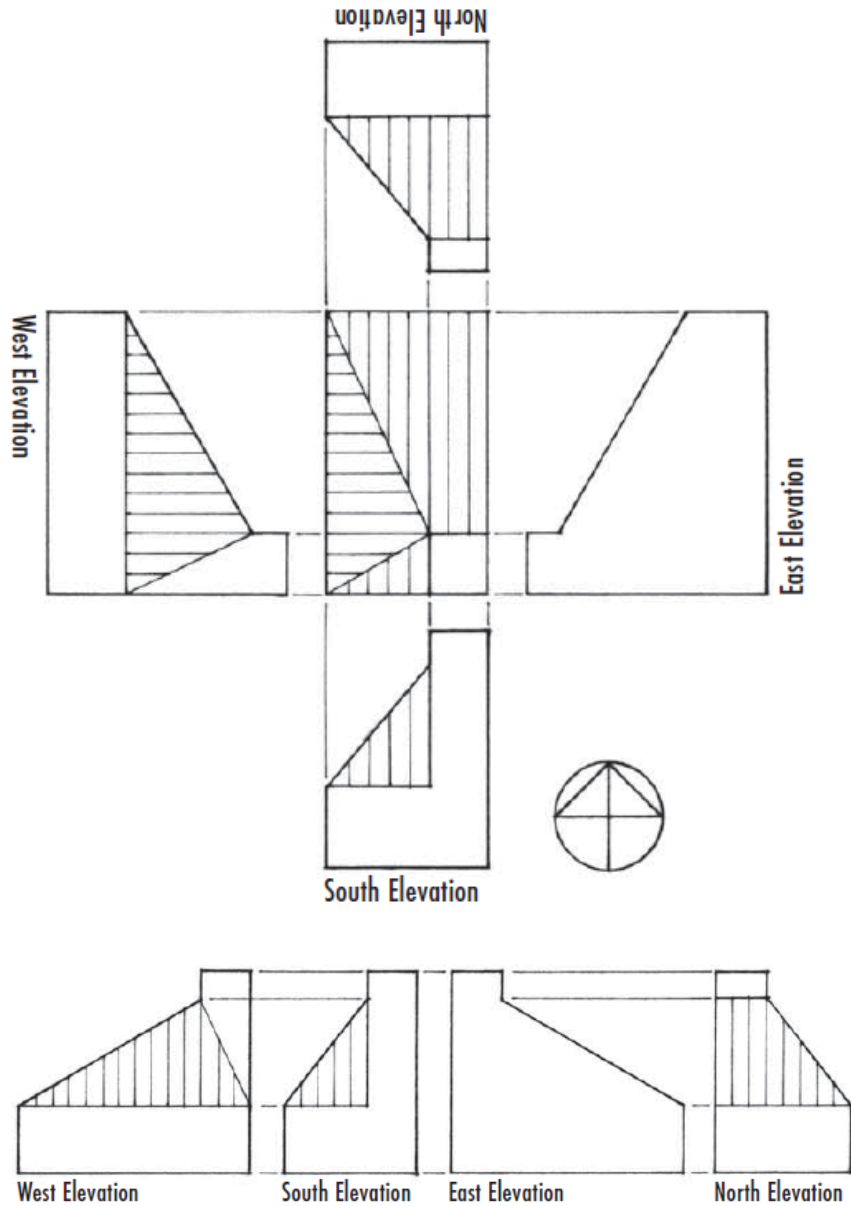
Scales 1:5 / 1:10



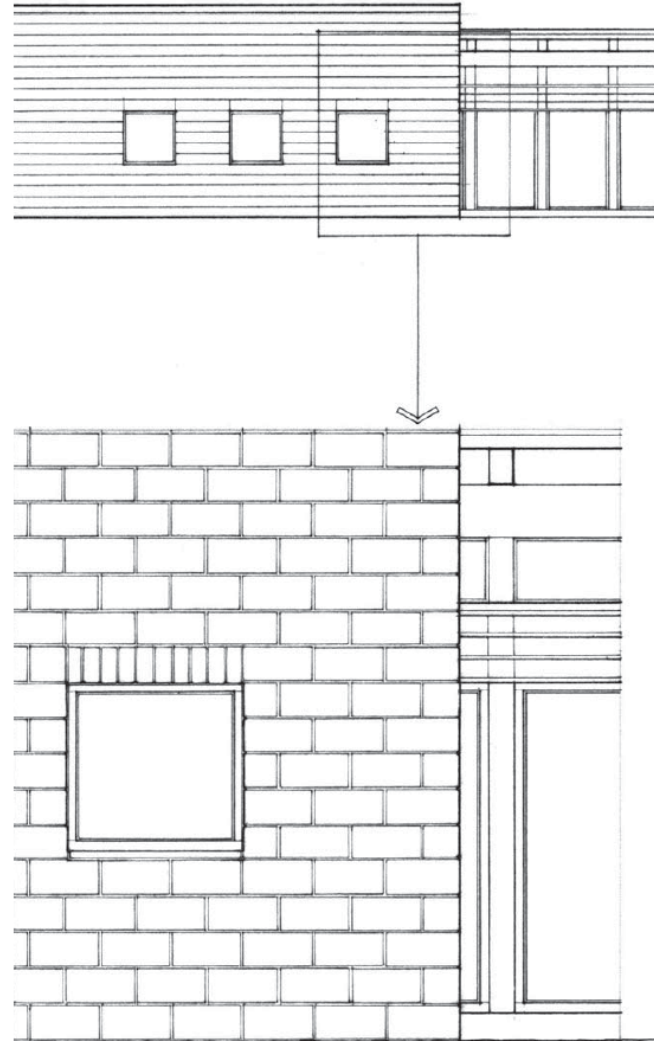
## Site Sections

Scale 1:200 / 1:500

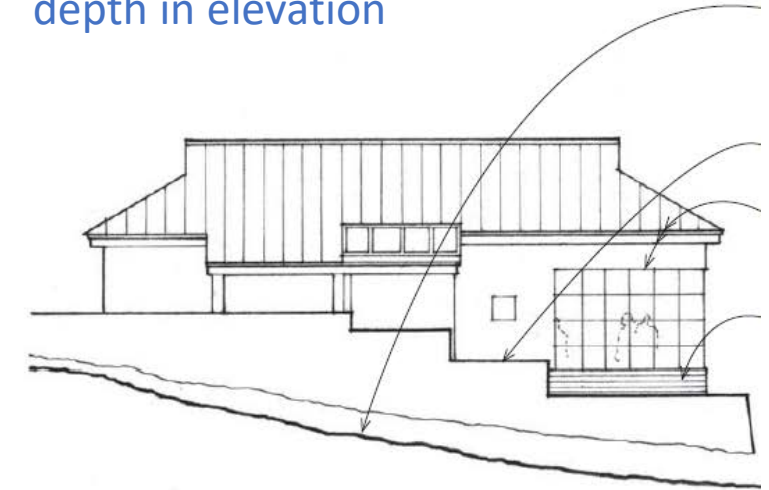
