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What We Should Really Be Teaching in the AutoCAD® Classroom, Part II

J.C. Malitzke – Moraine Valley Community College

ED311-1 This class will focus on the 3D commands and features of AutoCAD. For the past 21 years, AutoCAD has had marginal updates to its 3D functionality. With the introduction of AutoCAD 2007, the rules changed! In this class, you'll learn about what you really should be teaching in your AutoCAD classes. We'll discuss new tools and tried-and-true techniques for creating new teaching and learning strategies for both the instructor and the student. We will discuss new techniques that will supersede your old-school techniques, and explore the new features from both a technical and pedagogical point of view. If you've used AutoCAD 3D in the past, attend this session and prepare to be surprised!

About the Speaker:

J.C. is the department chair of Computer Integrated Technologies and a faculty member at Moraine Valley Community College in the Chicago area. He manages and teaches for the Autodesk Authorized Premier Training Center in his area and has been instrumental in the college's consistent receipt of awards from Autodesk. He is an Authorized AutoCAD instructor, has been using and teaching Autodesk products for 21 years, and was a founding member of the Autodesk Training Center Executive Committee, which consults with Autodesk on training matters. He is the recipient of several educator awards and has presented at numerous conferences. This is his 14th year presenting at Autodesk University. He holds a Bachelor's degree in Education and a Master's degree in Industrial Technology from Illinois State University



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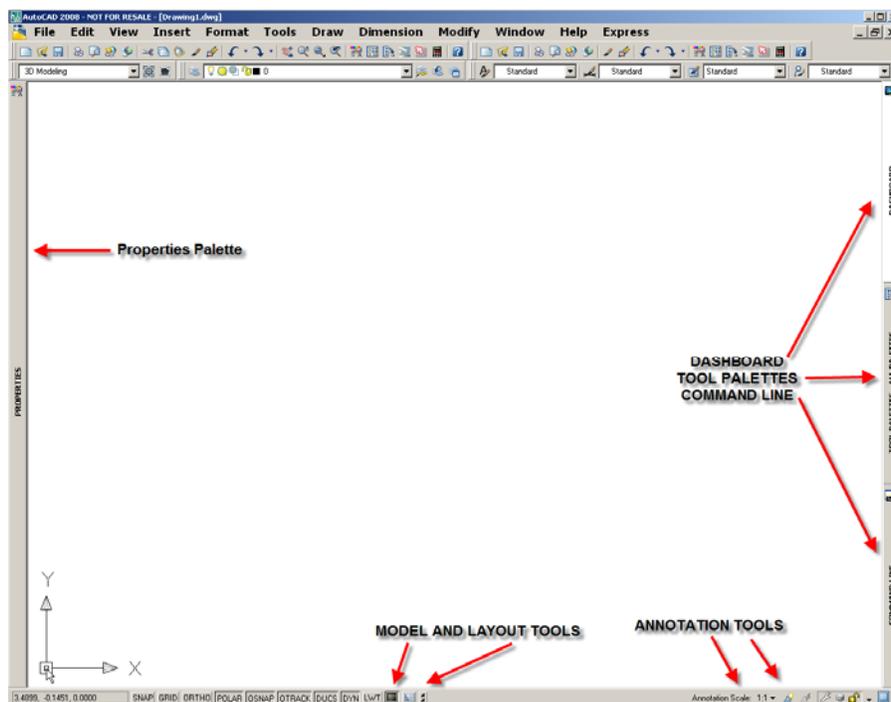
What We Should Really Be Teaching in the AutoCAD® Classroom, Part II

1. Techniques, Techniques, Techniques

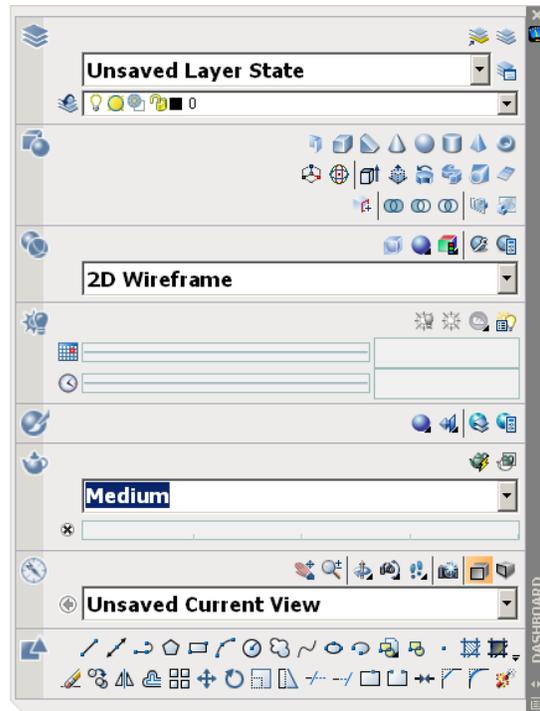
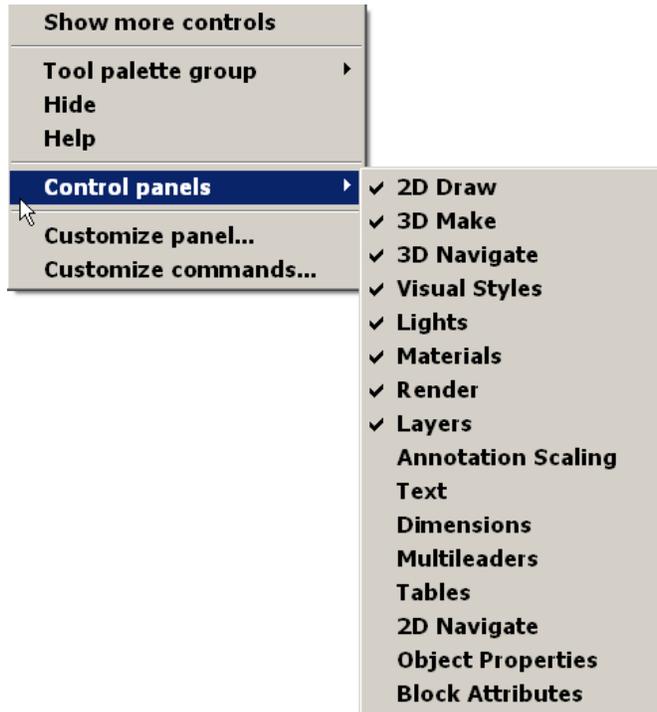
In AutoCAD 2007 and AutoCAD 2008, 3D is a whole new world! If you are an experienced AutoCAD 3D user, you will really appreciate the new 3D commands and features in AutoCAD 2007 or AutoCAD 2008. USE as many new techniques that AutoCAD 2007 or AutoCAD 2008 has. However, do not forget some of the old tried and true techniques that have lasted the test of time.

2. Screen layout and the New Dashboard

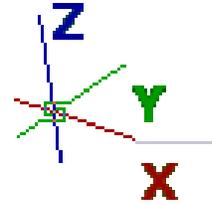
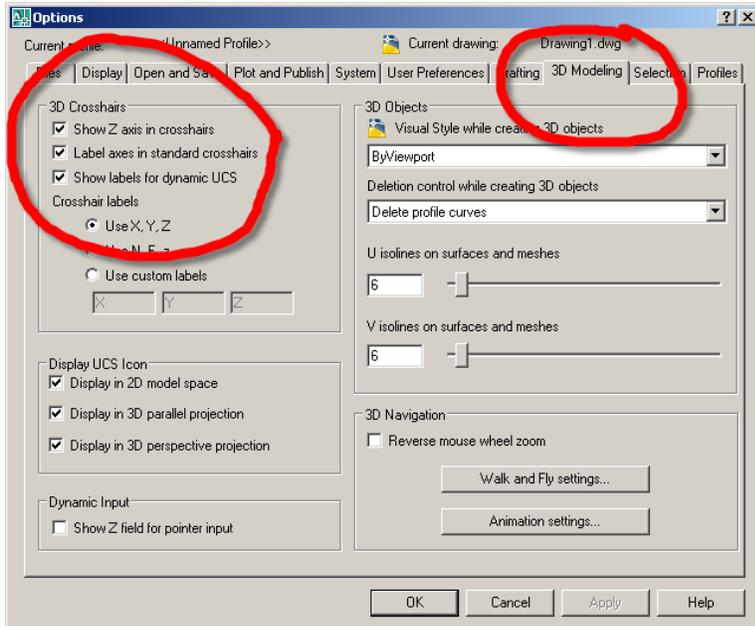
One of the major changes to AutoCAD 3D is the use of the Dashboard Palette. Many great tools are right at our finger tips! Check it out!



Right click on the Dashboard and add or subtract control panels. **USE THE DASHBOARD!**



Go to OPTIONS and Select all the radio buttons for a new 3D XYZ cursor!

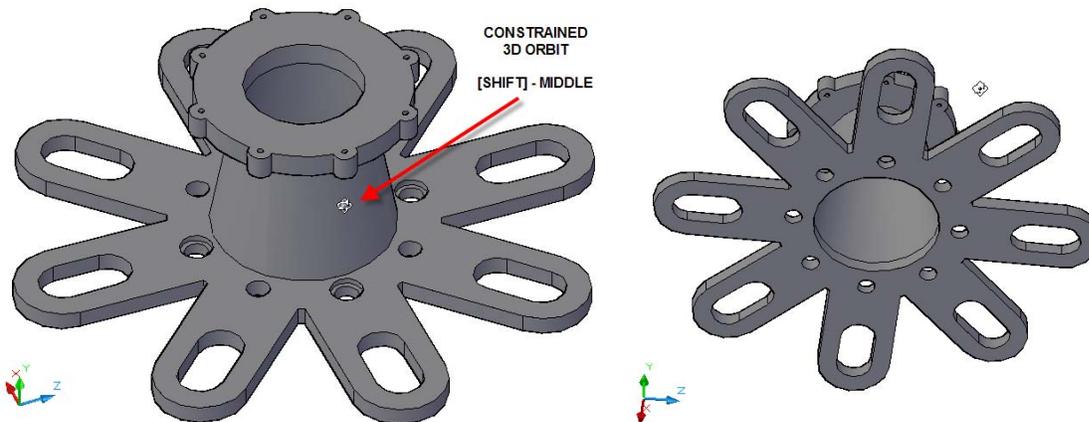


3. Visualization If you cannot visualize where you are, then how can you design 3D models?

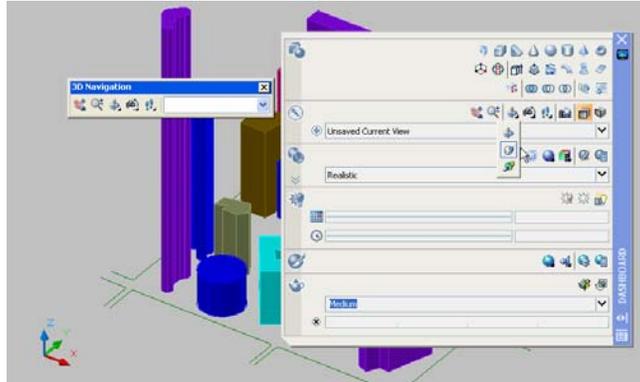
A. [Shift] – Middle Mouse Button

TRY THIS! Hold your middle mouse wheel down and the SHIFT key at the same time!
Constrained Orbit!

