

## Back to Flat – Producing 2D Output from 3D Models

David Cohn

**AU122-2** Modeling in 3D is fine, but eventually, you need to produce 2D drawings. In this class, you'll learn about tools in AutoCAD® that let you quickly take 3D models and represent them in 2D to create orthographic, section, and detail views. Discover which methods let you quickly update your 2D views when the 3D model changes. We'll look at each tool and consider the pros and cons of each to develop best-practices suited to your particular needs. Don't draw it twice; leverage the power of 3D to create your 2D drawings.

### **About the Speaker:**

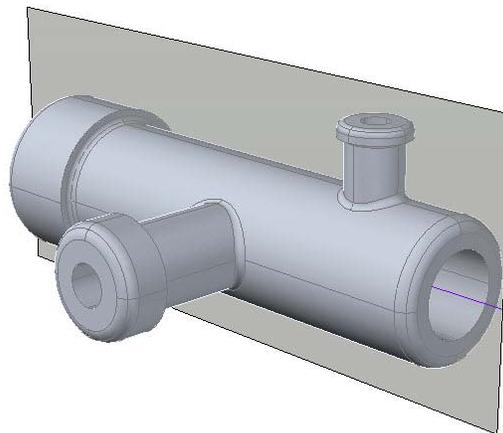
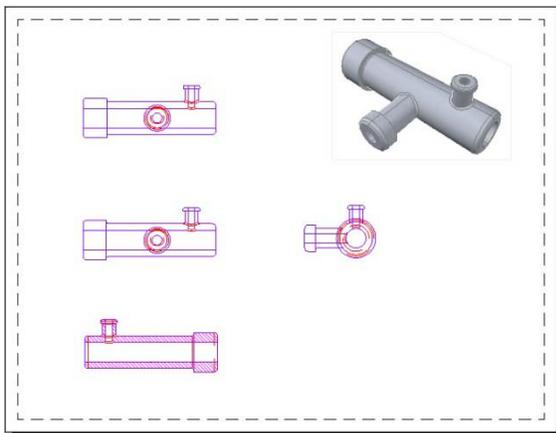
David has more than 25 years of hands-on experience with AutoCAD® as a user, developer, author, and consultant. He is an independent CAD consultant, a contributing editor to *Desktop Engineering* magazine, the former publisher and editor-in-chief of *CADCAMNet* and *Engineering Automation Report*, the former senior editor of *CADalyst* magazine, and the author of more than a dozen books about AutoCAD. A licensed architect, David was also one of the earliest AutoCAD third-party software developers, creating numerous AutoCAD add-on programs. As an industry consultant, David has worked with many companies including Autodesk. He teaches college-level AutoCAD courses and is always a popular presenter at both Autodesk University and AUGI® CAD Camps.

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People have been creating two-dimensional drawings using AutoCAD for many years. And while it's often easier to actually model real-world objects in 3D, eventually you will probably need to create two-dimensional drawings of those three-dimensional objects. You don't have to manually create all of those 2D drawings. AutoCAD provides tools that can create those views automatically directly from the 3D objects. These tools include:

- Section Plane
- Live Section
- Add Jog
- Create Block
- Flatshot

There are also three related tools—Solid View, Solid Drawing, and Solid Profile—that can be used to create two-dimensional representations of 3D objects and place them in a paper space layout in a way that mimics conventional 2D drafting. We will look at this legacy method as well, but it lacks many of the advantages of the newer tools in AutoCAD.

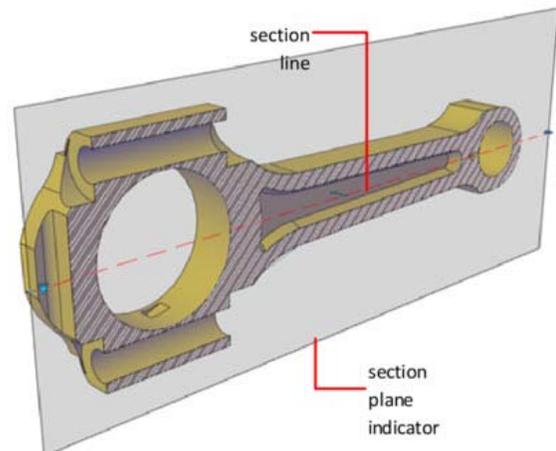


## Working With Section Planes

The Section Plane tool (SECTIONPLANE command) lets you create one or more section objects and place them wherever needed within a 3D model. These planes can be moved through a model composed of 3D solids, surfaces, meshes, and regions to obtain different views.

The section plane contains a section line that stores the section object properties. You can create multiple section objects to store different properties.

Once you've created the section plane, you can turn on live sectioning to see the inner details. You can even move the section plane through the 3D model to see various portions of the cross section in real time. And once you've got section planes positioned where you want them, you can use the section planes to create 2D blocks of the section and elevation views and place those views into a drawing to create two-dimensional documentation.



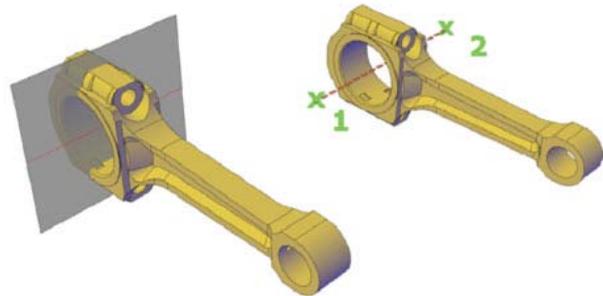
If you subsequently make changes to the 3D model, you can easily update the blocks created based on those section planes to quickly update the two-dimensional views to reflect those changes.



