



## Applying 2D Commands to 3D Solids

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Mohmed Zuber Shaikh  
AUGI India, Board of Directors



***Mohmed Zuber Shaikh, Civil Engineer by profession is associated with Sardar Sarovar Narmada Nigam Limited, Bharuch in India. He is enjoying AutoCAD capabilities since 1990- Release 10 – and still hanging on with different versions. 3D Modelling and training is his passion using AutoCAD and 3D studio MAX.***

Think 3D. As most of you are aware, AutoCAD provides numerous ways to accomplish the same task. Its open architecture and customization facility invites users to add more functionality, assisting their quest for new, easier ways of doing things. As AutoCAD is being widely used by the engineering community, new requirements and solutions suitable to them are being circulated in CAD magazines, e-magazines, and through Internet forums, further adds to the list of possible solutions. All of this activity takes place for a single reason: everyone in this world wants to finish the job, at its best, with minimum time requirement.

In this scenario, 3D is better and easier than 2D. 3D construction involves fewer commands but the result is far better than the 2D model. In AutoCAD you are working on real size, real shape, real-look model; hence, you don't need to find many ways for doing the same task. The easiest and most straightforward methods of 3D modeling are sufficient enough to pave a 'Think 3D' path for you. Just keep in mind that 3D is a concept and not a sequence of commands.

Do I sound "anti-2D?" No way. In this article, I will discuss the effective use of 2D commands on 3D solid models. What we refer loosely as 2D commands, can be used very effectively on 3D solid modeling objects. There is no special category called 2D commands, but I am referring to those commands that you have grown accustomed to in your routine drafting. It is unfair to separate commands based on the 2D or 3D capability of the command. If you really wanted to divide all AutoCAD commands into two segments, a more reasonable division would be this:

1. Commands that work on the current XY plane only.
2. Commands that work across the planes.

I am separating commands into two segments purely to enhance your understanding of 3D. The comparisons will lead to a better understanding of the XY plane and the concept of UCS.



For example, Pline cannot be drawn across the planes, but line can be. Rotate works on current the XY plane only. For rotation across the planes, there is a separate command called Rotate3D. I would like to discuss all such 2D commands, which can make difference when doing 3D solid modeling in AutoCAD.

- Copy command can be used effectively on a 3D solid object or whole assembly of 3D solids. There is no separate command for duplicating 3D solids.
- Move command is another modification tool common between 2D and 3D.
- Mirror command can be used for mirroring any AutoCAD objects including 3D solids, but mirroring is limited to the current XY plane only. There is a separate command called Mirror3D for mirroring across planes.
- Offset duplicates a 2D object depending on type of object chosen. Offset cannot be operated on a solid object in its true sense of perpendicular duplication. Use the Copy command on solid objects for obtaining offset effect. The offset of a 3D solid face is possible and it is covered under the command Solidedit.
- Array is capable of multiple duplication in Row and Column. It is effective on 2D as well as 3D solids. An array of 3D street lights, road center line objects, road side grill, bench marks, etc. requires duplication on one plane; hence, Array can be used to advantage. A command called 3Darray is also available for multiple duplication in Row (X direction), Column (Y direction), and Level (Z direction) fashion.
- Scale can enlarge or reduce an object in two directions for 2D and in three directions for 3D.
- The Stretch command is limited to 2D objects only. If you try to stretch a 3D solid object using this command, the object will move, but it will not stretch.
- Trim, Break, Lengthen, Join, Extend, Divide, and Measure cannot be used directly on 3D solid objects, but they can be trimmed or broken using the Slice command. The 3D solid can be enlarged or reduced in size by various options of Solidedit. (This aspect of Solid editing alone could fill a separate article!)
- Chamfer and Trim are very effective on both types of objects.
- The Block - Insert - Minsert - Wblock mechanism is useful for solid modeling, too. While using this set of commands, you need to be careful about the alignment of your current UCS. I'll address this later in the article.
- Concepts of Layer & Coloring are extremely important to 3D solids. In 2D drafting they make drawing management easy and effective. In 3D Modeling, you cannot survive without Layers and Colors.
- Dimensioning works on current the XY plane only; hence, UCS alignment plays a major role when dimensioning 3D solid object.
- Text - Dtext - Mtext are similar to dimensioning, working on the current XY plane. UCS alignment plays a major role here, too.