OPEN: Flange.dwg



B. Viewing tools in AutoCAD 2007 and AutoCAD 2008



There are 3D navigation tools on the 3D navigation toolbar. The Dashboard has these tools also.

From the AutoCAD Help Menu.

Constrained Orbit (1). Constrains orbiting to the XY plane or the Z direction.

Free Orbit (2). Allows orbiting in any direction, without being constrained to the XY plane or the Z direction. See 3DFORBIT.

Continuous Orbit (3). Changes the cursor to a sphere with two continuous lines encircling it and enables you to set the objects into continuous motion. See 3DCORBIT.

Adjust Distance (4). Simulates moving the camera closer to the object or farther away. See 3DDISTANCE.

Swivel (5). Changes the cursor to an arched arrow and simulates the effect of swiveling the camera. See 3DSWIVEL.

Walk (6). Changes the cursor to a plus sign and enables you to "walk through" a model at a fixed height above the XY plane, by dynamically controlling the location and target of the camera. See 3DWALK.

Fly (7). Changes the cursor to a plus sign and enables you to "fly through" a model without being restricted to a fixed height above the XY plane. See 3DFLY.

Zoom (8). Changes the cursor to a magnifying glass with plus (+) and minus (-) sign and simulates moving the camera closer to an object or farther away. Works like the Adjust Distance option. See 3DZOOM.

Pan (9). Changes the cursor to a hand cursor and moves the view in the direction that you drag. See 3DPAN.

Open one of your 3D models and try these 9 visualization techniques!

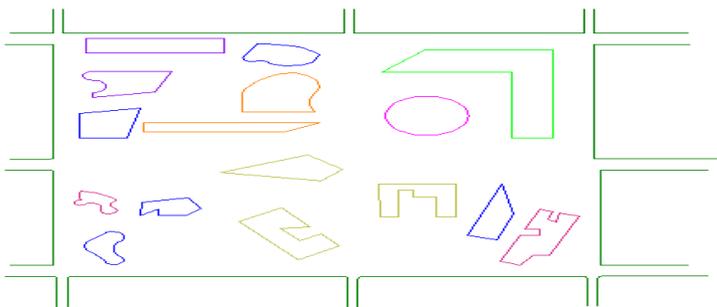
4. Conceptual Design

If we need to convey an idea, we can use AutoCAD 3D for conceptual design purposes. Each 3D object that we create combined with other 3D objects form an effective method to communicate our designs. If we follow a logical design workflow by combining various forms of conceptual design such as 2D drawings, 3D models, animations, scanned images, and even hand drawn sketches, conceptual design brings us closer to our final design realities.

For Example: Let's take a 2D drawing and create 3D massing models for an architectural conceptual design.

A 2D drawing to 3D conceptual designs using 3D primitives and PRESSPULL

Below is a 2D drawing using polylines. **OPEN: Architectural Conceptual Design-2D.dwg**



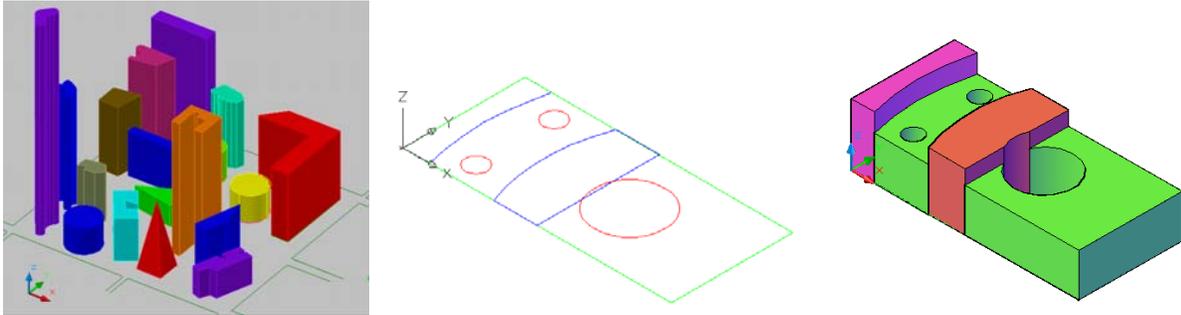
Use standards solid Primitives or the new PRESSPULL command to create simple conceptual designs.

OPEN: Architectural Conceptual Design-2D.dwg

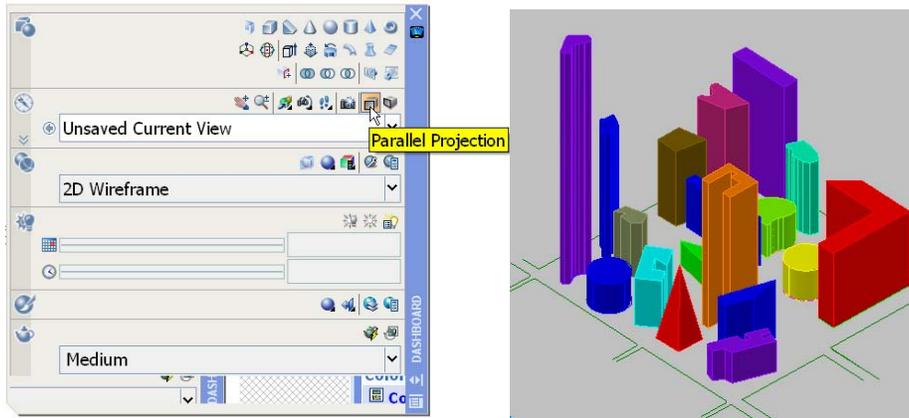
OPEN: SlideBase-2D.dwg

Architectural Example:

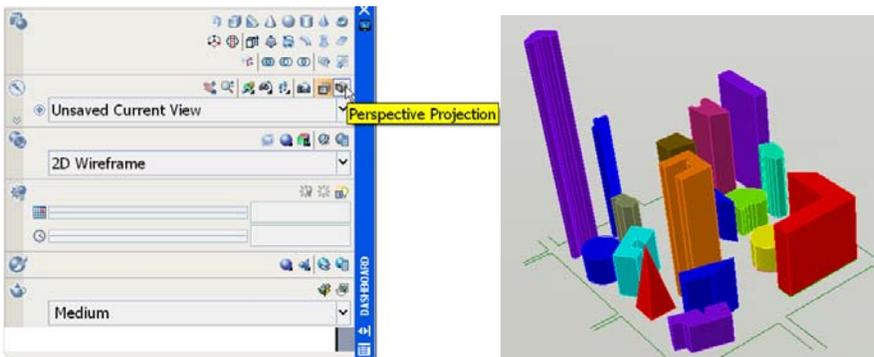
Mechanical Example using PRESSPULL.



Parallel Projection – Draws parallel line projection.

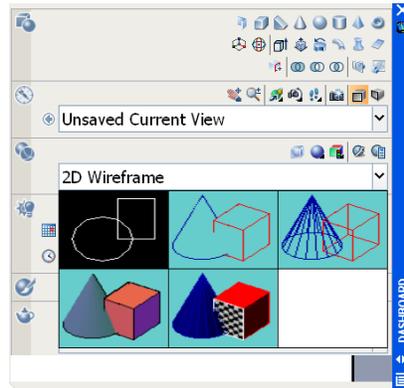


Perspective - Displays objects in perspective so that all parallel lines converge at one point. One point perspective in nature. The shapes are somewhat distorted.



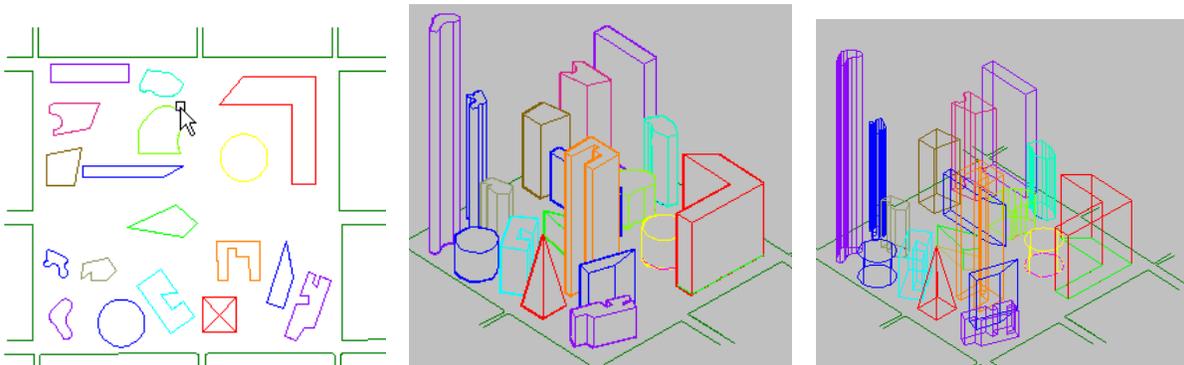
5. Visual Styles

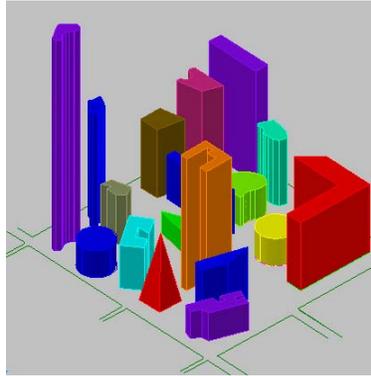
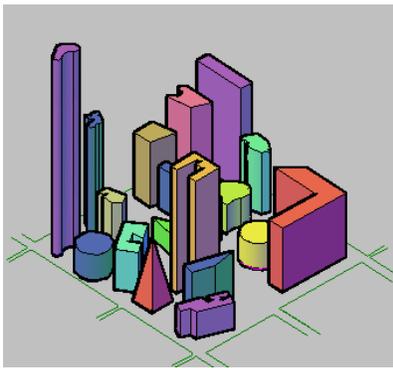
AutoCAD 2008 provides methods for the visualization of 3D objects. Visual Styles are a temporary setting until saved! The Visual Styles control panel, as shown below is used to manage the visual appearance of a 2D drawing or 3D model.



See Below the five basic standard visual styles.

- 2D Wireframe displays objects in standard 2D plan view.
- 3D Hidden displays objects using 3D wireframe representation and hides lines creating a 3D solid looking object.
- 3D wireframe displays objects in wire representations.
- Conceptual displays the object as shades and will smooth out the edges between polygon faces.
- Realistic displays the object as shades in a more realistic manner.

