

## CAD Basics

### Objectives:

- To recognise different ways of calling commands.
- To understand the co-ordinate system.
- To specify points in the drawing window.
- To set and use object snap tools.
- To set and use drawing aids: snap mode, grid display, ortho mode and polar tracking.

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### Subject Matters:

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#### Drawing objects

A drawing object is referred to an AutoCAD graphical element, such as a line, an arc, text, dimension, etc. It is treated as a single element for creation, manipulation and modification. Also called entity.

#### Calling commands

There are three ways in which a command can be called for into action:

##### 1. Using a toolbar

Left-click on a tool icon from a toolbar to start a command and then respond to the prompts displayed on the command line or choose options in a dialogue box.

##### 2. Using the pull-down menu

Left-click the command on the menu bar to display the pull down menu, click to select the appropriate command and then respond to the prompts displayed on the command line or choose options in a dialogue box.

##### 3. Using the command line

Enter the command or its abbreviation on the command line, AutoCAD responds either a set of options or a dialogue box. Respond to the prompts displayed on the command line or choose options in the dialogue box.

Always keep an eye on the **command line** because this is where AutoCAD communicates with you. There may be more than one option for a command once a command is running and AutoCAD prompts for a response.

1. Options are listed on the command line [inside square brackets] and the required option can be selected by typing keyword letters.
2. Type all capitalised (keyword) letters of the desired option to use that option (most options have only one capital letter).
3. When an option appears inside <angled brackets> it can be invoked by pressing the **Enter** ↵ key.

4. A shortcut menu of those options inside [square brackets] can be invoked by a right-click in the drawing area, then select the required option.

To cancel the current command, press the **Esc** key or invoke a shortcut menu by a right-click in the drawing area and pick **Cancel**.

### The co-ordinate system

The co-ordinate system of AutoCAD is in x, y, z co-ordinate units. Drawings constructed using AutoCAD are in either a 2D system (where z=0), or 3D system.

1. When working in 2D the co-ordinates are expressed in terms of X and Y.
  - (i) X units are measured horizontally, being +ve to the right of the origin and -ve to the left.
  - (ii) Y units are measured vertically, being +ve above the origin and -ve below it.
2. When working with 3D the co-ordinates are expressed in terms of X, Y and Z.
  - (i) X and Y units are similar to 2D system.
  - (ii) Z units are measured perpendicular to the screen, being +ve if coming towards the operator from the drawing window perpendicular to the screen and -ve if it is perpendicular to the screen away from the operator.

With this co-ordinate system, any point in the drawing window can be referred to in terms of x,y for 2D system and x,y,z for 3D system.

### Locating a co-ordinate using absolute units

The absolute co-ordinates method locating a point requires the entry at the keyboard its X and Y values in the format X,Y of that point, e.g. 20,250.

### Locating a co-ordinate using relative units

The relative co-ordinates method locating a point requires the entry at the keyboard its X and Y values in the format @X,Y of that point in relation to the previous point. The symbol @ is used to differentiate between absolute and relative entry. Also called **Relative Cartesian Co-ordinates**.

E.g. A horizontal line AB of length 100 is drawn. The absolute co-ordinate of A is 15,30, then the relative co-ordinate of B is @100,0.

When drawing with the aid of the relative co-ordinates method, lines at an angle relative to the horizontal are constructed by keying the "<" symbol from the keyboard in the format @134<45 where 134 stands for the distance from the previous point and at an angle of 45° to the horizontal. Also called **Relative Polar Co-ordinates**.

E.g. An inclined line AB of length 100 is drawn 65° to the horizontal. The absolute co-ordinate of A is 15,30, then the relative co-ordinate of B is @100<65.

### Locating a co-ordinate using direct distance entry

Once the first point has been entered, the direct distance entry method locating a subsequent point requires moving the pointing device to indicate a direction and then entering the distance from the first point. This method is an efficient way to draw lines vertically and horizontally when **ORTHO** (ortho mode) or **POLAR** (polar tracking) is on.

### Object snaps

Object snaps are tools that provide a quick way to locate an exact position on an object without having to know the co-ordinate or drawing construction lines.

When an object snap is in operation, the positioning of points in the construction of drawings can be made with precision. The use of object snap allows the CAD operator to construct drawings by accurately *snapping* objects to various parts of other objects e.g. to the end point of a line, to the centre of a circle, etc.

### Calling the object snap toolbar

At start-up, it is the default that AutoCAD opens the **Draw** and **Modify** toolbars docked against the left hand edge of the drawing window. The object snap toolbar can be called for use by one of the following methods:

#### 1. From the **View** menu

Procedure:

- (i) Left-click **View** and choose **Toolbars...**
- (ii) The **Toolbars** tab of the **Customize** dialogue box appears.
- (iii) Click the box beside **Object Snap**.
- (iv) Close the **Toolbar** dialogue box.
- (v) Drag and dock the toolbar against the right hand edge of the drawing window.