In order to create a cross section, you must first create a section plane, which you can do by using the Section Plane tool in the Section panel of the Home ribbon tab (when working in the 3D Modeling workspace). Note that these tools are also available in the Section panel on the Mesh Modeling ribbon tab.

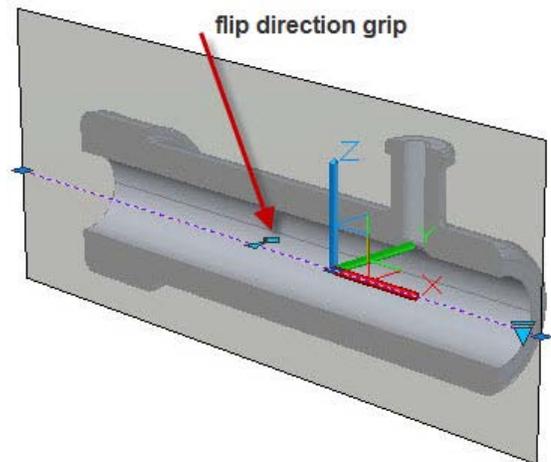
The section plane is created on the current layer, so you may first want to create a new layer on which the section plane will be created. That way you can control its visibility separately from the other objects in the drawing.

When you start the SECTIONPLANE command, AutoCAD prompts you to locate the section plane. You can select a face or any other point on the object to locate the section line. There are also options that enable you to align a section plane to one of the standard orthographic views, or you can draw the section plane.



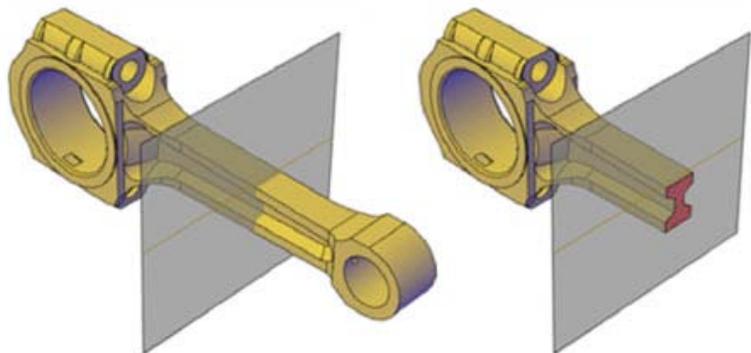
Once the section plane has been created, you can then move it as you would any other object in the drawing. One of the best ways to move the section plane is to select it and then use the 3D Move Gizmo.

Even after the section plane has been positioned, it isn't actually cutting anything yet. To have the section plane show the cross section, you need to turn on live sectioning. You can do this one of two ways. If you click the Live Section tool, available by expanding the Section panel of the Home ribbon tab, AutoCAD prompts you to select a section object. As soon as you select the section plane, AutoCAD uses that plane to display a cross section through the model. You can also select the section plane, right-click, and choose Activate Live Sectioning from the shortcut menu.



Live sectioning is a toggle. When turned on, the section plane cuts through the model, displaying it as a cross section. When turned off, the section plane remains visible but the model is no longer shown in cross section.

If the section is looking in the wrong direction, you can flip it by clicking the small arrow, the Direction grip, located near its midpoint grip.



live sectioning turned off

live sectioning turned on

## Adding Jogs to a Section Plane

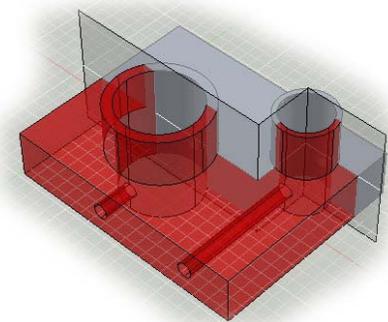
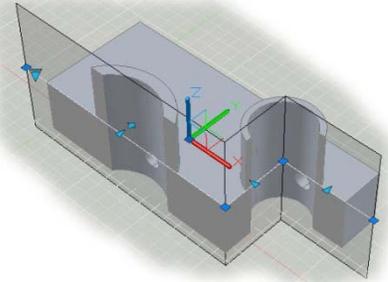
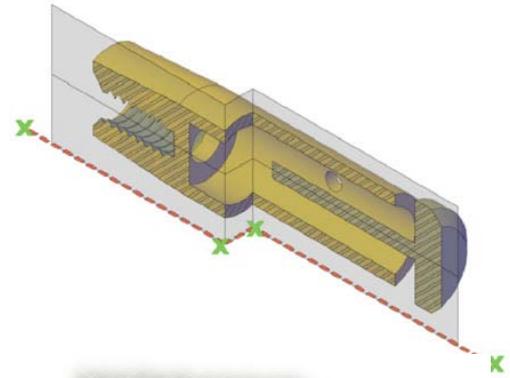
When you first create a section plane, it is a single plane that follows the path of the section line. But sometimes the 3D models you create are not symmetrical. Sometimes you may want to jog the section so that it cuts through the most interesting portions of the 3D model. This is quite easy to do using the Add Jog tool.

You can add a jog to a section plane by using the Add Jog tool (SECTIONPLANEJOG command), available by expanding the Section panel, or by right-clicking the section plane and choosing Add Jog to Section from the shortcut menu.

After starting the command and selecting the section plane, AutoCAD prompts you to specify a point on the section line to add the jog. It is often helpful to change the orientation of the view so that you can better see where you are positioning the jog. Click on the section plane where you to add the jog. The Nearest object snap is temporarily turned on to help you place the jog. The jog is immediately created perpendicular to the selected section.