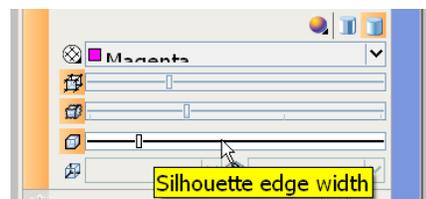
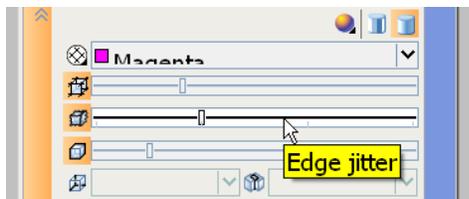
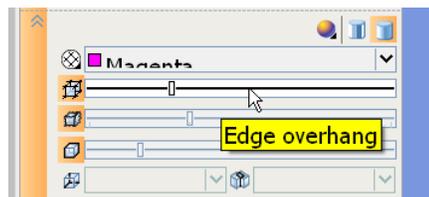
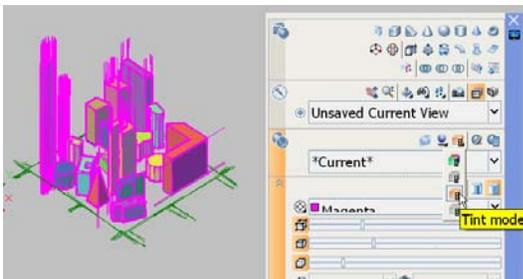




Creating your own Custom Visual Styles in AutoCAD 2008

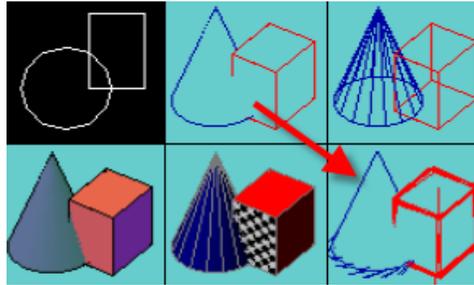
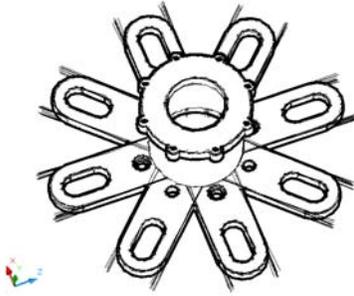
Visual Style Overrides

The visual styles control panel manages visual styles and can also be used to make *temporary* visual changes to your drawing or model. These changes are made from the visual style control panel are not saved to the current visual style. Below are a few example of visual style setting changes.



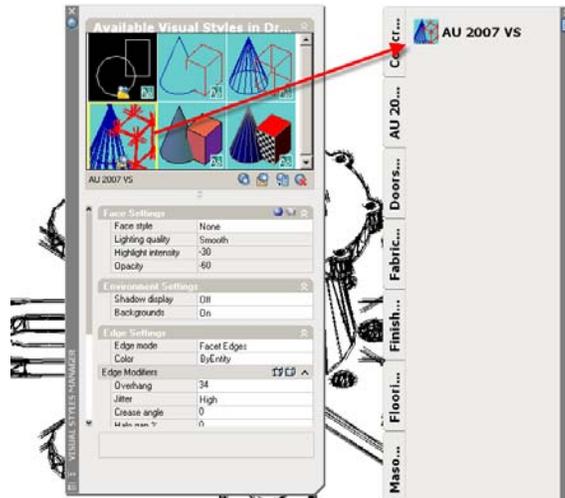
You can add your own custom visual styles to the five default visual styles. Follow these three simple guidelines:

1. Start with one of the default visual styles.
2. Modify the style using the dashboard control panel tools.

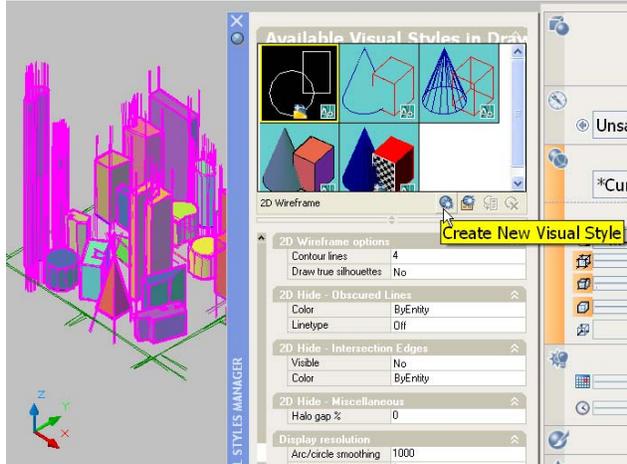


3. Type, **VSSAVE** to save your new visual style to the current drawing.

You can also add your own custom visual styles to the five default visual styles. Follow these three simple guidelines when using the Visual Styles Manager.

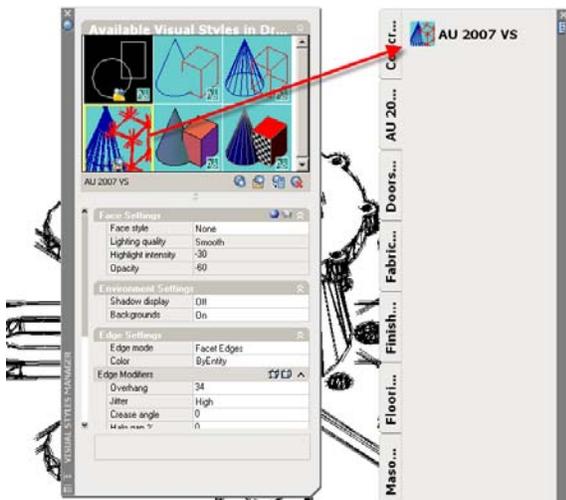


1. To create a new visual style using the Visual Style Manager
2. To create a new visual style using the Visual Style Manager, select the Create New Visual Style button, and create a new named visual style.

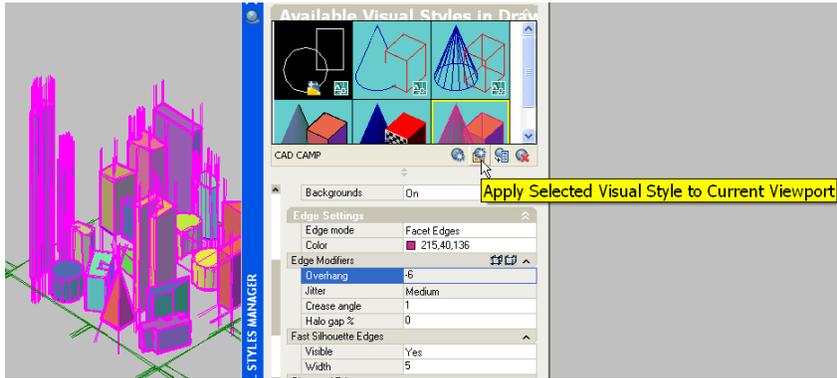


3. Modify the setting in the dialog box to your liking. Select the Apply Selected Visual Style to Current Viewport button.

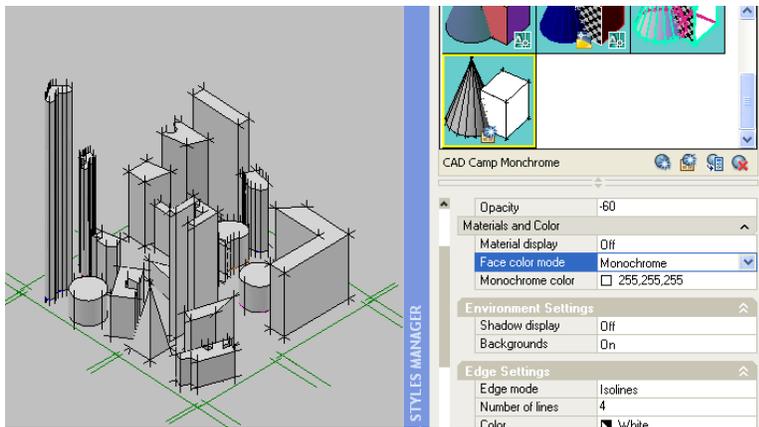
4. Then select the Export the Selected Visual Style to the Tool Palette button.



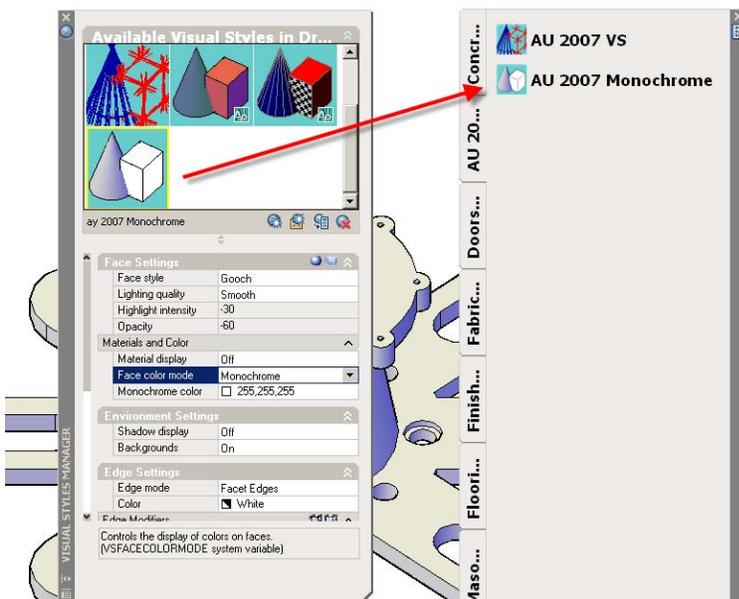
5. Make changes in the dialog box to fit your needs. We created a new visual style named AU2007 VS.



6. Add another custom Visual Style – AU 2007 Monochrome.



7. Using the tool palette named AU 2007, select the Export the Selected Visual Style to the Tool Palette button to create the visual style tool.



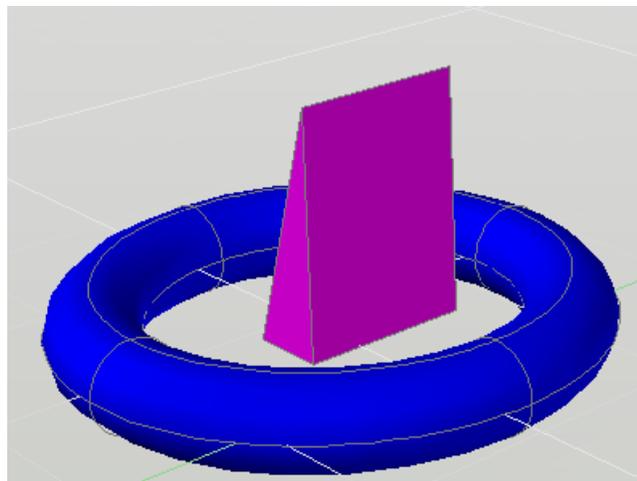
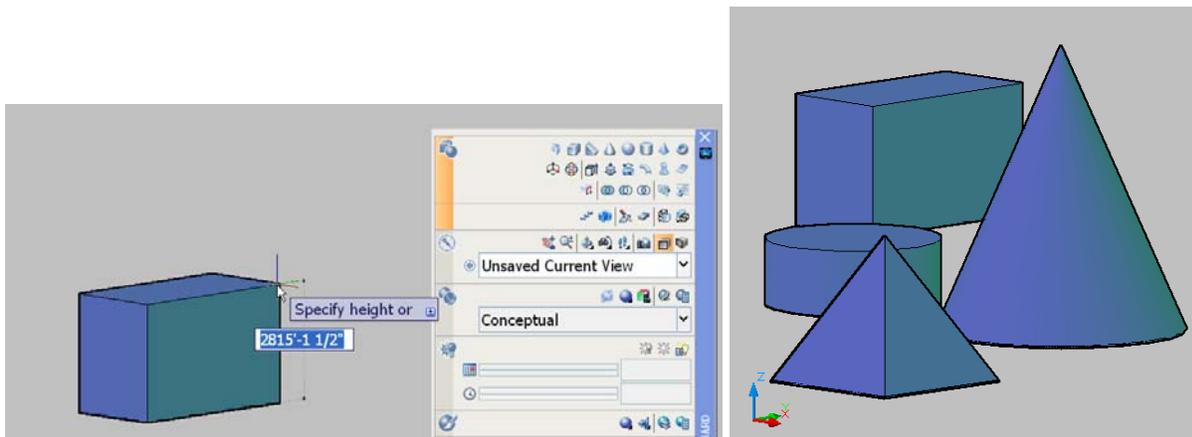
6. 3D Primitives

Creating simple 3D Primitives in AutoCAD 2007 and AutoCAD 2008 has changed from previous releases. We create solid primitives one by one or in conjunction with other primitives to form other complex shapes.