## Conventions - Elevations



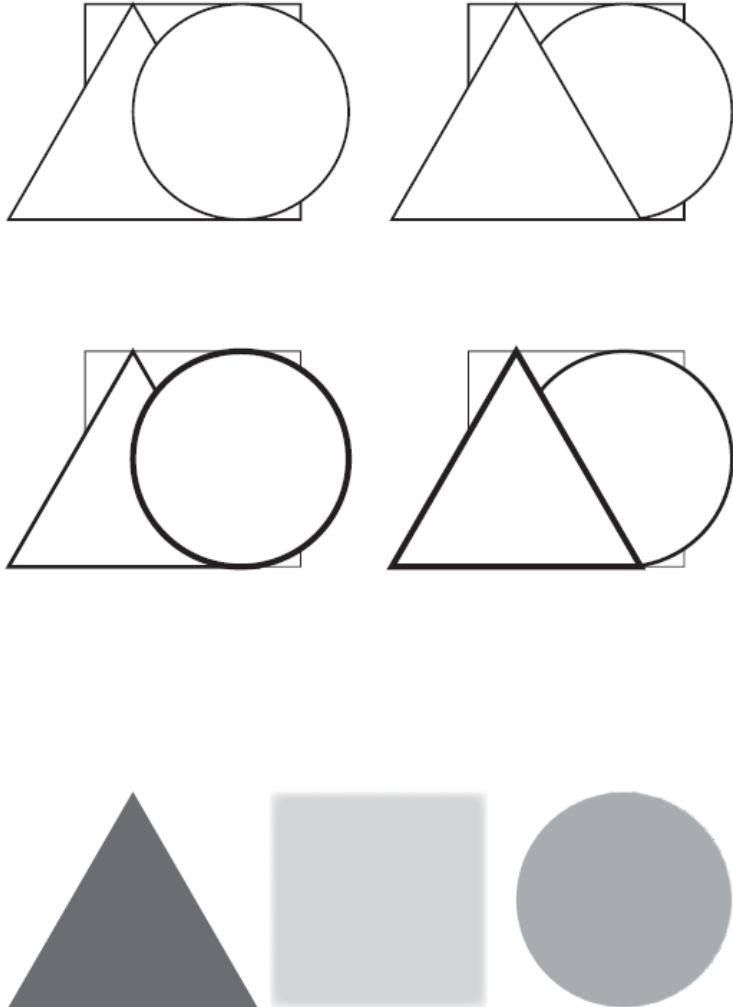
Elevations are normally drawn in a scale relative to the floor plans. 1:100  
Further detail can be emphasised at a larger scale. (1:50)