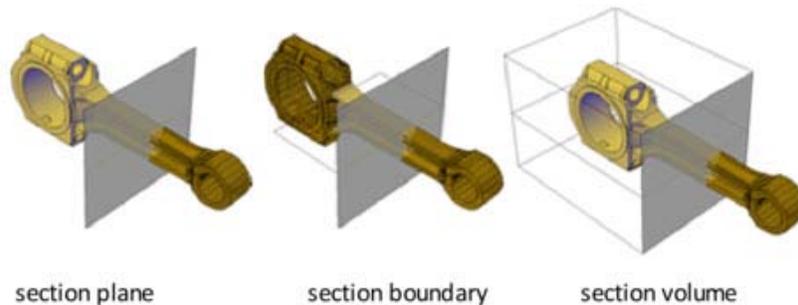
Note that after adding the jog, if it isn't positioned where you want it, you can reposition the jog by dragging the section object grips. You can also use the Add Jog tool again to add additional jogs to the section plane.

You can also choose Show Cut-Away Geometry from the shortcut menu to display the portion of the 3D model on the opposite side of the section plane.



## Changing the Section Object States and Using Grips to Modify Section Objects

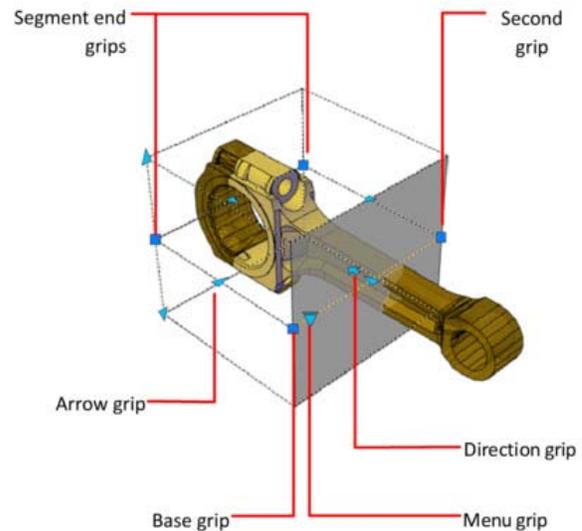
When you select a section plane object, several of its grips become visible, including a Menu grip and the Direction grip. If you click the Menu grip, you can change the display of the section object to one of three possible display states:



- **Section Plane.** The section line and transparent section plane indicator are displayed. The cutting plane extends infinitely in all directions.
- **Section Boundary.** A 2D box shows the XY-extents of the cutting plane. The cutting plane along the Z-axis extends infinitely.
- **Section Volume.** A 3D box shows the extents of the cutting plane in all directions.

Depending on the section plane display state, various additional grips also become visible when you select the section object. You can then use these grips to move and resize the section object to adjust the location, length, width, and height of the cutting area.

- **Base grip.** Acts as the basepoint for moving, scaling, and rotating the section object. It always displays adjacent to the Menu grip.
- **Second grip.** Rotates the section object around the base grip.
- **Menu grip.** Displays a menu of section object states, which control the display of visual information about the cutting planes.
- **Direction grip.** Controls the viewing direction of the 2D section. To reverse the viewing direction of the section plane, click the Direction grip.
- **Arrow grip.** (Section boundary and Volume states only.) Modifies the section object by modifying the shape and position of the section plane. Only orthogonal movements in the direction of the arrow are permitted.
- **Segment end grips.** (Section Boundary and Volume states only.) Stretches the vertices of the section plane. You cannot move segment end grips so that segments intersect. Segment end grips are displayed at the endpoints of jogged segments.



Note that unlike other types of grips in AutoCAD, you can select only one section grip at a time. You cannot press the SHIFT key to select multiple section grips.

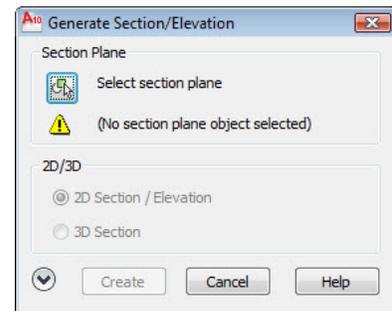
## Creating 2D Sections and Elevations

Once you have created and positioned section planes, you can save the representation of the cross-sectional area where the section object intersects the 3D model as a block. You can then use that block to create two-dimensional documentation.

To create a block from a section object, use the Create Block tool (SECTIONPLANETOBLOCK command), which can be found by expanding the Section panel on the Home ribbon tab. Note that this same tool, labeled Generate Section, appears in the Section panel of the Mesh Modeling tab. You can also select a section object, right-click, and then choose Generate 2D/3D Section from the shortcut menu.

When you use this tool, AutoCAD displays a Generate Section/Elevation dialog. Note that the dialog box may initially display in a reduced state. You can click the arrow in the lower-left corner to expand the dialog.

If you start the command from the ribbon and no section object has been selected, the dialog box displays an alert and you must click the Select Section Plane button and select the section plane you want to use to create the block before proceeding.



Once you've selected a section plane, the other controls in the lower portion of the dialog become available.

**2D/3D** These controls let you choose to create a two-dimensional section/elevation or a 3D section.

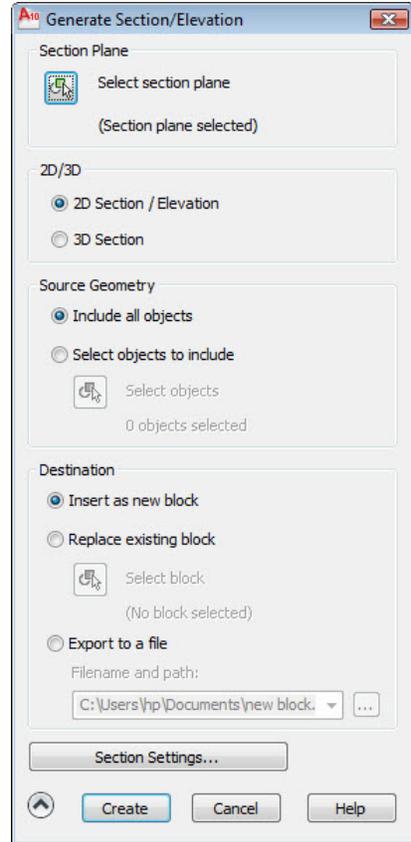
**Source Geometry** These controls let you choose to include all of the 3D objects in the drawing (including objects in xrefs and blocks) or manually select just those objects you want to include.