Open the Dashboard for solid Primitive selection. **Create a NEW drawing: Use acad3d.dwt**



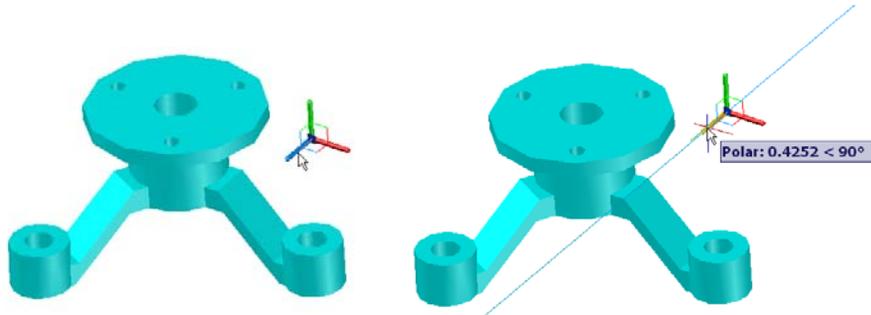
Notice the new dynamic creation method! You can dynamically drag to size or input precise values.



7. 3D Move, 3DRotate and Dynamic UCS's

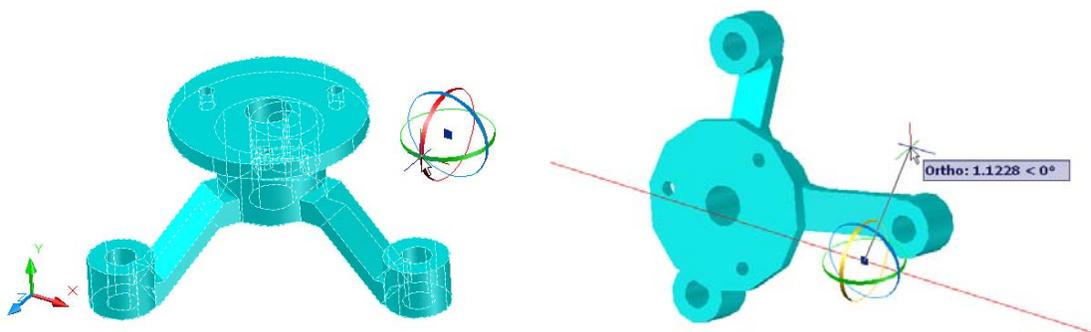
AutoCAD 2007 and AutoCAD 2008 have two new tools for the placement of a dynamic UCS. Use 3DMOVE, 3DROTATE tools and the Dynamic UCS.

Click on the 3DMOVE tool on the Dashboard and select a surface on your 3D Model. Then, select the X,Y, Z axis and move along the selected axis. **OPEN: Clutch.dwg**



Use the 3DROTATE tool to rotate your 3D model. In the example below, the part will be rotated along the X axis 90 degrees.

Select the part, select the basepoint, the angle start point and the angle end point.

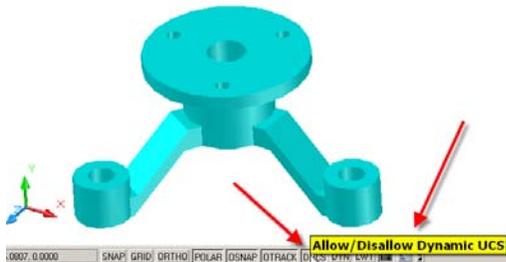


Dynamic UCS

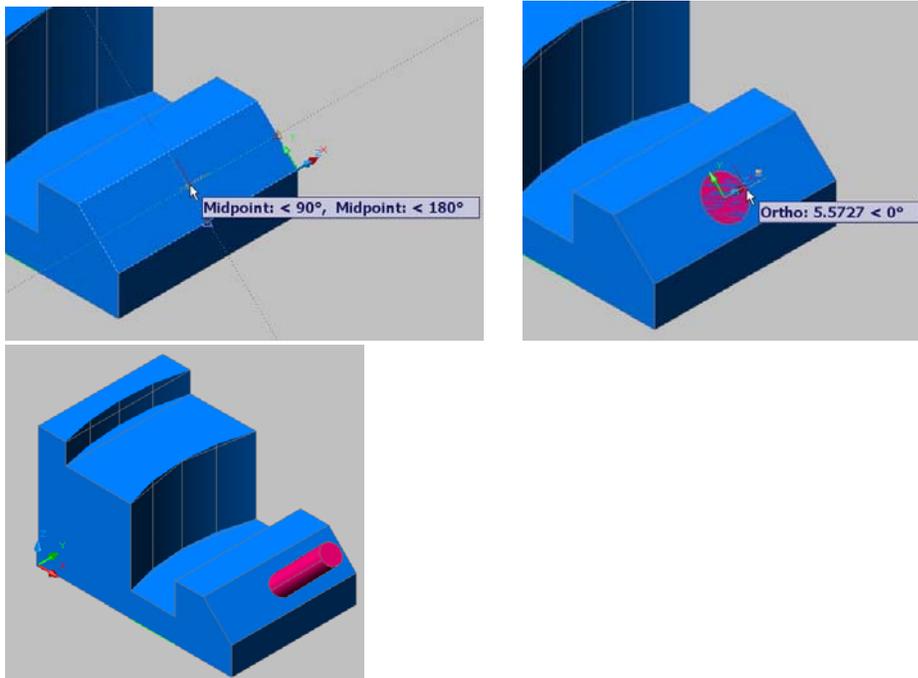
Click on the surface and the UCS will temporarily stick to the flat surface or face selected.

HINT: **use object tracking** to easily position your new geometry as shown below.

With the Dynamic UCS turned on, hover the cursor over an existing flat surface or solid face while in a command.



Create to cylinder based off of the midpoint to midpoint OSNAP. **OPEN: Dynamic-UCS.dwg**



8. A special note on the DELOBJ system variable

From the AutoCAD Help menu

When you create a unique profile for extrudes, sweeps, revolves and lofts you may want to keep the unique geometry for future editing purposes. Set the DELOBJ variable as noted below. DELOBJ control whether the geometry is retained or deleted.

- 0 All defining geometry is retained.

1 Profile curves are deleted, including those used with the EXTRUDE, SWEEP, REVOLVE, and LOFT commands. Cross sections used with the LOFT command are also deleted.

2 All defining geometry is deleted, including paths and guide curves used with the SWEEP and LOFT commands.

-1 Prompt to delete profile curves, including those used with the EXTRUDE, SWEEP, REVOLVE, and LOFT commands. Cross sections used with the LOFT command are also deleted.

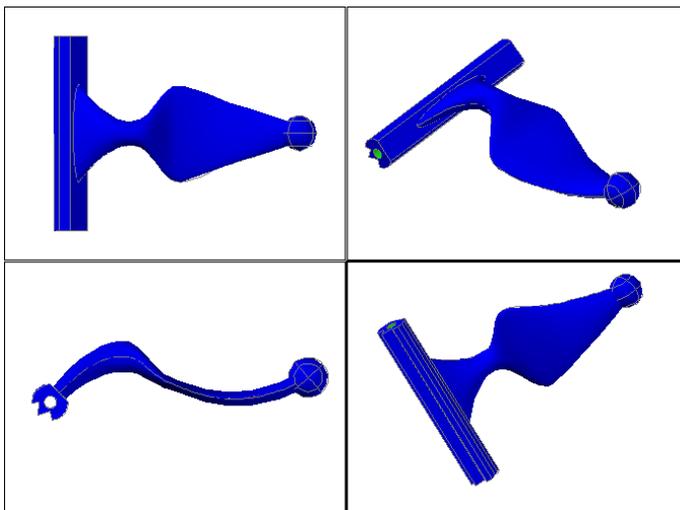
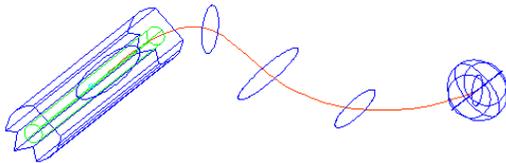
-2 Prompt to delete all defining geometry, including paths and guide curves used with the SWEEP and LOFT commands.

9. Creating Models from 2D Profiles - Loft, Shell, Sweep, Slice and Helix

Loft, Sweep and Helix were new to AutoCAD 2007 and remain the same for AutoCAD 2008.

