



The Hitchhiker's Guide to 3D Solid Modeling

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You will learn the basics of 3D solid modeling using only about 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 in an hour with as few commands as possible, and to avoid overwhelming you with information.

Learning Objectives

At the end of this class, you will be able to:

- Use the basic 3D solid modeling commands
- Apply practical solid modeling techniques
- Avoid common pitfalls
- Begin creating 3D solid models effectively, using the minimum set of tools and essential information



About the Speaker

Dieter Schlaepfer is a principal technical writer at Autodesk, Inc., creating a variety of AutoCAD software documentation and quick-training materials. In prior employment he provided on-site CAD, CAM, and CAE consultative training to manufacturing firms, and he provided CAD training to architecture, engineering, and construction firms. He has 34 years of experience in the field, and he specializes in 3D modeling.

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Topics

Basic Definitions

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

Common 2D Commands Used with 3D Solids

Common Editing Commands

- MOVE, COPY, ROTATE, MIRROR, ERASE, PEDIT, FILLET
- Ortho mode [F8] and direct distance entry

Common 2D Geometry Commands

- PLINE, RECTANG, CIRCLE
- BOUNDARY (works best in a plan view)
- HELIX (spirals springs, threads)

Common Inquiry, Visibility, and Controls

- ID, MEASUREGEOM, PROPERTIES
- GROUP, UNGROUP for assemblies
- Isolate and Hide objects on the status bar
- OPTIONS for behaviors and background colors
- 3D Basics workspace – browse the ribbon

Viewing in 3D

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

The User Coordinate System

- What is it for?
 - Orientation: Construction plane for creating and editing 2D objects
 - Orthogonal directions: X, Y, and Z for direct distance entry
 - Rotation: The Z axis is the “hinge”

Tip: Turn off automatic UCS, set UCSDETECT=0 [F6]

Note: UCS display – 2D wireframe, other visual styles

- UCS - What are the most common options?
 - UCS 3P – Relocating the XY plane for 2D geometry, Ortho
 - UCS ZA – Specifying the Z Axis direction for rotating
 - UCS World – Getting back
- UCSICON – Control the display of the UCS icon
 - Off
 - Origin

Extrusion

- EXTRUDE
- REVOLVE
- SWEEP
- Tip: Set DELOBJ = 0 to retain profile geometry
 - Why? Revise and reference
 - Keep on separate Reference layer(s)
 - Choose a distinctive color

Boolean Operations

- UNION
- SUBTRACT
 - REGION
 - SUBTRACT region objects for profile (avoid “underlapping” objects)
- INTERSECT

Best Practices and Advice

- Learn using simple models, become comfortable with the commands
- Organize your model with layers to manage visual complexity
- Start by creating 2D objects: closed polylines and circles
- Move and rotate 2D and 3D objects into place
- Create and keep wireframe reference geometry (set DELOBJ to 0)
- Check and recheck distances and dimensions frequently
- Check geometry with 3D Orbit and orthographic views
- Delay adding fillets to preserve sharp corners for measurement and placement
- Limit the detail to what is justified for your goals
- Make sure that you’re on the right layer
- Use GROUP to associate objects that you don’t want to Union
- Create blocks from complex repetitive objects to reduce DWG size
- Save a version of a model at each stage so you can easily go back
- 3D landscaping – purchase it, insert as blocks

Next Steps

- Review the presentation, try things with the class models
- Create some simple models
- Review the Further Study section in the class handout
- Explore additional commands from the Basic Modeling workspace
- Create your own 3D workspace and drawing template files
- 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, SECTION, SECTIONPLANE

3D Object Creation

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

UCS

- UCS X, Y, Z rotation (90 degrees)
- 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, CONVTOSOLID
- 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, SWEEP objects along a path
- 40 Walkway – a real-life walkway 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 – 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 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

Building models - Boston Redevelopment Authority

<http://www.bostonredevelopmentauthority.org/planning/urban-design/urban-design-technology-group>

Note: These drawings all are saved in AutoCAD 2013 format. If you need them in an earlier format, use DWG TrueView to resave them.