AUTODESK **UNIVERSITY** 2015

GEN10117

The Hitchhiker's Guide to 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 Experts

Dieter Schlaepfer is a principal technical writer 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.

Definitions for Context

- 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

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)
- HELIX (spirals, springs, threads)

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

- 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
    - 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"

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

- 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

  Tip: Enter UCS directly at the Command prompt

- UCSICON – Control the display of the UCS icon
  - Off for screenshots
  - On + display at Origin for modeling

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

Profile Operations

- EXTRUDE (direction)
- REVOLVE (axis)
- SWEEP (path)
  - 2D polylines
  - + profiles

Tip: Set DELOBJ = 0 to retain profile geometry

  - 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

- 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, 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

http://www.bostonredevelopmentauthority.org/document-center?doctype=10&sortby=name&sortdirection=asc