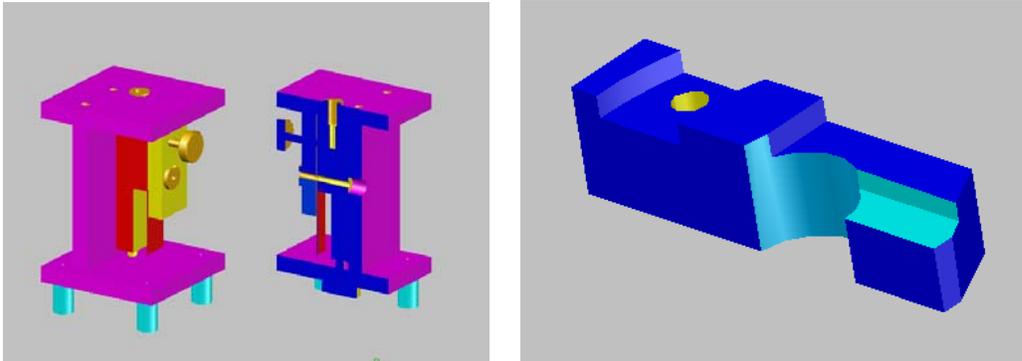
Example: The LOFT command is use to create freeform shapes. Lofts are created by selecting multiple cross sections causing the model to be created based on transitional size, shape and form from one cross section to another. Closed loop and open loops can be used as cross sections. Guide rails and other options can also influence the lofted shape. **OPEN:**

Shaver-Loft.dwg



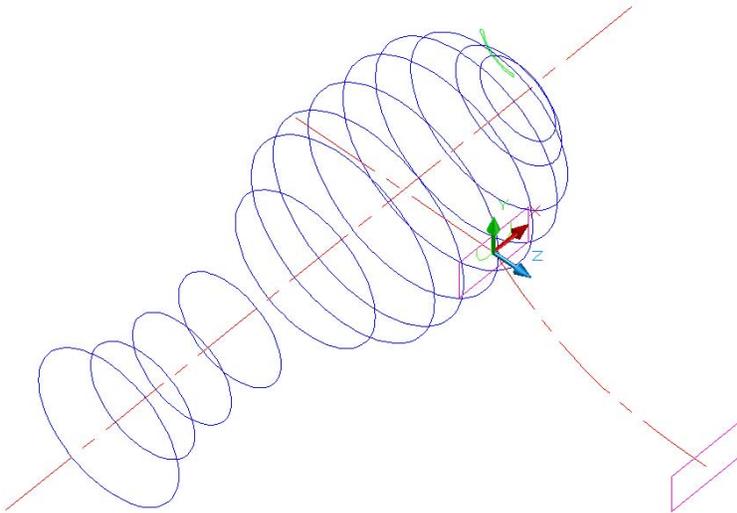
Slicing Solid Models

The SLICE command is used to slice away material from a solid model or to split a model into two parts. The SLICE command may create similar results that the CHAMFER command creates; however, the SLICE command will create results that the CHAMFER command cannot create. **OPEN: SlideBase-Slicing.dwg**

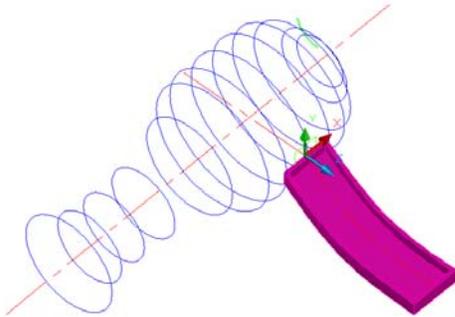


Example: Hair Dryer Number 1 OPEN: Hair Dryer-Loft-Shell.dwg

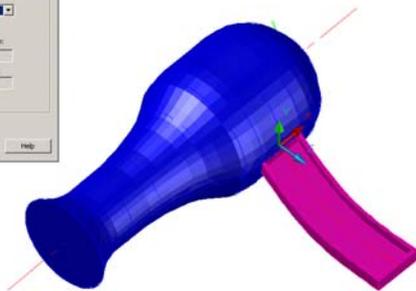
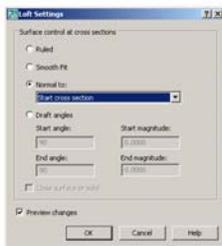
You can create a shell from your 3D solid object. Hollow out your object! New faces are created by offsetting existing ones inside or outside the model.



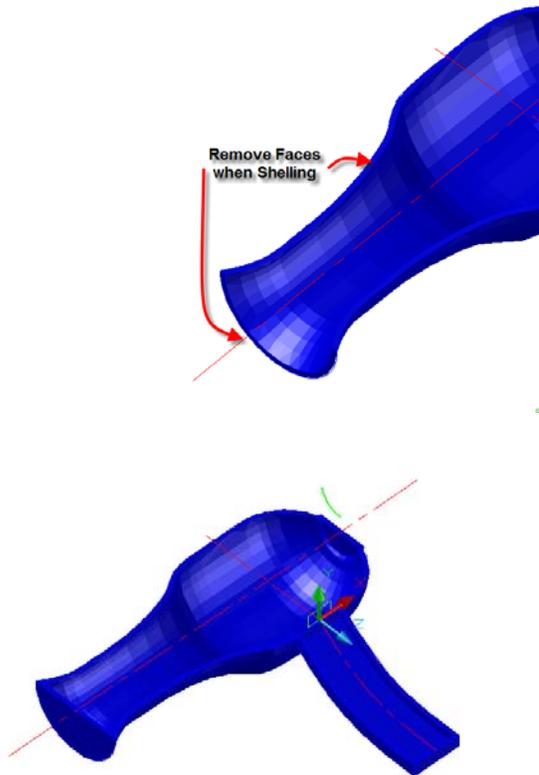
1. Loft the Handle first using the centerline as your path. Slice the handle in half and Shell the handle. (We are using .100 shell thickness for this example)



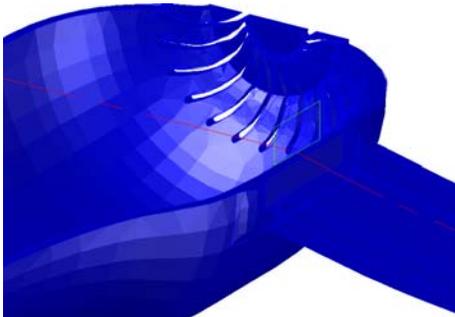
2. Use the LOFT command and loft the main body using the pre-defined cross sections while setting the surface control Normal to the start.



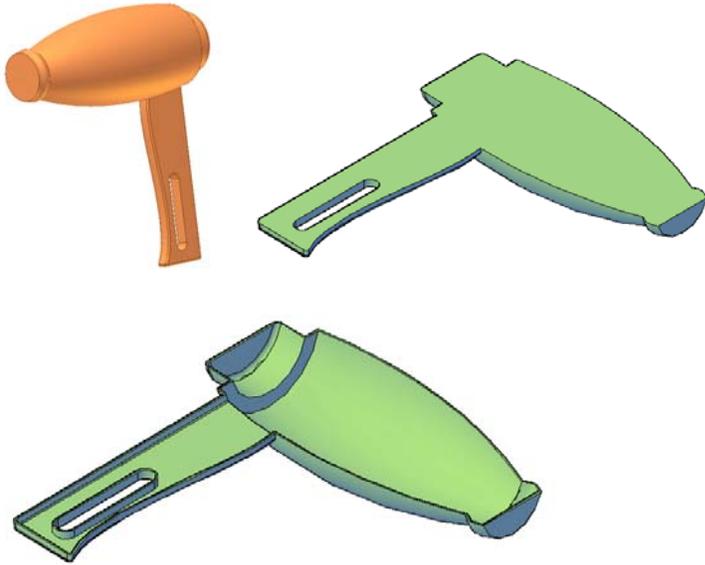
3. Slice then Shell the main body at the handle intersection. Union the parts together. (Use .100" for shell thickness for this example) Make sure you select the main body and the front opening of the hair dryer to remove faces. If you do not select the hole opening as part of your selection to remove the faces you will not have a hole to let the air flow through the hair dryer. In the example below, the open hole face *was not selected*. How would the air flow through the hair dryer?



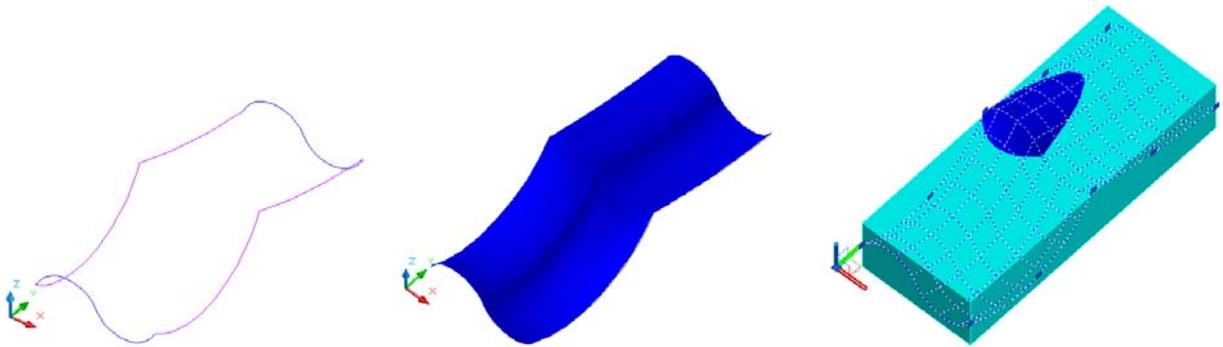
4. Add fillets and create the vents at the back of the hair dryer.



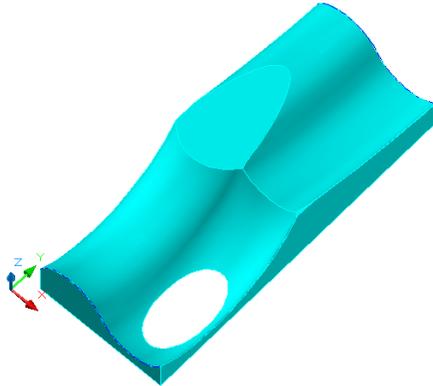
Example: Hair Dryer Number 2. Loft and/or Revolve and Shell the hair dryer. Use the Loft command to create the body of the hair dryer. Shell the hair dryer to create a plastic body.
OPEN: Hair Dryer from Inventor Sliced.dwg.



Example: Another use for the Loft tool is to *create a surface for use as a cutting tool*. Loft 2 cross sections and 2 guides to create a LOFTEDSURFACE to use as a cutting tool. **OPEN: Slice-Lofted-Surfaces.dwg**

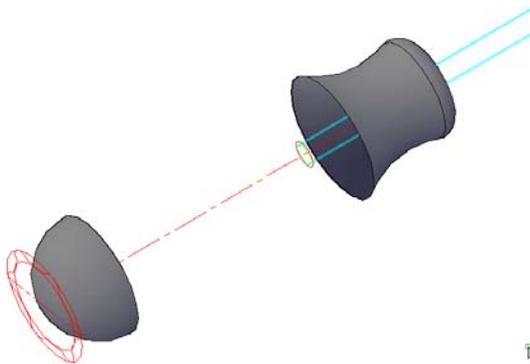


Use the **SLICE** tool to slice away the top of the box using the LOFTEDSURFACE as the cutting tool.

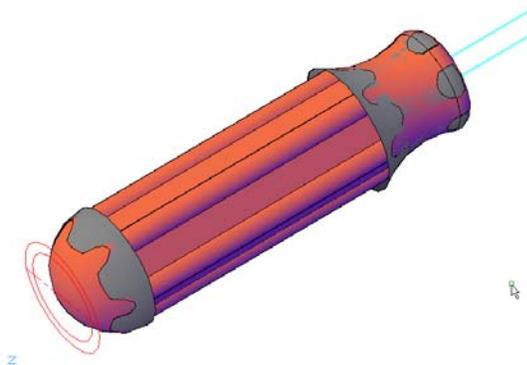


Example: Use Surfaces and solids to create composite solids. **OPEN: Screw Drive-Lofted-Surfaces.dwg**

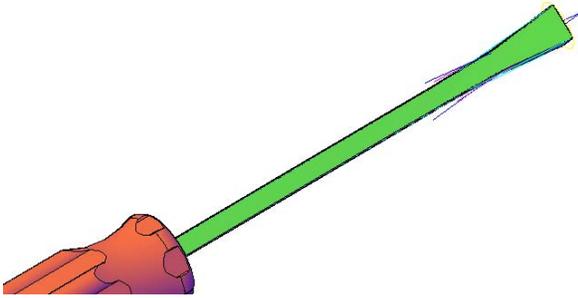
We start by crating a revolved surface.