Here are some examples that go along with the above discussion.

### Copy

Duplication of object(s) at the appropriate location is easy if you use the COPY command in 3D view. In the views similar to figure 1, object snapping points are clearly visible; hence, Osnap on points for searching base point and second point of displacement is easier than any other Plan view. When copy is to be performed based on existing points, copying in 3D view is best.

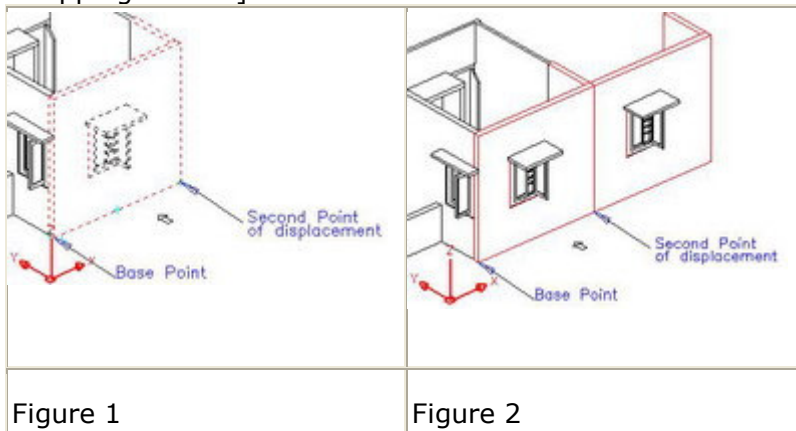
Command: COPY

Select objects: Specify opposite corner: 15 found

Select objects: Press Enter

Specify base point or displacement, or [Multiple]: Select Point as shown in figure 1 [End of object snapping is used]

Specify second point of displacement or : Select Point as shown in figure 1 [End of object snapping is used]



The walls and window we have copied in 3D view above can also be copied with the same result while remaining in WCS plan as shown in figure 3. As objects are to be copied in only X direction, you can select any point on screen (without object snapping) as base point. The second point of displacement is to be assigned by relative coordinate method.

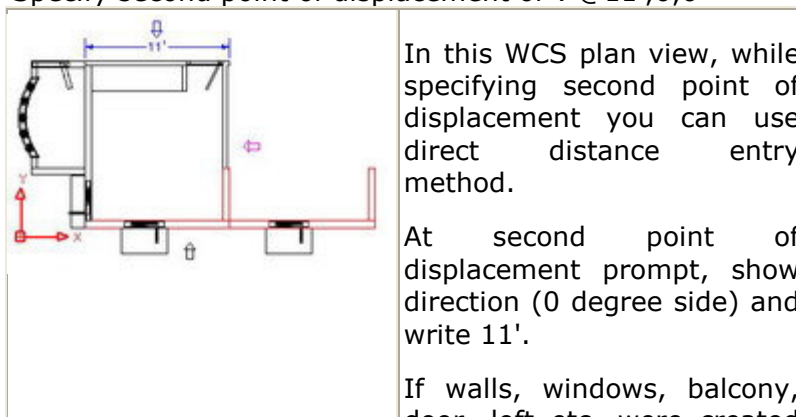
Command: COPY

Select objects: Specify opposite corner: 15 found

Select objects: Press Enter

Specify base point or displacement, or [Multiple]: Select Point anywhere on screen [No osnap]