**Destination** These controls let you choose to insert the section/elevation as a new block, replace an existing block, or export the geometry to a separate drawing file.

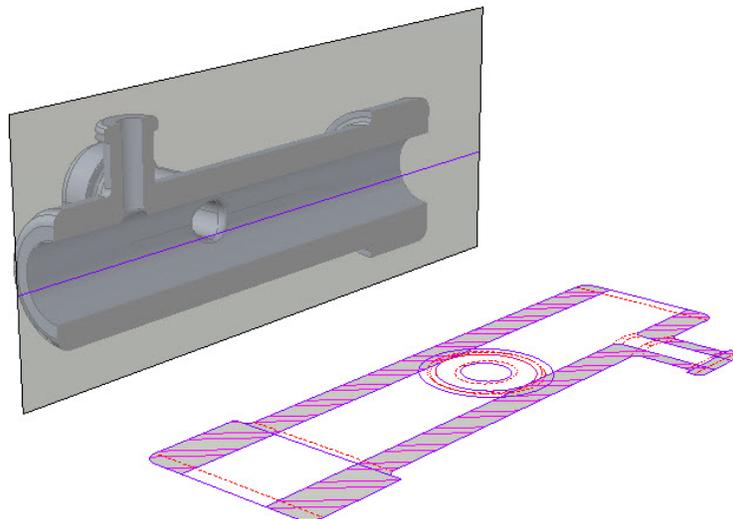
**Section Settings** This button displays the Section Settings dialog.

To create a two-dimensional cross section and insert it as a block in the current drawing:

1. Open the Generate Section/Elevation dialog.
2. Select the section plane from which you want to create the section.
3. In the 2D/3D area, choose 2D Section/Elevation.
4. Under Source Geometry, choose Include All Objects.
5. Under Destination, choose Insert As New Block.
6. Click the Create button.
7. In the drawing, specify an insertion point for the block and press ENTER to accept the default values for scaling and rotation angle.



An unnamed block is inserted consisting of the 2D cross-section geometry. The block is inserted on the current layer and aligned with the current UCS.



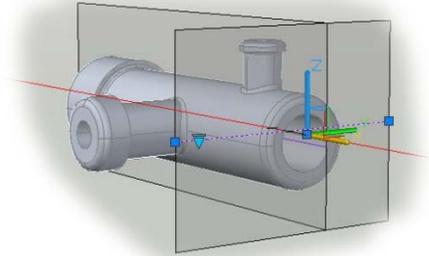
If you subsequently make changes to the 3D model, you can repeat this process, but instead of inserting a new block, you can choose Replace Existing Block and then select the block you previously created. AutoCAD immediately updates the block to reflect the changes you made to the 3D model.

## Creating 2D Elevations

You can use this same method to create two-dimensional elevations, but instead of creating section planes that cut through the model, you can position section planes away from the 3D objects. The object is then projected onto the section plane, creating an elevation view.

To create an elevation of the right side of a 3D object:

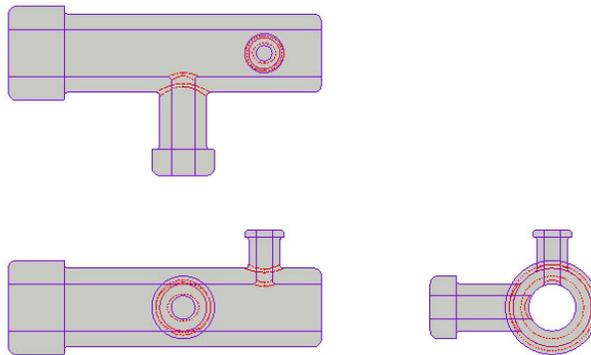
1. Start the Section Plane tool.
2. Right-click and choose the Orthographic option.
3. Right-click and choose the Right orthographic alignment.  
AutoCAD immediately creates a new section plane and places it within the 3D model.
4. Select the section plane and use the 3D Move Gizmo to pull it along the X-axis until the plane is outside the volume of the 3D model.



Once the new section plane has been created, you can use the tools in the Generate Section/Elevation dialog to create a new two-dimensional block that shows the 3D model projected onto the section plane and place that block into your drawing. Again, if you subsequently make changes to the 3D model, you can use the tools in the Generate Section/Elevation dialog to replace the block with an updated version.

To create additional elevations, simply position additional section planes using the other orthographic alignments. You can create as many section planes as necessary. Remember that each section plane is created on the current layer. You may want to create additional layers to control the visibility of the additional section planes you create.

As you insert each additional elevation view block, remember that you can use the Basepoint option during block insertion to align each block in its proper relationship. This will make it easier to organize the orthographic views when you create viewports and place them on a paper space layout.