Sweep the main part of the handle. Use the revolved surfaces as the slice tool.

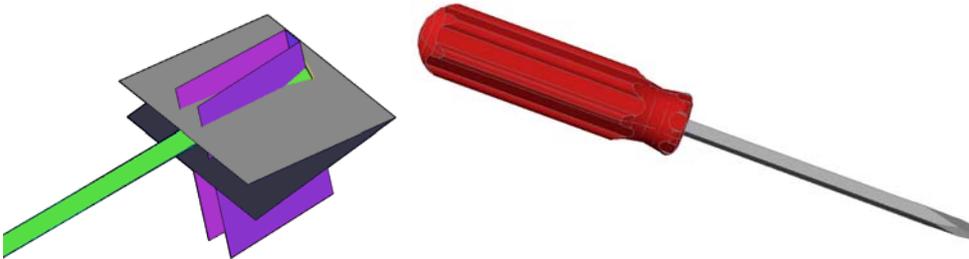


Loft the blade using the rails as your guides.



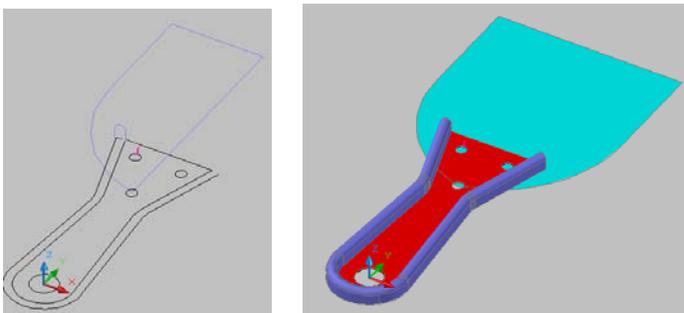
Create Extruded surfaces to create the final end shape of the blade.

Slice the solid blade using the extruded surfaces as cutting tools.



Example: The SWEEP command creates a more free formed shape. Swept models have a planar shape that follows a defined path that was created by another piece of geometry. Solid sweeps are created using closed loop object. Open loops create surface sweeps. The handle's rim of the putting knife was created using the SWEEP command. The handle and blade used the PRESSPULL command to add 3D thickness.

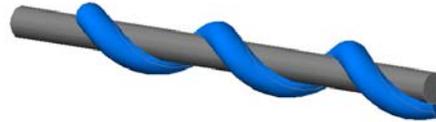
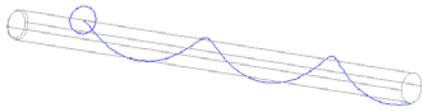
OPEN: Taping Knife.dwg



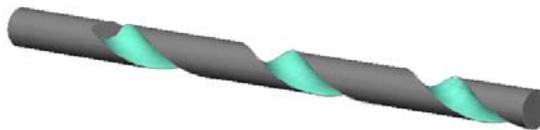
Example: Sweep the profile around the shaft.
Twist.dwg

Revolve the shaft.

OPEN:

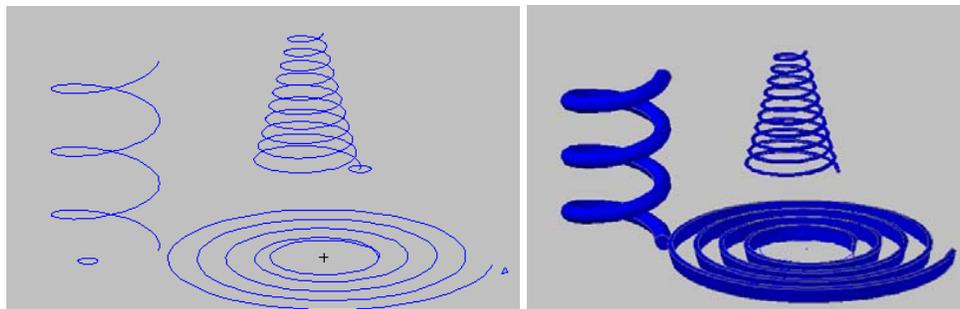


Subtract the swept profile.

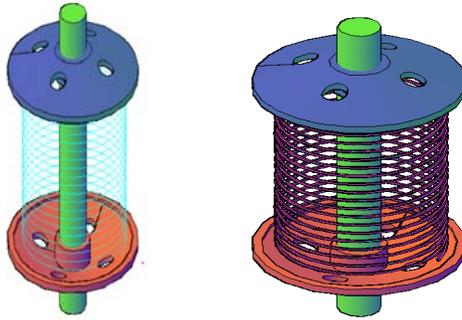


Example The HELIX command

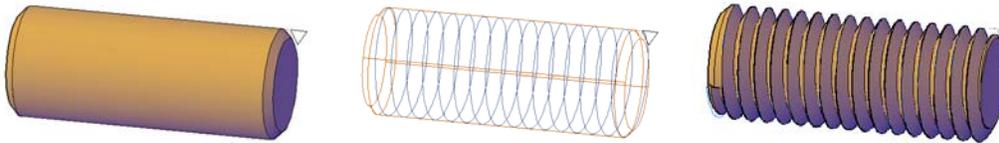
The HELIX command is similar to a Sweep and Loft. A helix can use different paths as shown below. When creating a helix you, specify the diameter of the base of the helix, specify the diameter of the top of the helix, specify the endpoint location for the helix axis, specify the number of turns (revolutions) for the helix, (the number of turns for a helix cannot exceed 500), specify the height of one complete turn within the helix, specify distance between and specify whether the helix is drawn in the clockwise (CW) or the counterclockwise (CCW) direction. Create the Helix and sweep the profile. **OPEN: Helix-2D.dwg**



Creating a spring between two caps. **OPEN: Spring Caps.dwg**

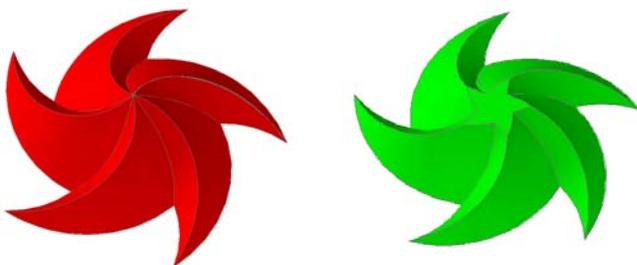


Example: Creating threads using the HELIX and SWEEP commands, then subtract the sweep. 1. Create the solid shaft. 2. Create the thread profile based on current industrial standards for each unique thread design. 3. Sweep the profile. 4 Subtract the swept profile. **OPEN: Helix with Threads.dwg**



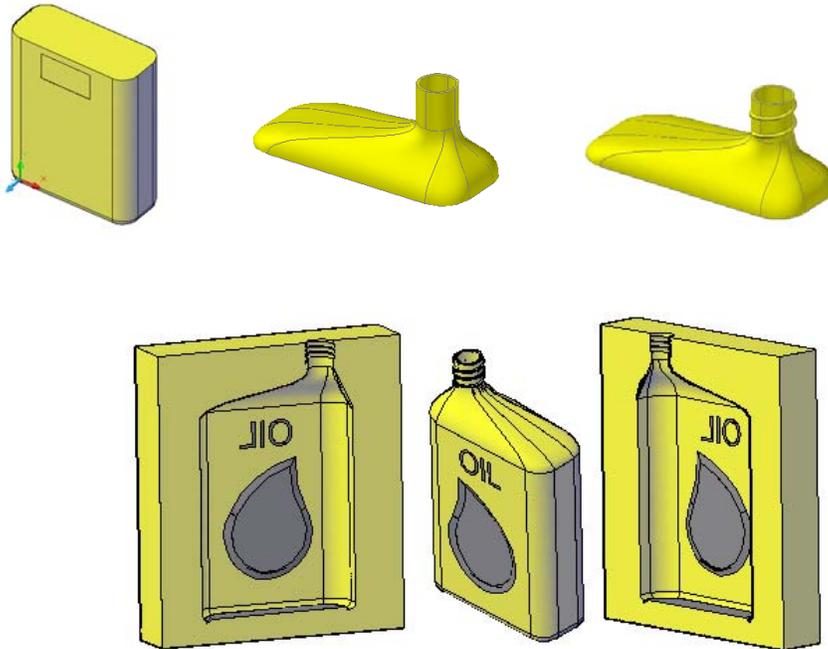
Example: Helix, Sweeps and Slice

Use a helix, sweep a profile and slice the top surface.



Create multiple lofted surfaces to create the bottle. Also, notice the helical threads!

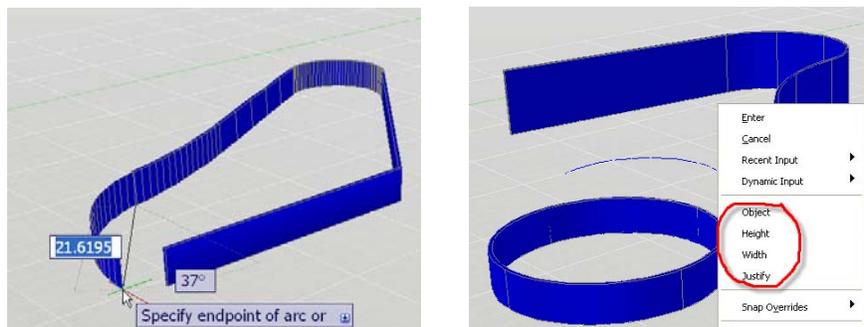
Example: OPEN: Lofted Bottle Example.dwg Create multiple lofts, a helix for the threads and a sweep for the thread profile. Shell as needed.



10. POLYSOLIDS

A POLYSOLID is drawn the same way you draw a POLYLINE. By default, a POLYSOLID always has a rectangular profile. You can add arcs and width just like a 2D POLYLINE.