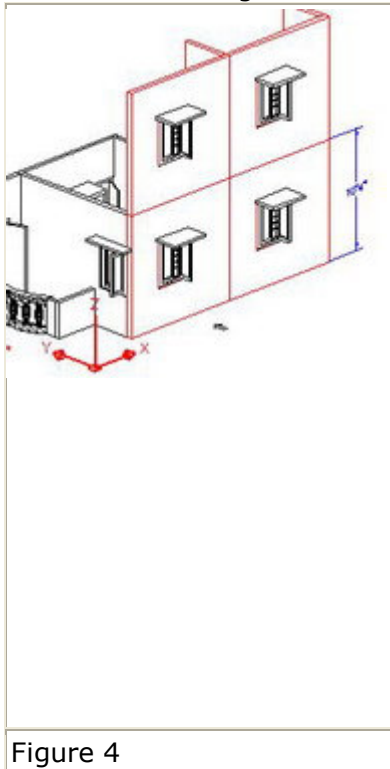
Specify second point of displacement or : @11',0,0





	on different layers, editing like copy would be less painstaking. You can make layers of other objects 'OFF' to avoid accidental selection of objects in window selection.
Figure 3	

While remaining in plan view similar to Figure 3, you can copy walls and windows in Z direction also. Though Z direction is not visible in this plan view, walls and windows can be copied in Z direction to be a part of First Floor of building. The command sequence will be exactly similar to above but having the difference of Specifying second point of displacement by writing @0,0,10'4" The result of ground floor objects copied to first floor will be as shown in figure 4.

	<p>As Copying to First Floor is not visible in Plan view, the third quadrant view is shown here.</p> <p>Copy, Move, and Rotate are being used frequently in AutoCAD. Get comfortable with these commands from all possible UCS 3D view and Plan Views. Let's assume that original walls were on layer called Fwall, then all copied walls will be also on Fwall layer.</p> <p>You are Superman in the virtual world! Lift first floor objects 4" in Z direction using MOVE command and slip BOX of 4" to be treated as a slab.</p>
Figure 4	

### **Mirror**

As mirroring is performed on XY plane only, you need to be little cautious about current alignment of UCS. You are defining a mirror line by selecting two points on same plane. There is a separate command called Mirror3D for performing 3D mirroring. In case of Mirror3D command, the mirror plane is defined (not mirror line) and hence you can mirror objects across planes.

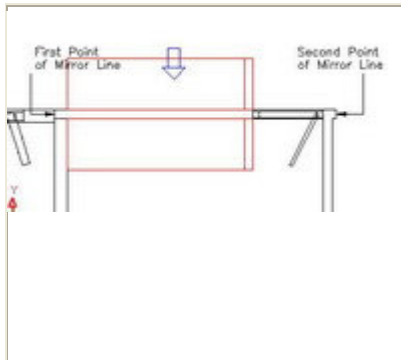


Figure 5

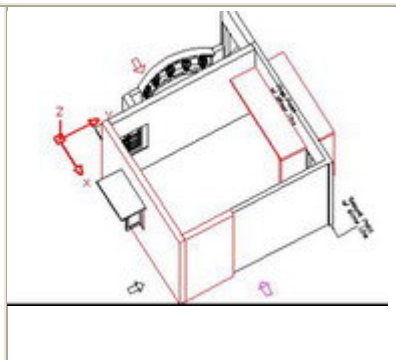


Figure 6

### Array

Array is used for multiple duplication of objects. The multiple duplication is done either in Rectangular (row and column) fashion or Polar (circular) fashion. In the following example, we will use the same set of objects that we used for the Copy demonstration. The UCS setting in this example is UCS>G>Front. The PLAN view of this setting will provide you the view similar to Front Elevation view of your 2D drawing. Now you are in your comfort zone of 2D XY plane. Just do array, as you must have done on 2D objects before.