Hierarchy of Lines, showing depth in elevation



# Conventions - Depth

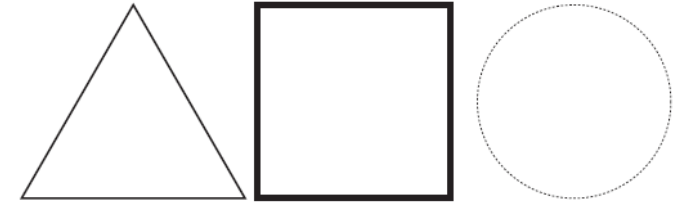


## Spatial Depth Cues

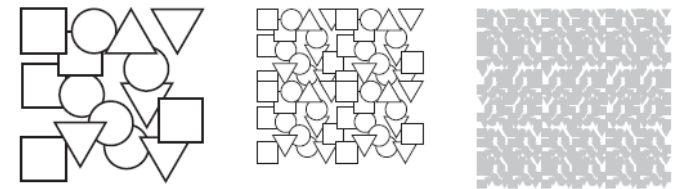
The examples on the previous two pages illustrate the use of varying line weights and detail to convey a sense of spatial depth in the drawing of building elevations. This series of drawings illustrates in a more discrete and abstract way how visual cues can enhance the sense of depth in any orthographic projection.

- **Continuity of Outline:** We tend to perceive a shape as being in front of another when it has continuity of outline and disrupts the profile of the other shape. Since this visual phenomenon relies on nearer objects overlaying or projecting in front of objects farther away, we often refer to this depth cue simply as overlap.
- By itself, overlap tends to create relatively shallow intervals of space. However, we can achieve a greater sense of intervening space and depth if we combine overlap with other depth cues, such as by varying the line weights of a pure-line drawing. Darker and thicker profile or contour lines tend to advance and appear to be in front of lighter and thinner outlines.
- **Atmospheric Perspective:** A progressive muting of hues, tonal values, and contrast occurs with increasing distance from the observer. Objects seen up close in the foreground of our visual field typically possess more saturated colors and sharply defined contrasts in value. As they move farther away, their colors become lighter in value and more subdued, and their tonal contrasts more diffuse. In the background, we see mainly shapes of grayed tones and muted hues.

- **Perspective of Blur:** This depth cue reflects the fact that we normally associate clarity of vision with nearness and blurring of outlines with farness. The graphic equivalent of perspective blur is a diminishing or diffusion of the edges and contours of more distant objects. We can use either a lightly drawn line or a broken or dotted line to delineate these edges of shapes and contours of forms that exist beyond the focus of a drawing.



