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A Quick Start to AutoCAD 3D Solid Modeling

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Learning Objectives

- Learn the basics of 3D solid modeling using only 9 commands.
- Become familiar with practical tips and techniques with real-life models.
- Learn the next steps for becoming proficient in 3D solid modeling.

Description

You will learn the basics of 3D solid modeling using only 9 essential 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.

Speaker

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

Definitions for Context

Isometric drafting – illustrations in flat “2½ D”

Wireframe modeling – pipe cleaners

Surface modeling – paper thin

Mesh modeling – sculpting, smoothing chicken wire

Solid modeling – volume and mass

2D commands used in 3D modeling

Move, copy, rotate, mirror, erase

Ortho mode and direct distance entry

Polylines, circles, lines

HELIX (spirals, springs, threads)

BOUNDARY—creates 2D profiles

Tip: Create reference and construction geometry to reduce errors.

Tip: Causes of boundary fails:

Area is not fully enclosed

Objects off screen, extreme zooms

Super complex boundary

Non-plan view

Inquiry, visibility, and controls

ID, DIST, PROPERTIES

GROUP and UNGROUP for assemblies

Isolate and Hide objects



Viewing in 3D

3DORBIT (3DO)

Perspective vs. orthographic
Visual styles (VS)
Options > Display tab > Colors (background)
Quick: Shift + press mouse wheel

PLAN

XY plane of the current UCS
Mechanical Design vs. Architectural conventions

The User Coordinate System

What is it? A sort of 3D T-square
What's it for?

Orientation - Construction plane for creating 2D objects
Orthogonal directions - X, Y, Z for direct distance entry, Ortho mode
Rotation axis - The Z axis is the “hinge” for rotation, right-hand rule

The essential options

3P (default) – Locates the XY construction plane
ZA – Specifies the Z-axis for rotations
W – Returns the UCS to be coincident with the World Coordinate System

UCSICON – Controls the display of the UCS icon

On + Origin for modeling (default)
Off for screenshots

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

Tip: Enter UCS ZA, and UCS W (Enter) directly at the Command prompt

Profile Operations

EXTRUDE **Direction**

Select closed objects
Rules for positive direction
- Right-hand rule for rotation
- mouse + distance

EXTRUDE **/Path**

Profiles need to be aligned to path or use SWEEP
Use 2D polyline paths for fillets

REVOLVE (axis)

Tip: Work in isometric views
Tip: Limit boundary complexity
Tip: Use EXTRUDE /Path with profile and helix to create threads
Tip: Use the FACETRES system variable to smooth facets
Tip: Set DELOBJ = 0 to retain profile geometry

Why? (1) Reference, (2) Revisions, and (3) Precision
Keep profiles on separate reference layers
Choose a distinctive color for profiles

Boolean operations

UNION
SUBTRACT
INTERSECT

2D Boolean operations

BOUNDARY
REGION
Use as profiles for extrude, revolve, etc.

Tip: Use a wireframe visual style for easy selection

Best practices and advice

- Learn with simple models, become comfortable with the 9 commands
- Use layers to manage visual complexity
- Create and retain 2D profiles (set DELOBJ to 0)
- Move and rotate 2D profiles and 3D objects into place
- 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 – outline or transparent extrusion

Next steps

- Submit feedback survey
- Download the class presentation, notes, and drawing files
- Review the presentation **ASAP**
- Create some simple models, try things with the 24 class models
- Review the Further Study section below . . .
- Explore the 3D Basics ribbon 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

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

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, CONVTSOLID
- 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, the AutoCAD Model Documentation feature set 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, EXTRUDE /Path or SWEEP objects along a path
- 40 Walkway – a real-life walkway and driveway design, EXTRUDE and then UNION profiles, use MASSPROP to estimate concrete volume needed
- 41 Florette-S.dwg – a real-life tip of an electric foil blade used in sport of fencing
- 42 Bowsight.dwg – an old-fashioned 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 INTERSECT 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