The result of Rectangular array in 2 Rows and 3 Columns, having Row Offset 10'4" and Column Offset 11' is displayed in figure 7

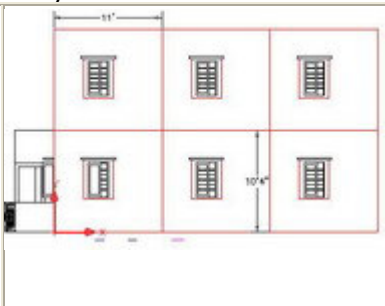


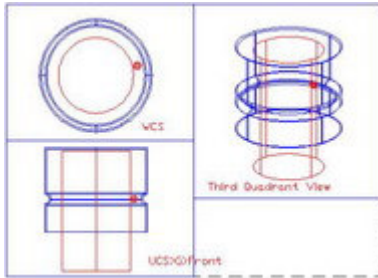
Figure 7

The polar or circular array can be performed on 3D solids if multiple copies required are spreading in circular fashion and on the same plane. In the following example, array is performed while remaining in WCS. Other views are displayed for visual understanding of its effect on associated solids.

Can you perform polar array in WCS plan view? Yes.

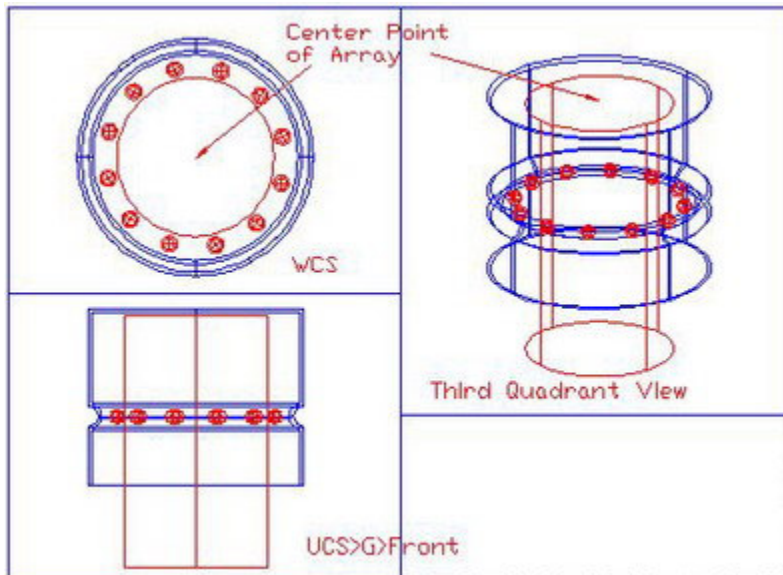
Can you perform polar array in UCS>G>Front? No.

As circular copying of bearing balls is to be performed on the XY plane of WCS, do array from this view.



**Figure 8**

- Start array command.
- Click on Polar array radio button.
- Select object - steel ball (it is drawn by Sphere command) shown in figure 8.
- Provide center point of array as shown in figure 9.
- Total number of balls required is 12.
- 12 balls to be distributed in 360 degree.



**Figure 9**

### Block

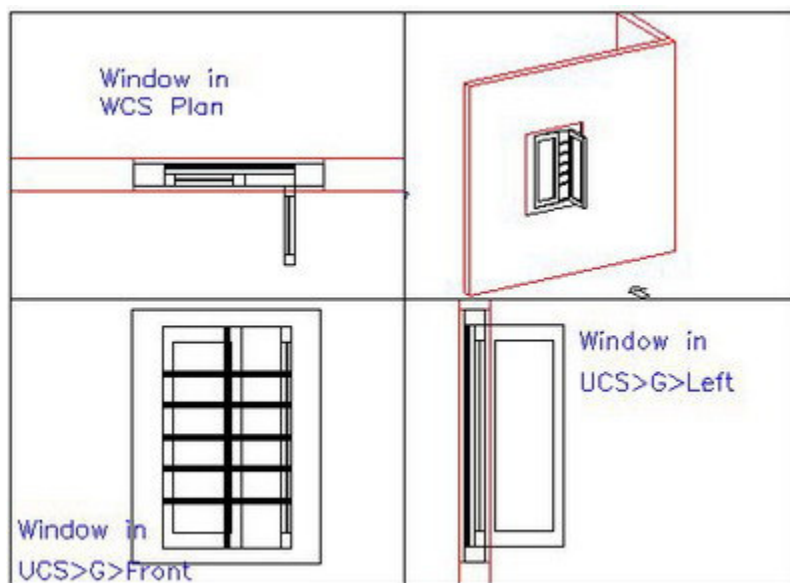
Grouping of objects under a unique name is called Block making. You must have created 2D block library for furniture, windows, doors, nuts, bolts, etc. Many such objects are readily available in AutoCAD. Just navigate to Design Center and discover ready-to-use blocks of various engineering disciplines.