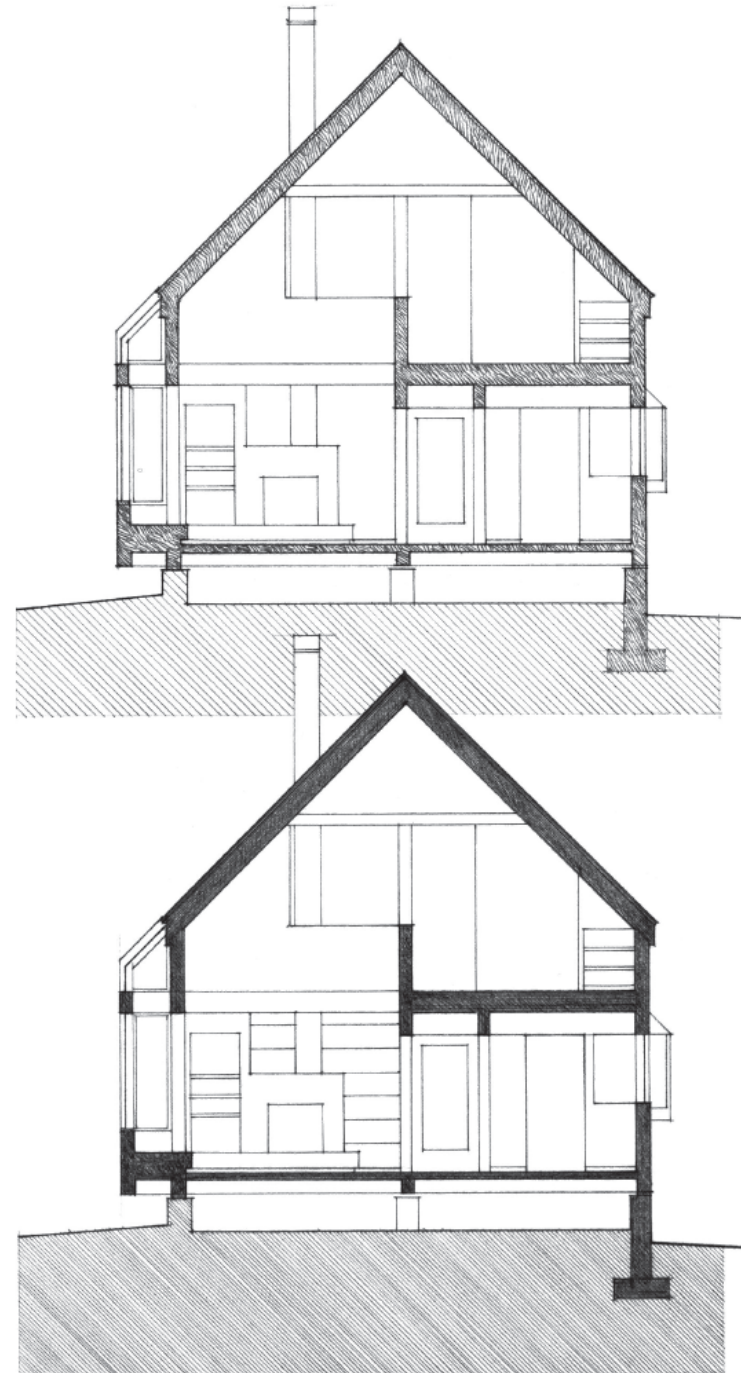
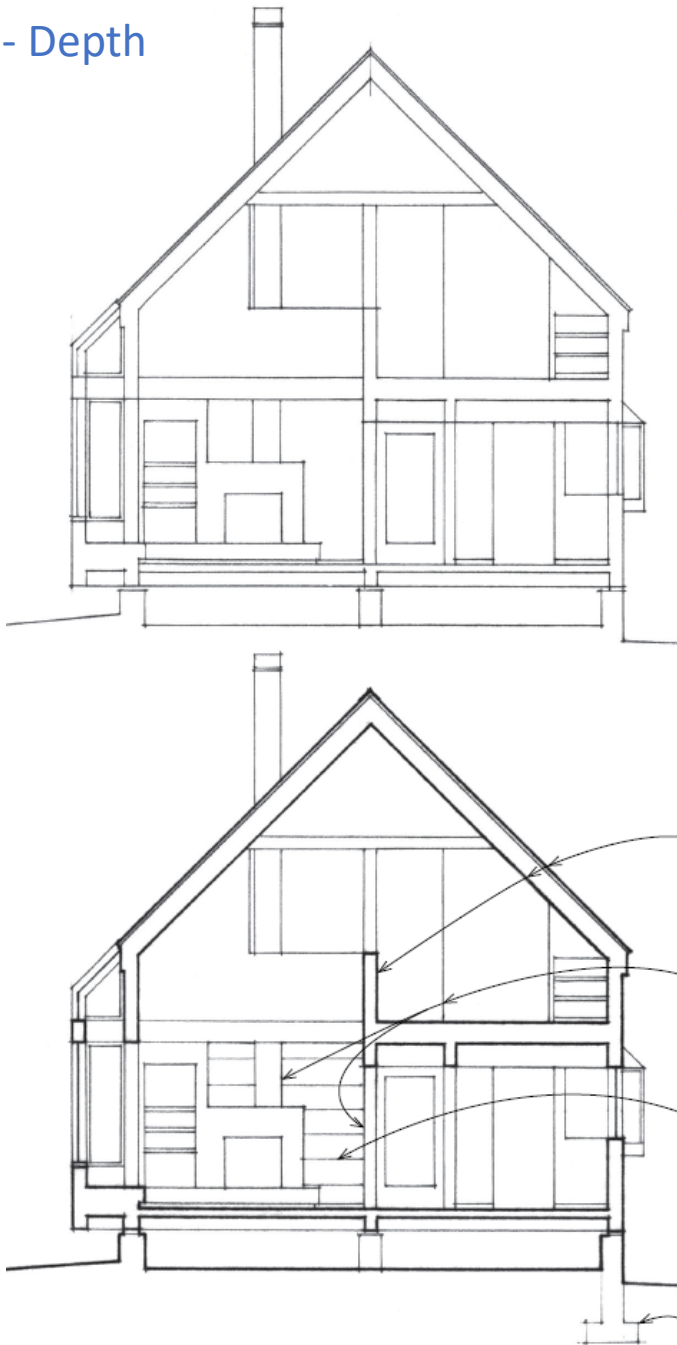
- **Texture Perspective:** The density of the texture of a surface gradually increases as it recedes into the distance. The graphic technique for depicting the visual phenomenon of texture perspective involves gradually diminishing the size and spacing of the graphic elements used to portray a surface texture or pattern, whether they be dots, lines, or tonal shapes. Proceed from identifying units in the foreground to delineating a textured pattern in the middleground and finally to rendering a tonal value in the background.