You can use a POLYSOLID to create walls in your model. With the POLYSOLID command, you can also create a POLYSOLID from an existing line, 2D polyline, arc, or circle. **OPEN:** Polysolid.dwg

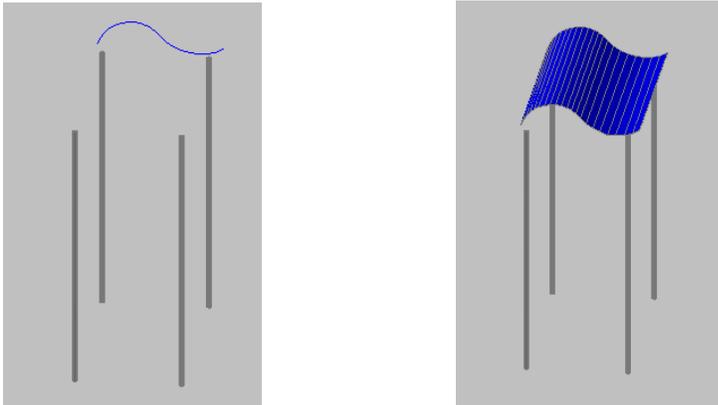


11. Converting Surfaces and Solids

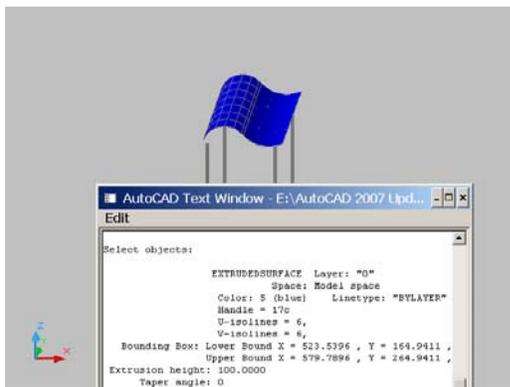
You can create a surface or a solid from simple 2D geometry. The THICKNESS system variable must be set before you create the 2D objects or use PROPERTIES to change the 2D geometry with a given thickness setting. Objects can be converted to solid models that are closed loops while objects can be converted to surface models are not closed.

The two commands are: CONVTO SOLID to CONVETOSURFACE.

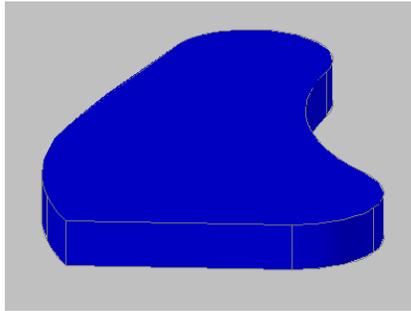
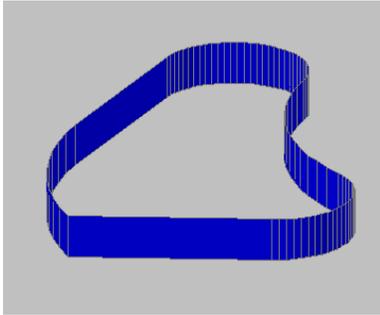
Create a polyline roof shape. Editing the THICKNESS to span poles to poles. **OPEN: Convert.dwg**



From the Dashboard select Convert to Surface tool and select the roof.

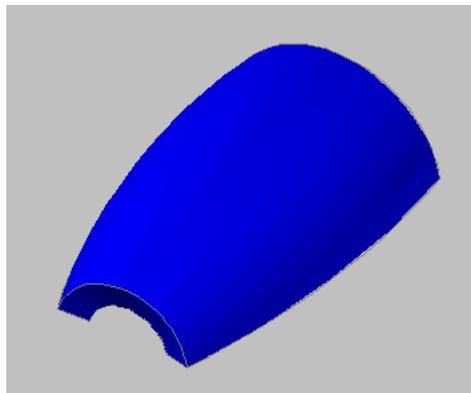
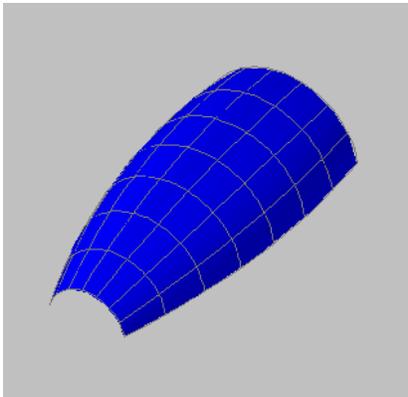


The model below is a polyline with a thickness of 100. Select the Convert to Solid tool. The object converts to a solid model.



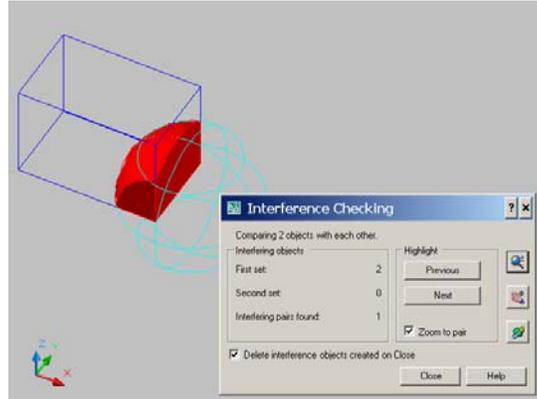
12. The THICKEN command

You can create a 3D solid from any surface type by using the THICKEN command. If you have free formed 2D objects, using the THICKEN command converts an existing surface to the desired solid model thickness. Create three arc shapes and LOFT the shapes to create a surface. Use the THICKEN command to convert the surface to a solid. **OPEN: Thicken.dwg and Thicken Surface Example.dwg**



13. Interference Checking

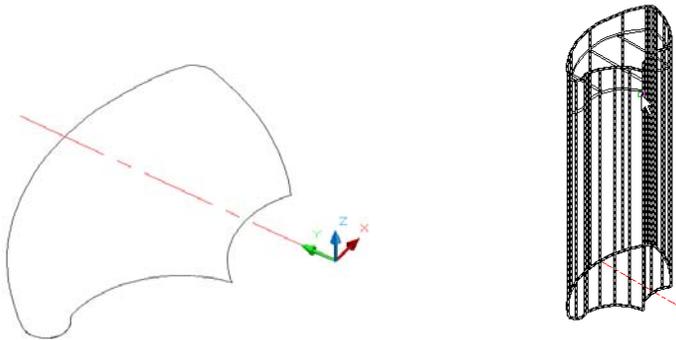
The INTERFERE command creates a temporary solid object from a selection of two or more 3D objects that overlap or maintain the same 3D space. You can view various objects that interfere and you can discard or keep the temporary solids created. **OPEN Interfere.dwg**



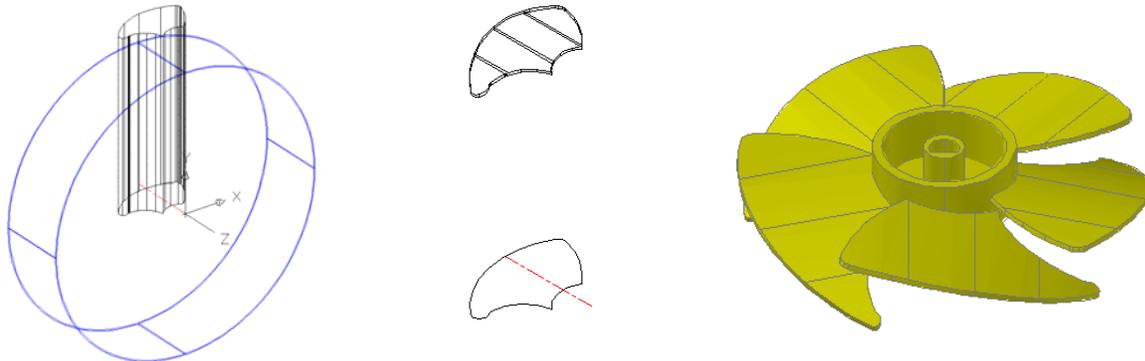
14. Intersection

Intersection creates composite solids from the intersection of two or more solids. In the Fan Blade example below, two intersection solids created the curvature of the blade. You create two solids, then use the Intersect command, creating a composite solid of the first two solids. (Special thanks to Joanne R. Reid of Corporate Development Associates, Lombard, Illinois, ATC Instructor at Moraine Valley Community College, Palos Hills, Illinois) for this example.)

Create the Fan Blade shape as a polyline. Extrude the profile.



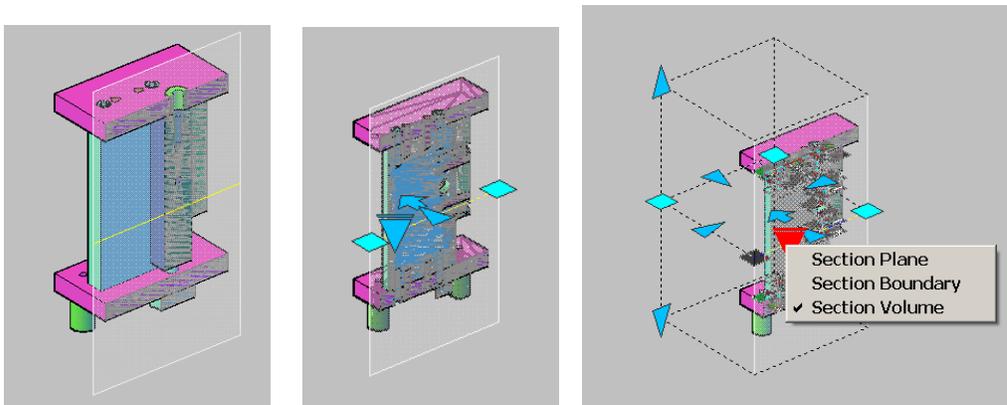
Create *two* cylinders with different diameters for intersecting with the extruded fan blade profile shape to create the curvature of the fan blade. The two cylinders make up the thickness of the blade. In the example below, we used a 6" diameter and a 5.90" diameter. Subtract the smaller cylinder from the larger cylinder. Use the Intersect command to intersect the cylinder and the fan blade profile. Create the hub and array the fan blade to create the finished part.



15. Creating Section Planes

You can create sectional viewing planes by using the SECTION command. You use section planes to view internal parts (sections) of 3D models. The models can be assembled as separate parts by using the 3DALIGN command and sectioned by using the SECTION command. You can also create 2D cross sections of models. You can draw a section by defining a series of points or use orthographic mode to create a plane based on the six orthographic projection views. The section below uses the orthographic front view. Use GRIPS to reposition the section plane. Click on the visibility grip and change your selection as shown below. (Note: You can create a 2D cross section by selecting the section plane and doing a right click!) (Other options are also available)

OPEN: SectionPlanes.dwg



16. Editing Solids

AutoCAD 2008 has added new features for editing existing geometry, Use PRESSPULL to add or subtract to existing solid faces, or hold the CTRL Key and select your 3D model. Notice the

sub-object grips. Select the grips to edit. *You can edit sub objects such as fillets, rounds, chamfers and circles in a solid model.*

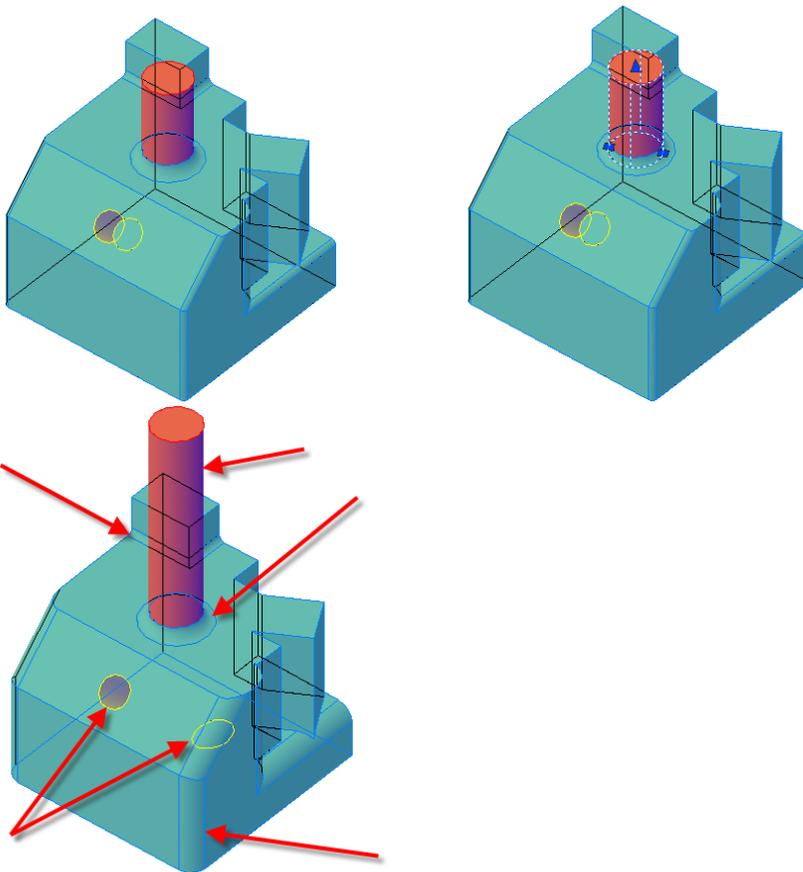
OPEN: Edit Fillets and Rounds.dwg. In this example we will edit fillets, rounds, use PRESSPULL and grips to edit the model.