#### 2. Right-click the displayed toolbar

Procedure:

- (i) Move the cursor hairs under mouse control until they point into a toolbar and the cursor changes to an arrow type.
- (ii) Right-click to invoke a shortcut menu of **Toolbars**.
- (iii) Select **Object Snap**.
- (iv) Drag and dock the toolbar against the right hand edge of the drawing window.

#### 3. Enter **toolbar** at the command line and the **Toolbars** tab of the **Customize** dialogue box appears. Then follow the same procedures as in 1 above.

Other toolbars can also be called for use in the same way.


















### Object snap tools

The object snap toolbar contains the following tools:

1. **Temporary tracking** – use to visually locate points relative to other points in the drawing
2. **Snap From** - establish a temporary reference point as a basis for specifying subsequent points

3. **Snap to Endpoint** - snap to the nearest endpoint of objects such as lines or arcs
4. **Snap to Midpoint** - snap to the midpoint of object such as lines or arcs
5. **Snap to Intersection** - snap to an intersection of objects such as lines, arcs, circles or splines
6. **Snap to Apparent Intersection** - snap to the intersection of two objects that do not intersect each other in 3D space but might appear to intersect on screen
7. **Snap to Extension** - snap to points along an extension of an arc or line
8. **Snap to Center** - snap to the centre of an arc, circle or ellipse
9. **Snap to Quadrant** - snap to the nearest quadrant point of an arc, circle or ellipse
10. **Snap to Tangent** - snap to a tangent point on a circle or arc from another object
11. **Snap to Perpendicular** - snap to the point on an object that forms a perpendicular with another object
12. **Snap to Parallel** - snap to an extension that is parallel to another object
13. **Snap to Insert** - snap to the insertion point of a block, or block attribute
14. **Snap to Node** - snap to a point object
15. **Snap to Nearest** - snap to a point object or to the location on another type of object that is nearest to the specified point
16. **Snap to None** - turns off any object snap in operation
17. **Object Snap Settings** - call the **Drafting Settings** dialogue box on screen displaying the **Object Snap** tab

**Abbreviation OSNAP mode**

TT		Temporary Tracking (NOT an osnap)
FROM		From (NOT an osnap)
ENDP		Endpoint
MID		Midpoint
INT		Intersection
APPINT		Apparent Intersection
EXT		Extension
CEN		Center
QUA		Quadrant
TAN		Tangent
PER		Perpendicular
PAR		Parallel
INS		Insert
NOD		Node
NEA		Nearest
NON		None
		Settings (NOT an osnap)

### Object snap overrides

The use of an object snap (osnap) allows snapping onto various geometric positions of objects. It helps drawing quickly and precisely without having to enter co-ordinates or perform tedious calculations. There are three ways to use an osnap override when AutoCAD prompts for a point:

1. Type the **abbreviation** of the desired osnap mode.
2. Left-click the desired **osnap mode icon** from the object snap toolbar.
3. Press and hold the <Shift> key and right-click in the drawing area to invoke a **shortcut menu** of osnaps, select the desired osnap mode.

### Running object snaps

An osnap override is only valid for the next point to pick and it is more efficient to use running osnap for several points. Running osnap has to be set in the **Object Snap** tab of the **Drafting Settings** dialogue box, which can be called for use in a variety ways:

1. Type **dsettings** on the command line.
2. Left-click the **Object Snap Settings icon** from the object snap toolbar.
3. Right-click on the **OSNAP** button in the status bar to invoke a shortcut menu and select settings...
4. From the **Menu** toolbar, select **Tools** ⇒ **Drafting Settings...** ⇒ **Object Snap** tab.

Procedure:

- (i) Call the **Drafting Settings** dialogue box on screen displaying the **Object Snap** tab.
- (ii) Check the desired osnap modes. More than one mode can be set at the same time.
- (iii) Check **Object Snap On**.
- (iv) Left-click **Options** to call the **Options** dialogue box.
- (v) Check the **Marker**, **Magnet**, **Display AutoSnap tooltip** and **Display AutoSnap aperture box** under **AutoSnap Settings** of the **Drafting** tab.
- (vi) Change the AutoSnap marker colour and marker size if necessary.
- (vii) Click **OK** twice to close the dialogue box.