## Controlling Section Settings

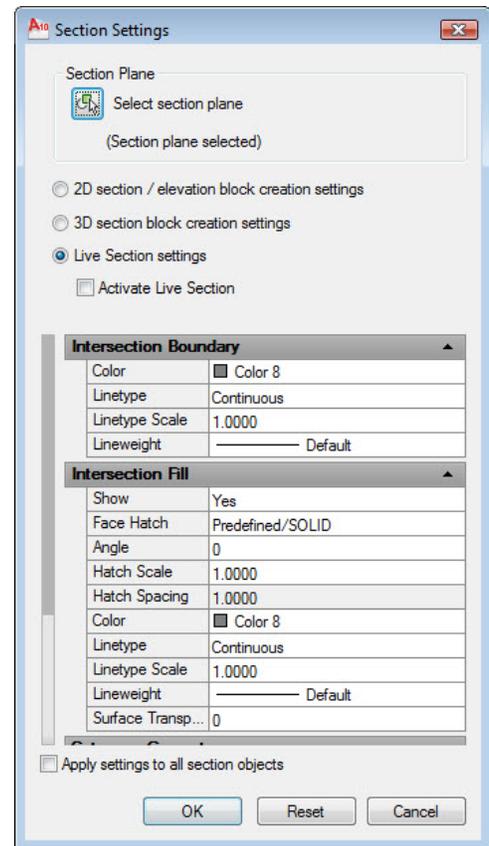
When you create or update sections or elevations based on a section plane, you can control various aspects of those views using the Section Settings dialog.

To display the Section Settings dialog, click the arrow in the lower-right corner of the Section panel on either the Home or Mesh Modeling ribbons (SECTIONPLANESETTINGS command). You can also display this dialog by clicking the Section Settings button in the Generate Section/Elevation dialog or by selecting a section plane and then right-clicking and choosing Live Section Settings from the shortcut menu.

The Section Settings dialog contains display settings for creating 2D and 3D sections and for live sectioning. Note that if a section plane was not already selected when you open the Section Settings dialog, you must select one (by clicking the Select Section Plane button) before you can adjust any of the settings.

The section settings are stored separately for each section plane. The radio buttons in the upper portion of the dialog determine which settings types are displayed in the properties list.

- **2D Section/Elevation Block Creation Settings** Determines how a 2D section or elevation from a 3D object is displayed when generated.
- **3D Section Block Creation Settings** Determines how a 3D object is displayed when generated.
- **Live Section Settings** Determines how sectioned objects are displayed in the drawing when live sectioning is turned on.
- **Activate Live Section** (Available only when the Live Section Settings option is selected.) Turns on live sectioning for the selected section object.



The controls in the properties list in the lower portion of the dialog set the properties to be applied to the new section block. This list is divided into three, four, or five sections, depending on the type of section setting selected.

**Intersection Boundary** Sets the appearance of line segments that outline the intersection surface of the section object plane.

**Intersection Fill** Sets the optional fill that is displayed inside the boundary area of the cut surface where the section object intersects the 3D object.

**Background Lines** (2D and 3D section blocks only.) Controls the display of background lines.

**Curve Tangency Lines** (2D section blocks only.) Controls the inclusion of curved lines that are tangent to the section plane.

**Cut-Away Geometry** Sets the properties for the cut-away objects.

Controls in each section let you determine whether the particular type of objects are displayed, and if displayed, their color, layer, linetype, linetype scale, lineweight, and so on.

For example, when generating a cross section, you can select the hatch pattern applied to the sectioned geometry and control the pattern's various settings, such as hatch scale and hatch angle. The layer controls enable you to select an existing layer or you can select "LayerByObject" to have AutoCAD automatically create new layers and split the selected block component onto a separate layer.

By default, the settings only apply to the current section object. If you select the Apply Settings to All Section Objects check box, however, the settings will apply to all section objects in the drawing.

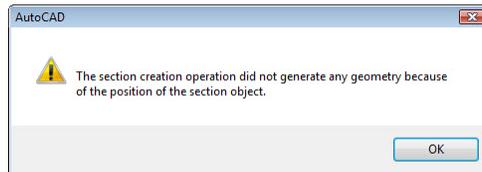
You can click the Reset button to return all settings in the dialog box to their default settings.

When you're done making changes, click OK to apply the changes to the section object. Changes will not affect existing blocks until you use the Replace Existing Block tool in the Generate Section/Elevation dialog to update the block.

☛ **Tip:** After you change section settings to produce the desired results for different types of views, you can drag-and-drop a section object onto a tool palette to save those settings as a new palette tool, so you can easily create a new section object using those same settings in the future.

## Best Practices

The Section Plane tools are the preferred method for generating two-dimensional cross-section views of 3D models. They also have the advantage of being able to easily update the 2D blocks whenever you modify the 3D geometry. This tool is also very useful when creating elevation views. However, there are currently some problems when doing this. Recent updates to AutoCAD 2010 have caused the program to no longer generate elevation views using section planes unless some part of the plane is in contact with the 3D object. If the plane is completely away from the object, when you attempt to create the 2D block, AutoCAD displays an alert:



In addition, when projecting hidden lines, internal geometry is created using the same linetype for all background lines. So at present, in order to show internal geometry as a hidden line, you must edit the resulting block. But any changes you make to the block will be lost if you subsequently modify the 3D model and replace the existing block with an updated version. For this reason, you should either leave the creation of elevation views until later in your work flow, or use the Flatshot tool to create 2D elevation views.