Existing Solid below.

Edited solid using PRESSPULL

Sub-Object Editing

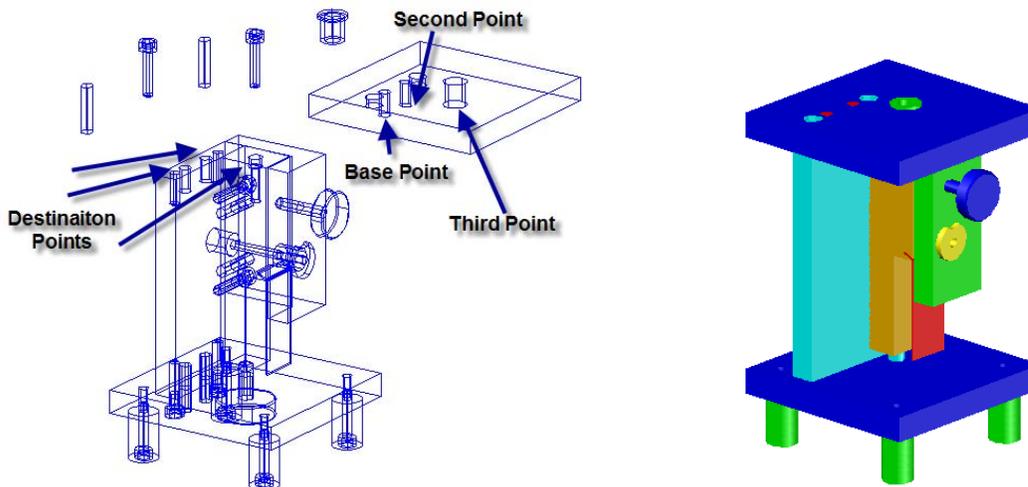
Select and hold the CTRL Key and select your 3D model. Notice the sub-object grips. Select the grips to edit.



17. Using 3DALIGN for assembly creation

To create assemblies in AutoCAD, we have used the ALIGN command for many years. The new 3DALIGN command is similar to the old ALIGN command. However, the new 3DALIGN

command gives the user the ability to make a copy of the object to align and the selection sequence has been modified. When using the 3DALIGN command you are prompted to select the base point, second point and third point on the object to be aligned and then you select the first destination point, second destination point and the third destination point on the object to align to. **OPEN: Spring Clamp Fixture 2D.dwg**

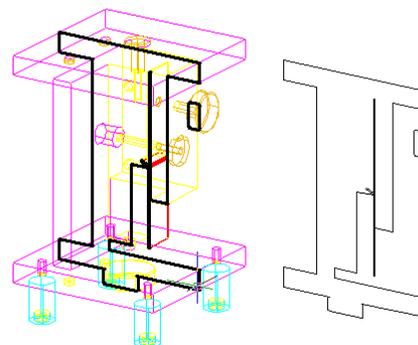
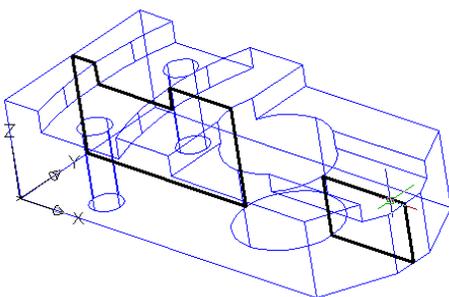


18. Creating Drawing views of 3D Models/Section and Flattening a View

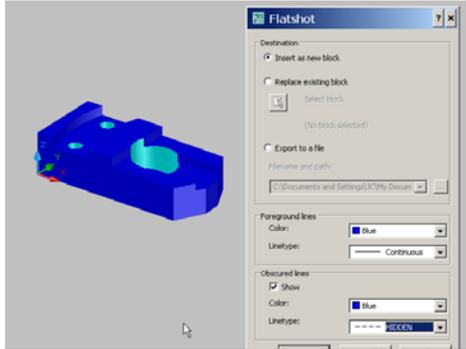
Create a 2D section of your 3D model by using the SECTION command.

OPEN: Slidebase-Section.dwg

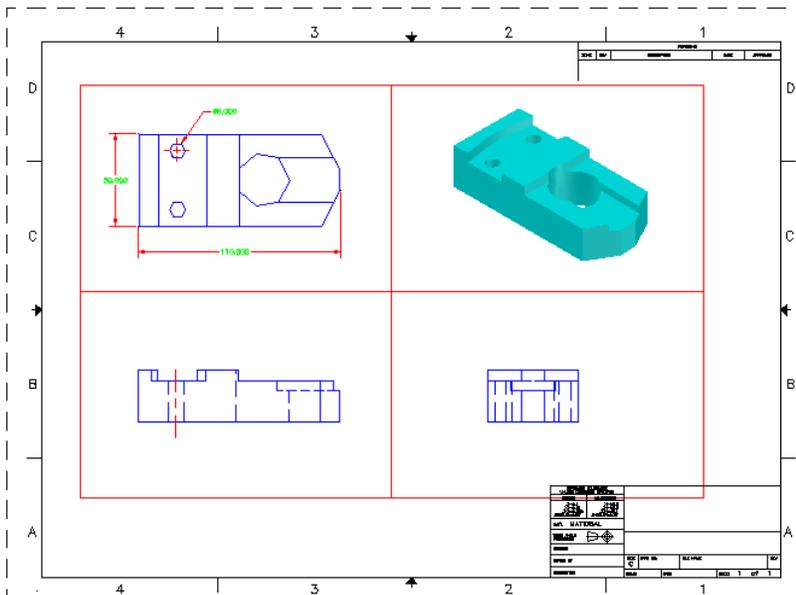
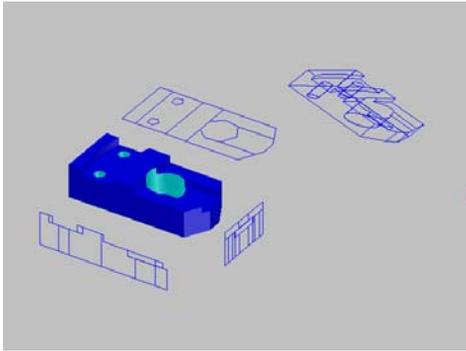
OPEN: Spring Clamp Fixture



You can use the FLATSHOT command to create orthographic and isometric views of your 3D models. You can also create DWF files. **OPEN: SlideBase.dwg**



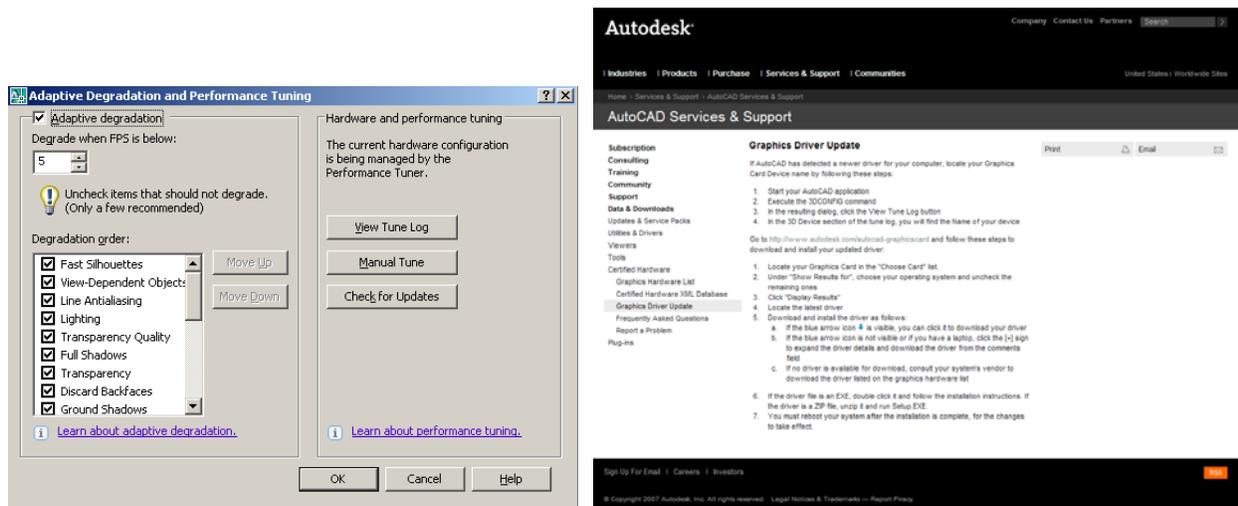
Make your settings in the FLATSHOT dialog box to create your views. Each view in the example below is a block. Create a new drawing with four viewports. Scale each viewport. Lock each viewport. Use MVSETUP to align the views. Dimension as needed.



19. Fine tune your graphics card

AutoCAD 2007 and AutoCAD 2008 take advantages of the power of many graphics cards. You need to check to see if your video card will take advantage of these commands and features. Use the manual tune in OPTIONS as shown below. Also, check out the Autodesk web site to see if your graphics card is certified. Also, type 3DCONFIG to open the dialog box as shown below.

<http://usa.autodesk.com/adsk/servlet/index?id=10087394&siteID=123112&linkID=9240618>



20. So what is missing?

Just add a tutorial for skeletal modeling and freeform surfaces, 8 to 10 3D part models, a midterm exam, a final exam and a student project and you have your beginning class!

21. Visualization Tools

Materials on models, Lights, Camera, Action.....that's for another day!

For his assistance with this paper

A Special thanks to

Dr. J.D. Mather

Assistant professor of CAD and Product Design

Pennsylvania College of Technology

Williamsport, Pennsylvania