The same concept of blocks can be used effectively on 3D solids. To understand this concept, we'll explore a window. The window modeled below contains 12 solids representing frame, shutters, glass panels, steel rods, and so on. If it is to be duplicated on another wall, you need to copy it by selecting all 12 objects. If you miss the main frame of the window



while copying, 11 window objects will be copied without the frame. This may not be noticed immediately if you are working on a project that contains a jungle of solids. It is better to convert those 12 objects into a block with a unique name such as Win3x4. The name is self-explanatory—windows of 3 feet by 4 feet. Once 12 objects are grouped as a single object, they can be copied or moved via single object selection.

Same command and dialog box are used for 3D block creation. But a word of caution: block will remember UCS icon alignment (X,Y,Z direction) as it existed at the time of block creation and will be inserted by aligning X direction of the block with current X direction of UCS. Similarly Y and Z of block will align with current Y and Z of UCS. Use the command Block to convert Window objects into a block while remaining in WCS plan view.



**Figure 10**

The block name assigned is Win3x4, having as a base point the lower left corner of window.

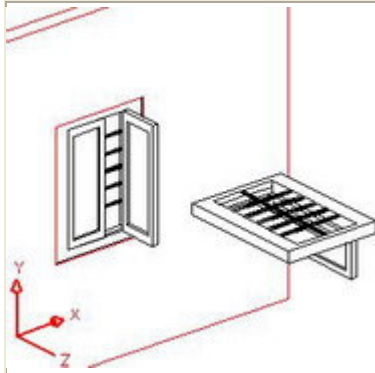
While inserting block you must remember that:

- X direction at the time of block definition will align with X direction of UCS setting at the time of block insertion.
- Y direction at the time of block definition will align with Y direction of UCS setting at the time of block insertion.
- Z direction at the time of block definition will align with Z direction of UCS setting at the time of block insertion.
- Use .xy point filter at the time of block insertion.
- XYZ option of Insert command allows you to change X scale, Y scale, and Z scale at the time of block insertion. Insertion Scale 1 means equivalent to size used at the time of block definition.
- Once the window is inserted, it will behave like one object. You can copy, move, rotate, and align as per your requirements.



- The width 3 feet is in X direction, Frame thickness 6 inches is in Y direction and height 4 feet is in Z direction at the time of block definition.

What will happen if your current UCS setting is UCS>G>front and you are trying to insert window block defined in WCS?

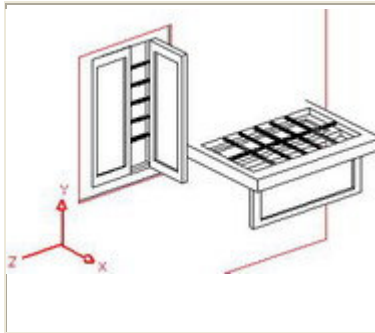


As you can see in figure 11, the 3 feet width is still trying to match current X direction and 4 feet height is trying to span in current Z direction.

No. This is not what you want.

Figure 11

What will happen if your current UCS setting is UCS>G>Left and you are trying to insert window block defined in WCS?



As you can see in figure 12, the 3 feet width is still trying to match current X direction and 4 feet height is trying to span in current Z direction.

No. This is not what you want.

Figure 12

The conclusion is simple. Keep your eyes on UCS while you are inserting the block. In fact, keep your eyes on UCS while doing anything in 3D space.

I feel jealous of people who got a free demo CD of AutoCAD 2007. The reason is simple: AutoCAD 2007 thinks 3D.