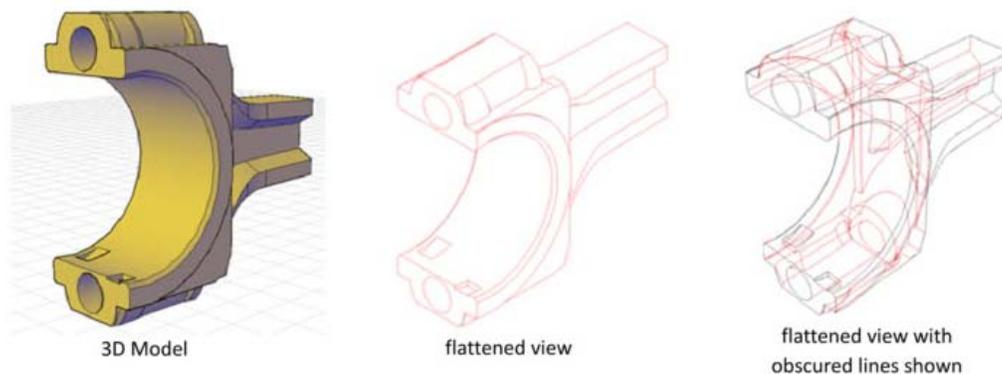
☛ **Tip:** You can associate section objects with named views and cameras in the View Manager. When you subsequently activate a named view or camera that has an associated section object, live sectioning is turned on for that section object, letting you quickly restore the desired settings.

## Creating 2D Representations of a 3D Object

You can use the Flatshot tool (FLATSHOT command) to create a two-dimensional representation of a 3D object. When you use this tool, AutoCAD projects the edges of all 3D solids, surfaces, and meshes in the drawing onto a plane parallel to the current viewing plane. The 2D representation of these edges can then be inserted as a block on the XY plane of the current UCS or saved as a separate drawing.

The process is like taking a photograph of the entire 3D model and then laying the photograph flat. This feature is useful for creating technical illustrations, and can also be used to create two-dimensional elevations.

The flatshot process works only in model space. Start by setting up the view you want, including orthographic, perspective, or parallel views. All 3D objects in the model space viewport are captured. Therefore, you need to be sure to place the objects you do not want captured onto layers that are turned off or frozen before capturing the geometry.



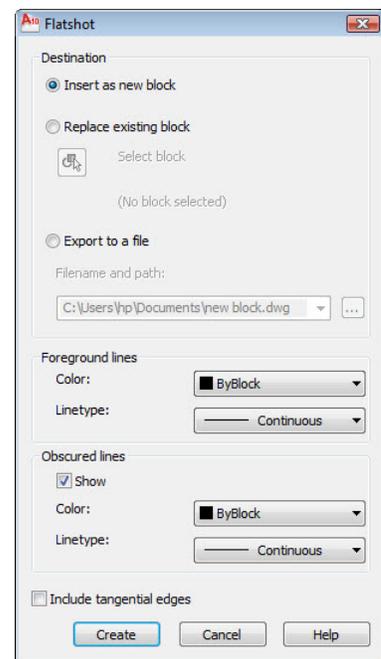
Once the model is set up the way you want it to be captured, select the Flatshot tool from the extended Section panel on either the Home or Mesh Modeling ribbons. AutoCAD displays the Flatshot dialog. This dialog lets you control various aspects of the creation of the 2D representation.

**Destination** These controls let you choose to insert the flattened representation as a new block, replace an existing block, or export the geometry to a separate drawing file.

**Foreground Lines** These controls determine the color and linetype for lines that are not obscured in the flattened view.

**Obscured Lines** These controls determine whether obscured lines are displayed in the flattened view, and if so, the color and linetype used to display those obscured lines.

**Include Tangential Edges** When selected, silhouette edges for curved surfaces will be included in the flattened 2D representation.



## Using Flatshot to Create 2D Elevations

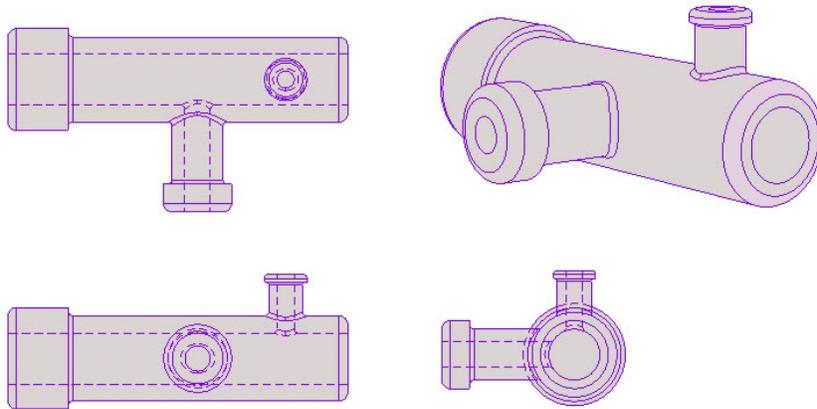
While the Flatshot tool is most useful for creating two-dimensional representations of 3D models shown in a perspective projection to depict the three-dimensional geometry for creating technical illustrations, if you first reorient the model to display a parallel projection elevation view, this tool can also be used to create two-dimensional elevation views.

To create a 2D elevation using Flatshot:

1. Use the ViewCube to reorient the model to the desired top, front, or side orthographic view.
2. Change the projection mode to a Parallel projection.
3. Start the Flatshot tool.
4. Under Destination, choose Insert As New Block.
5. Adjust the settings for foreground and obscured lines and determine whether to include tangential edges.
6. Click Create.
7. In the drawing, specify an insertion point for the block and press ENTER to accept the default values for scaling and rotation angle.

An unnamed block is inserted consisting of the flattened geometry. The block is inserted on the current layer. Because the block is aligned with the current UCS, it may appear strange when first inserted. However, if you reorient the drawing to a plan view of the current UCS, the elevation will appear correct.

☛ **Tip:** Create the elevations on the WCS and then use commands such as MOVE to arrange the elevations into the proper positions for a typical set of orthographic views.