- **Light and Shade:** Any abrupt shift in brightness stimulates the perception of a spatial edge or profile separated from a background surface by some intervening space. This depth cue implies the existence of overlapping shapes and the use of contrasting tonal values in a drawing. See Chapter 7 for more information on the use of tonal values in architectural graphics.



## Conventions - Depth



CAD Packages can assist in demonstrating spatial depth through hatching.

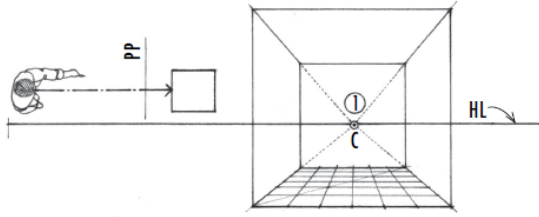
# Other Drawing Types

## TYPES OF PERSPECTIVE

In any rectilinear object, such as a cube, each of the three principal sets of parallel lines has its own vanishing point. Based on these three major sets of lines, there are three types of linear perspective: one-, two-, and three-point perspectives. What distinguishes each type is simply the observer's angle of view relative to the subject. The subject does not change, only our view of it, but the change of view affects how the sets of parallel lines appear to converge in linear perspective.

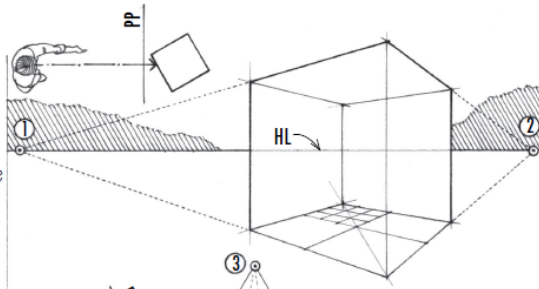
### One-Point Perspective

If we view a cube with our central axis of vision (CAV) perpendicular to one of its faces, all of the cube's vertical lines are parallel with the picture plane (PP) and remain vertical. The horizontal lines that are parallel with PP and perpendicular to CAV also remain horizontal. The lines that are parallel with CAV, however, will appear to converge at the center of vision (C). This is the one point referred to in one-point perspective.



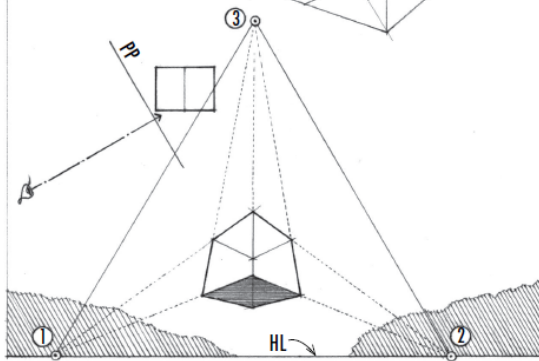
### Two-Point Perspective

If we shift our point of view so that we view the same cube obliquely, but keep our central axis of vision (CAV) horizontal, then the cube's vertical lines will remain vertical. The two sets of horizontal lines, however, are now oblique to the picture plane (PP) and will appear to converge, one set to the left and the other to the right. These are the two points referred to in two-point perspective.