Running object snap indicates the snap point when the pointing device is dragged over the object. The indications or visual cues of the snap point are:

1. **Marker** – a symbol that display the object snap location
2. **Magnet** – an automatic movement of the cursor that locks onto the snap point
3. **AutoSnap tooltip** - a description of the object snap
4. **AutoSnap aperture box** - a box at the centre of the cursor when one or more object snaps are selected

## OSNAP button

Running osnaps can be toggled **On** or **Off** at any time by left-clicking on the **OSNAP** button in the status bar. When it is off, running osnap settings are retained so they can be easily restored when required.

When **OSNAP** is **on** and AutoCAD is prompting for a point, a running osnap is invoked when the crosshairs moves over an object.

## Drawing aids

### Snap mode (SNAP)

It allows the pointing device to lock into alignment with a rectangular grid. When snap mode is on, the cursor movement is restricted to specified intervals as defined by the grid. A change in the snap grid affects only the co-ordinates of new points. Objects already in the drawing retain their existing co-ordinates.

### Grid display (GRID)

It is a pattern of dots that extends over the area specified by the drawing limits. Grid is used only for visual reference and does not appear in the printed drawing. The grid spacing can be adjusted anytime to suit the view magnification.

### Ortho mode (ORTHO)

It constrains the cursor movement to the horizontal or vertical directions (relative to the current snap angle and the user co-ordinate system, UCS).

### Polar tracking (POLAR)

It helps drawing objects at specific angles or in specific relationships to other objects. By default, polar tracking is set to a 30-degree increment angle. The polar increment angle can be changed and the increments at which the cursor snaps along polar alignment paths can be set when polar tracking and Snap mode are both on.

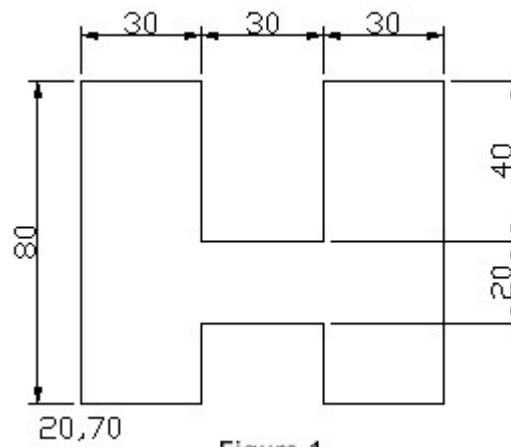
The use of these drawing aids can be toggled **On** or **Off** at any time by left-clicking on the corresponding button in the **status bar**.

To change the settings of these aids, call the **Drafting Settings** dialogue box, select the corresponding tab and change the settings as appropriate (right-click in the corresponding button will invoke a shortcut menu, select **Settings...** to call the **Drafting Settings** dialogue box).

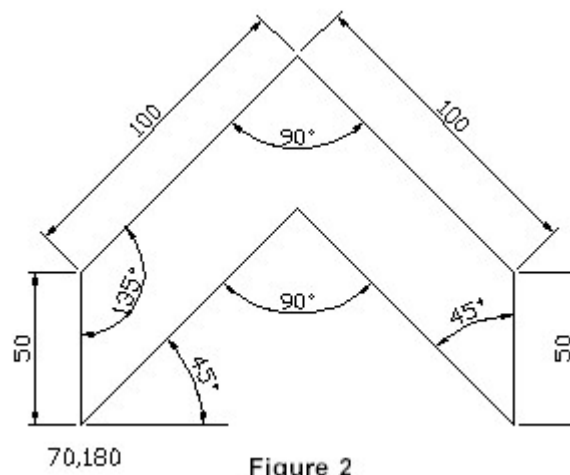
## Hands on practice

1. Select the **Line** tool from the **Draw** toolbar, draw the pattern shown in Figure 1 by
  - absolute co-ordinates method
  - relative co-ordinates method
  - direct distance entry
2. Select the **Line** tool from the **Draw** toolbar, draw the pattern shown in Figure 2 by relative polar co-ordinates method. The absolute co-ordinate of the starting point is 70,180.

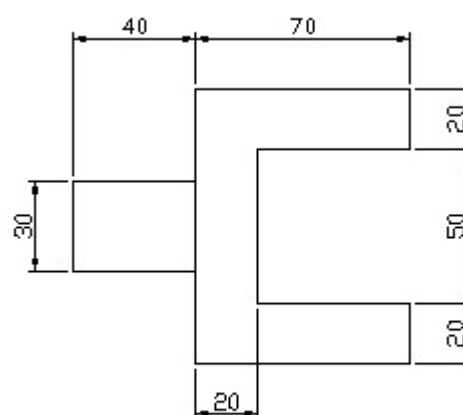
3. Select the **Line** tool from the **Draw** toolbar, draw the patterns shown in Figure 3.



**Figure 1**



**Figure 2**



**Figure 3**