



GEN20556

# A Quick Start into AutoCAD 3D Solid Modeling

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## Learning Objectives

- Learn how to use the basic 3D solid modeling commands
- Learn how to apply practical 3D solid modeling techniques
- Learn how to avoid common pitfalls
- Learn the next steps for becoming proficient in 3D solid modeling

## Description

You will learn the basics of 3D solid modeling using only ten commands. Included are practical techniques, tips, and caveats with real-life models.

My goal is to give you a solid introduction, demos, and a roadmap to 3D solid modeling that will make you functional with as few commands as possible, and avoid overwhelming you with information.

## Your AU Expert

Dieter Schlaepfer is a Principal Learning Content Developer at Autodesk, Inc., creating AutoCAD documentation and training guides. In prior employment he provided on-site consultative CAD/CAM/CAE training to manufacturing, architecture, engineering, and construction firms. He has 35 years of experience in the field, and he specializes in 3D modeling, training, and technical writing.



## Background Information

The following information has been included to provide you with a basic introduction and for context from your knowledge of 2D drawing with AutoCAD.

### Definitions

- Isometric drafting – think flat, “2½ D”
- Wireframe modeling – think “pipe cleaners”
- Surface modeling – think “paper thin”
- Mesh modeling – think sculpting, smoothing chicken wire
- Solid modeling – think volume and mass

### 2D Commands Used With 3D Solids

Many 3D operations make use of your current knowledge of 2D operations.

#### 2D Geometry Commands Used in 3D Modeling

- MOVE, COPY, ROTATE, MIRROR, ERASE, PEDIT, FILLET
- Ortho mode and direct distance entry
- PLINE, RECTANG, CIRCLE
- BOUNDARY (typically in plan view)
  - Sources of boundary errors:
    - Not closed
    - Off screen
    - Super complex
- HELIX (spirals, springs, threads)

#### 2D Inquiry, Visibility, and Controls Used in 3D modeling

- MOVE, COPY, ROTATE, MIRROR, ERASE, PEDIT, FILLET
- ID, MEASUREGEOM, PROPERTIES
- GROUP, UNGROUP for assemblies
- Isolate and Hide objects on the status bar



## The 10 Essential Commands for 3D Solid Modeling

### Viewing in 3D

- 3DORBIT (3DO)
  - Perspective vs. orthographic
  - Visual styles (VS)
  - Options > Display tab > Colors (backgrounds)
  - Quick: Shift + press mouse wheel
  
- PLAN
  - XY plane of the current UCS
  - Mechanical Design vs. Architectural conventions

### The User Coordinate System

- Orientation: Construction plane for creating 2D objects
- Orthogonal directions: X, Y, and Z for direct distance entry, Ortho mode
- Rotation: The Z axis is the “hinge”
- UCS – The essential options:
  - UCS 3P – Locating the XY plane for 2D geometry, Ortho
  - UCS ZA – Specifying the Z Axis direction for rotating
  - UCS World – Getting back home
  
- UCSICON – Control the display of the UCS icon
  - Off for screenshots
  - On + display at Origin for modeling

Tip: Turn off dynamic UCS by setting UCSDETECT = 0 [F6]

Tip: Enter UCS, UCSICON directly at the Command prompt

Tip: UCS display – 2D wireframe vs all other visual styles



## Profile Operations

- EXTRUDE (direction)
- REVOLVE (axis)
- SWEEP (path)
  - 2D polyline paths
  - Profiles to sweep along the path

Tip: Set DELOBJ = 0 to retain profile geometry

- Work in isometric views to reduce ambiguity and selection errors
- You will often need to revise and reference
- Keep profile and reference geometry on separate reference layers
- Choose a distinctive color for profile and reference geometry

## Boolean Operations

- UNION
- SUBTRACT
- INTERSECT

## Best Practices and Advice

- Learn using simple models, become comfortable with the commands
- Use layers to manage visual complexity
- Create 2D profiles first (closed polylines and circles)
- Move and rotate 2D profiles and 3D objects into place
- Create and keep profile geometry (set DELOBJ to 0)
- Check and recheck distances and dimensions
- Limit the detail to what is justified for your goals
- Delay filleting to preserve sharp corners for measuring and locating
- Use GROUP to associate objects that you don't want to Union
- Create blocks from repetitive objects to reduce DWG size
- Save a version of a model at each stage so you can revert
- 3D landscaping – purchase and insert as blocks
- People – Use transparent extrusions