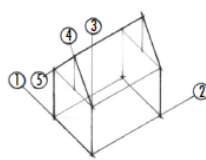


### Three-Point Perspective

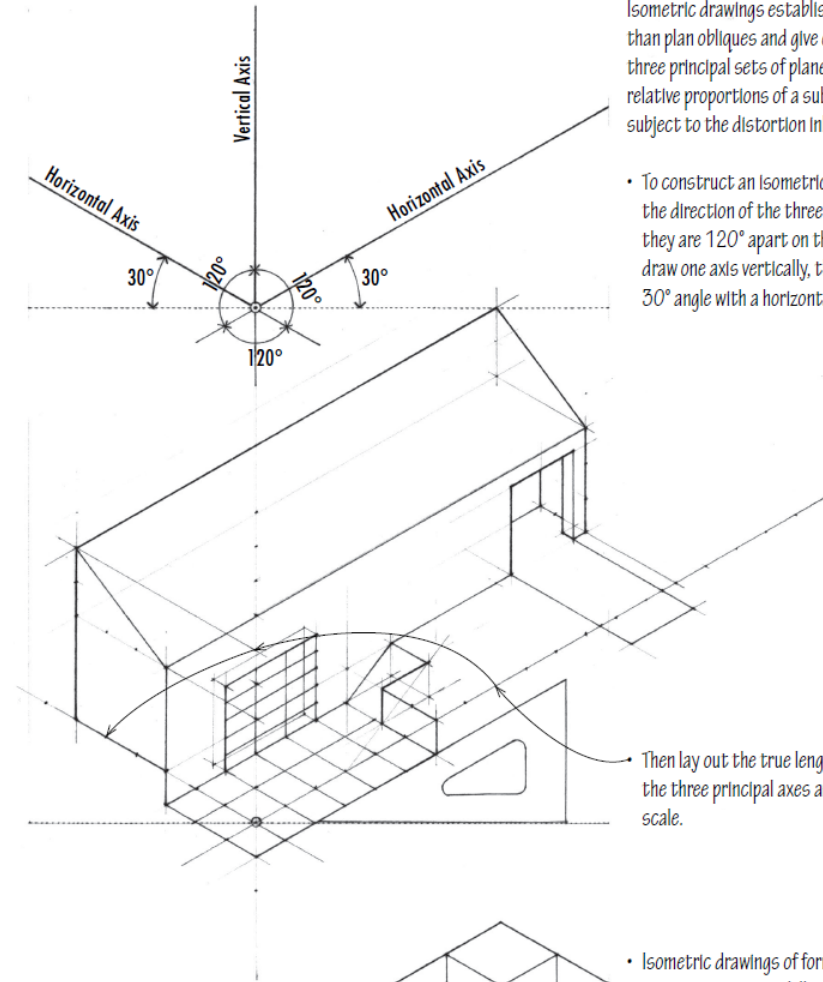
If we lift one corner of the cube off the ground plane (GP), or if we tilt our central axis of vision (CAV) to look down or up at the cube, then all three sets of parallel lines will be oblique to the picture plane (PP) and will appear to converge at three different vanishing points. These are the three points referred to in three-point perspective.



Note that each type of perspective does not imply that there are only one, two, or three vanishing points in a perspective. The actual number of vanishing points will depend on our point of view and how many sets of parallel lines there are in the subject being viewed. For example, if we look at a simple gable-roofed form, we can see that there are potentially five vanishing points, since we have one set of vertical lines, two sets of horizontal lines, and two sets of inclined lines.



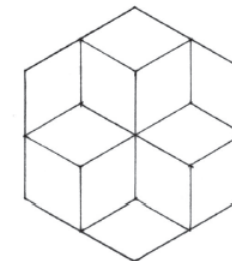
## ISOMETRIC DRAWINGS



Isometric drawings establish a lower angle of view than plan obliques and give equal emphasis to the three principal sets of planes. They preserve the relative proportions of a subject or scene and are not subject to the distortion inherent in oblique views.

- To construct an isometric drawing, first establish the direction of the three principal axes. Because they are 120° apart on the picture plane, if we draw one axis vertically, the other two axes make a 30° angle with a horizontal on the drawing surface.

Then lay out the true lengths of all lines parallel to the three principal axes and draw them to the same scale.



- Isometric drawings of forms based on the square can create an optical illusion and be subject to multiple interpretations. This ambiguity results from the alignment of lines in the foreground with those in the background. In such cases, a plan oblique might be a better choice.

CAD packages can assist in preparing views through snap grids and dynamic 3D modelling.