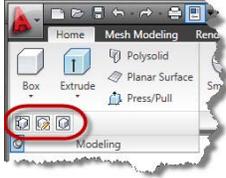


As is true with views created using section planes, if you subsequently make changes to the 3D model, you can replace the existing blocks to reflect the changes you made to the 3D model.

### Best Practices

The Flatshot tool is the preferred method for creating two-dimensional depictions of 3D objects. The Section Plane tool is the preferred method for creating 2D elevations, but the Flatshot tool does have some advantages in this regard. It does not require you to first create section planes (and therefore does not suffer from the current inability to position the section plane completely away from the 3D object). And the Flatshot tool can easily create obscured internal geometry as hidden or dashed lines (something not easily accomplished using section planes). But Flatshot has one significant disadvantage. If you need to update a block previously created using Flatshot, you must first reorient your model back to the view that was current when you initially used Flatshot, or the resulting block will change.

## Using Solid View, Solid Draw, and Solid Profile Tools



You can also use three related tools to automate the steps needed to create 2D representations of solids that mimic conventional 2D drafting. These three tools—Solid View, Solid Drawing, and Solid Profile—are found by expanding the Modeling panel on the Home ribbon tab (when working in the 3D Modeling workspace).

These tools are meant to be used in the order in which they appear in the Modeling panel and you need to follow the proper sequence of steps in order to get the desired results.

Once you've created your 3D model, you can use these tools to create a 2D paper space layout containing the desired views. The following command sequence will be used to create the classroom example (which will be available online at [www.dscohn.com](http://www.dscohn.com) so students can repeat the process on their own):

Command: **SOLVIEW**

Enter an option [Ucs/Ortho/Auxiliary/Section]: **U**

Enter an option [Named/World/?/Current]<Current>: **W**

Enter view scale <1.0000>: **.5**

Specify view center: **(locate view center near upper-left area of the paper space layout)**

Specify view center <specify viewport>: **ENTER**

Specify first corner of viewport: **(locate one corner of the viewport)**

Specify opposite corner of viewport: **(locate the opposite corner of the viewport)**

Enter view name: **TOP**

Enter an option [Ucs/Ortho/Auxiliary/Section]: **O**

Specify side of viewport to project: **(click the bottom edge of the TOP viewport)**

Specify view center: **(locate view center below the TOP viewport)**

Specify view center <specify viewport>: **ENTER**

Specify first corner of viewport: **(locate one corner of the viewport)**

Specify opposite corner of viewport: **(locate the opposite corner of the viewport)**

Enter view name: **FRONT**

Enter an option [Ucs/Ortho/Auxiliary/Section]: **O**

Specify side of viewport to project: **(click the right edge of the FRONT viewport)**

Specify view center: **(locate view center to the right of the FRONT viewport)**

Specify view center <specify viewport>: **ENTER**

Specify first corner of viewport: **(locate one corner of the viewport)**

Specify opposite corner of viewport: **(locate the opposite corner of the viewport)**

Enter view name: **SIDE**

Enter an option [Ucs/Ortho/Auxiliary/Section]: **S**

Specify first point of cutting plane: **(snap to the left midpoint in TOP view)**

Specify second point of cutting plane: **(snap to the right midpoint in TOP view)**

Specify side to view from: **(click below cutting plane defined in TOP view)**

Enter view scale <0.5000>: **ENTER**

Specify view center: **(locate view center below the FRONT viewport)**

Specify view center <specify viewport>: **ENTER**

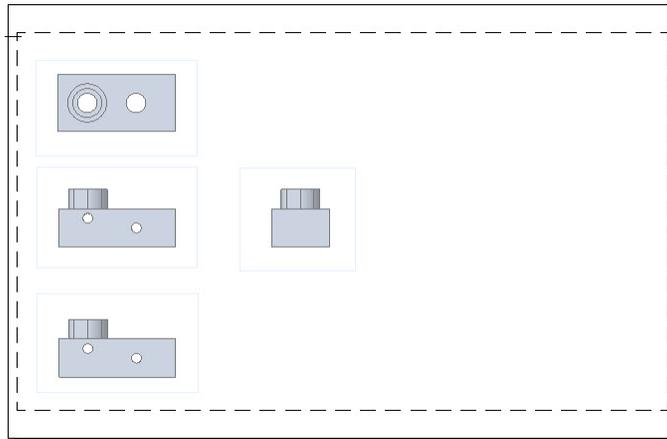
Specify first corner of viewport: **(locate one corner of the viewport)**

Specify opposite corner of viewport: **(locate the opposite corner of the viewport)**

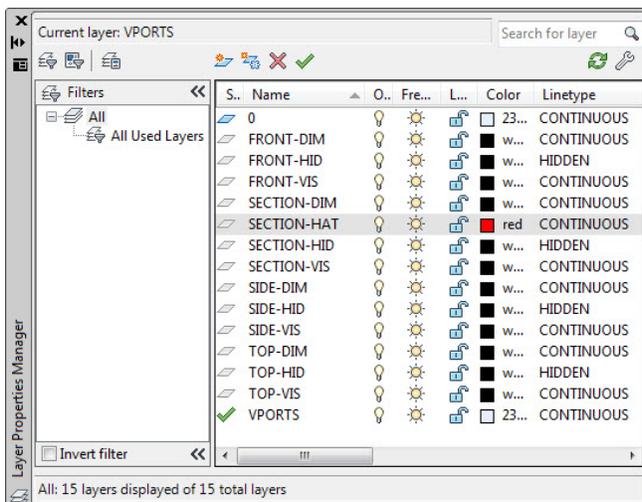
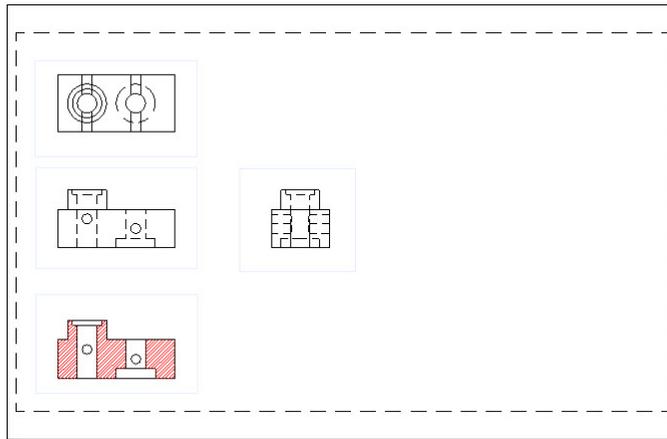
Enter view name: **SECTION**