## Next Steps

- Download the class presentation, notes, and drawing files
- Review the presentation, try things with the 24 class models
- Create some simple models
- Review the **Further Study** section below
- Explore the 3D Basics workspace
- Experiment and have fun





## Further Study

### Viewing and Display

- ViewCube, LENSLENGTH (perspective view), CAMERA, TARGET, VISUALSTYLES (VS), PERSPECTIVE
- Transparency (0-90%) – CETRANSPARENCY, set ByLayer or individually using the Properties palette by entering a value; use for glass windows and walls, “shadow” people but also note transparent materials for rendering
- Wireframe display controls: ISOLINES, VIEWRES, DISPSILH
- Rendered visual style display: FACETRES
- Sectioning: SLICE (3D trim), SECTION, SECTIONPLANE

### 3D Object Creation

- UNION
- SUBTRACT
- INTERSECT

### 3D Object Creation

- LOFT, INTERFERE, PRESSPULL, POLYSOLID, REGION with Booleans
- SUBTRACT
- INTERSECT

### UCS

- UCS X, Y, Z rotation (90 degrees), right-hand rotation rule (thumb=Z axis, fingers curl positive)
- Isometric dimensioning with the UCS

### Editing

- ROTATE3D, MIRROR3D, ALIGN
- Subobject selection (Ctrl + select + right click options)
- Shell a 3D solid – SOLIDEDIT /Body /Shell (remove faces that are not to be shelled)
- Separate noncontiguous 3D solids termed “lumps” (SOLIDEDIT /Body /seParate)
- Convert surfaces and meshes to solids: THICKEN, SURFSCULPT, CONVTO SOLID
- SOLIDHIST for retaining component solids

### Analysis

- Massing studies, sun and shadow studies, wind studies
- MASSPROP, DIST, MEASUREGEOM – Volume, centroid, moments of inertia, etc.
- AREA /Object – Surface area, including any fully enclosed volumes
- FEM/FEA analysis

### Output and Processing

- 2D drawings: FLATTEN, FLATSHOT, SOLVIEW, SOLDRAW, SOLPROF, Fusion 360, AutoCAD Model Documentation for mechanical design: VIEW\* commands
- Rendering, materials: RENDER, MATERIALS, etc.
- EXPORT: STL (3D printing), SAT (CNC) output



## List of Drawings

- 10 Kitchen.dwg – a real-life kitchen remodel project, EXTRUDE profiles
- 20 Playscape.dwg – a wireframe model for UCS practice
- 30 Glass.dwg – the profile of a real-life wine glass, REVOLVE profile about centerline
- 31 Bike Rim.dwg – a heavy duty bike rim design, REVOLVE profile about axel
- 32 Chair.dwg – a chair design, SWEEP objects along a path
- 40 Walkway – a real-life walk and driveway design, EXTRUDE and then UNION profiles
- 41 Florette-S.dwg – a real-life tip of an electric foil blade used in sport of fencing
- 42 Bowsight.dwg – a bow sight bracket, EXTRUDE and then INTERSECT profiles
- 43 Roof.dwg – a hip roof, EXTRUDE and INTERSECT profiles
- 44 Envelope.dwg – an envelope of a building or part, EXTRUDE and INTERESECT three profiles
- 45 Box.dwg – create a plastic box with draft angles, EXTRUDE and INTERSECT profiles
- 46 Eclipse.dwg – a real-life model of a scoring machine used in the sport of fencing
- 50 Keyboards.dwg – two keyboards with different levels of detail
- 51 Stairs.dwg – two sets of stairs with different levels of detail
- 52 Interference.dwg – HVAC duct meets brace, brace wins, INTERFERE
- 53 Arbor.dwg – a real-life 2D drawing of an arbor design
- 54 Arbor Profiles.dwg – profiles converted into plines and rotated into place
- 55 Arbor 3D.dwg – 3D model of arbor done in pieces with EXTRUDE and INTERSECT
- 56 Deck – a real-life deck design. Stress analysis performed by an architect before it was built
- 57 Interfere2.dwg – estimated cut from the interference volume between a building footprint and a solid that was lofted using contour lines, LOFT and INTERFERE
- 58 Room 3 render.dwg – a room to render, RENDER and MATERIALS
- 59 3D House.dwg – a house to experiment with
- 60 Campus.dwg – lots of experiments here, pan and zoom within 3DORBIT