Enter an option [Ucs/Ortho/Auxiliary/Section]: **ENTER**

At this point, the views should look something like the illustration below. The views are all arranged, but the viewports still display the actual 3D model using the current visual style. These will need to be converted into two-dimensional versions, using the Solid Drawing tool.



The Solid Drawing tool converts the 3D objects displayed in the viewports created using the Solid View tool into two-dimensional representations of those objects. When you start the command, AutoCAD prompts you to select the viewports to draw and prompts you to select objects. Select the four viewports and then press ENTER. AutoCAD immediately processes the viewports, converting the 3D model into 2D lines. The results should look similar to the illustration below.



If you look in the Layer Properties Manager palette, you will see that AutoCAD has created new layer names based on the names of the various views created using the Solid View tool. Then, for each viewport, AutoCAD has created a layer for dimensions, a layer for hidden lines, and a layer for visible lines. For the section view, it has also created a layer for the hatch patterns applied to the cross section. You can then change the color, linetype, and lineweight for each of these layers, as necessary.

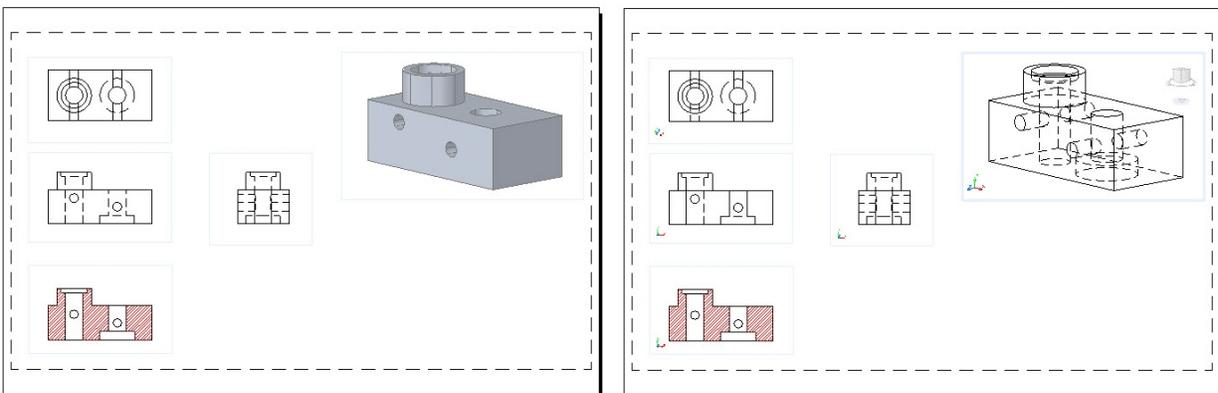
You can also use the Solid Profile tool to create a paper space viewport containing a two-dimensional profile of a three-dimensional solid. The profile is based on the current viewpoint and can display hidden lines on a separate layer so that you can control their color and linetype.

Before you can use the Solid Profile tool, you need to create a new viewport and orient the three-dimensional model the way you want it to be displayed in the resulting profile drawing.

Once the viewport has been created and the model is sized and oriented in that viewport the way you want it to appear in the resulting profile view, make sure the viewport is the current view and then click the Solid Profile tool (SOLPROF command). AutoCAD prompts you to select objects. Click to select the 3D model and then press ENTER. AutoCAD then asks three questions (the answers used in our class example are shown):

```
Display hidden profile lines on separate layers? [Yes/No] <Y>: Y
Project profile lines onto a plane? [Yes/No] <Y>: Y
Delete tangential edges? [Yes/No] <Y>: Y
```

When the command is finished, it doesn't appear that anything has happened. But if you again look in the Layer Properties Manager palette, you will see that AutoCAD has created two new layers. The layer name beginning with the letters PH contains the hidden profile lines; the layer name beginning with the letters PV contains the visible profile lines. If you freeze the layers on which the original model was created, you can clearly see the new 2D profile.



## Best Practices

You can use the Solid View, Solid Drawing, and Solid Profile tools to create various 2D orthographic views of the 3D model, all nicely arranged on a layout, to create your finished documentation. But this tool only creates two-dimensional views that are no longer related to the original 3D model. If you modify the model after you've created these views, you'll have to create all of the views over again whereas the Section Plane and Flatshot tools let you do similar things and have the advantage of creating blocks that can be easily updated if you subsequently make changes to the 3D model. Also, the Solid View, Solid Drawing, and Solid Profile tools are legacy tools that require much more user intervention.

## Conclusion

It truly is easier to create real-world objects as three-dimensional models. Doing so greatly reduces the risk of errors. Then, when you need to create two-dimensional drawings of those three-dimensional objects, you can use the tools described in this class to create those drawings automatically directly from the 3D objects.

**Tip:** Drawings used in this class are available online at [www.dscohn.com](http://www.dscohn.com).