

AutoCAD 2017
for Engineers and Designers,
3D and Advanced
(23rd Edition)

CADCIM Technologies

*525 St. Andrews Drive
Schererville, IN 46375, USA
(www.cadcim.com)*

Contributing Author

Sham Tickoo

Professor

*Department of Mechanical Engineering Technology
Purdue University Northwest
Hammond, Indiana, USA*

*President & Founder: Tickoo Institute of
Emerging Technologies (TIET), INDIA*

DEDICATION

*To teachers, who make it possible to disseminate knowledge
to enlighten the young and curious minds
of our future generations*

*To students, who are dedicated to learning new technologies
and making the world a better place to live in*

SPECIAL RECOGNITION

*A special thanks to Mr. Denis Cadu and the ADN team of Autodesk Inc.
for their valuable support and professional guidance to
procure the software for writing this textbook*

THANKS

*To the faculty and students of the MET department of
Purdue University Northwest for their cooperation*

To employees of CADCIM Technologies for their valuable help

Online Training Program Offered by CADCIM Technologies

CADCIM Technologies provides effective and affordable virtual online training on various software packages including Computer Aided Design, Manufacturing and Engineering (CAD/CAM/CAE), computer programming languages, animation, architecture, and GIS. The training is delivered 'live' via Internet at any time, any place, and at any pace to individuals as well as the students of colleges, universities, and CAD/CAM/CAE training centers. The main features of this program are:

Training for Students and Companies in a Classroom Setting

Highly experienced instructors and qualified engineers at CADCIM Technologies conduct the classes under the guidance of Prof. Sham Tickoo of Purdue University Northwest, USA. This team has authored several textbooks that are rated "one of the best" in their categories and are used in various colleges, universities, and training centers in North America, Europe, and in other parts of the world.

Training for Individuals

CADCIM Technologies with its cost effective and time saving initiative strives to deliver the training in the comfort of your home or work place, thereby relieving you from the hassles of traveling to training centers.

Training Offered on Software Packages

CADCIM provides basic and advanced training on the following software packages:

CAD/CAM/CAE: *CATIA, Pro/ENGINEER Wildfire, PTC Creo Parametric, Creo Direct, SOLIDWORKS, Autodesk Inventor, Solid Edge, NX, AutoCAD, AutoCAD LT, AutoCAD Plant 3D, Customizing AutoCAD, EdgeCAM, and ANSYS*

Architecture and GIS: *Autodesk Revit (Architecture/Structure/MEP), AutoCAD Civil 3D, AutoCAD Map 3D, Navisworks, Primavera, and Bentley STAAD Pro*

Animation and Styling: *Autodesk 3ds Max, Autodesk 3ds Max Design, Autodesk Maya, Autodesk Alias, The Foundry NukeX, MAXON CINEMA 4D, Adobe Flash, and Adobe Premiere*

Computer Programming: *C++, VB.NET, Oracle, AJAX, and Java*

For more information, please visit the following link: <http://www.cadcim.com>

Note

If you are a faculty member, you can register by clicking on the following link to access the teaching resources: <http://www.cadcim.com/Registration.aspx>. The student resources are available at <http://www.cadcim.com>. We also provide **Live Virtual Online Training** on various software packages. For more information, write us at sales@cadcim.com.

Table of Contents

Dedication	iii
Preface	xv

Chapter 1: The User Coordinate System

The User Coordinate System (UCS)	1-2
Controlling the Visibility of the UCS Icon	1-2
Defining the New UCS	1-5
Managing the UCS through the Dialog Box	1-20
System Variables	1-23
Self-Evaluation Test	1-24
Review Questions	1-25

Chapter 2: Getting Started with 3D

Starting Three Dimensional (3D) Modeling in AutoCAD	2-2
Use of Three-dimensional Drawing	2-2
Types of 3D Models	2-3
Wireframe Models	2-3
Surface Models	2-3
Solid Models	2-4
Conventions Followed in AutoCAD	2-4
Changing the Viewpoint to View 3D Models	2-5
Changing the Viewpoint Using the ViewCube	2-6
Changing the Viewpoint Using the Ribbon or the Toolbar	2-7
Changing the Viewpoint Using the Viewpoint Presets Dialog Box	2-9
Changing the Viewpoint Using the VPOINT Command	2-11
In-Canvas Viewport Control	2-13
3D Coordinate Systems	2-15
Absolute Coordinate System	2-15
Relative Coordinate System	2-16
Direct Distance Entry Method	2-18
Trim, Extend, and Fillet Tools	2-21
Setting Thickness and Elevation for New Objects	2-22
The ELEV Command	2-22
Suppressing the Hidden Edges	2-24
Creating a 3D Polyline	2-24
Converting Wireframe Models into Surface Models	2-25
Creating 3D Faces	2-25
Creating Polyface Meshes	2-26
Controlling the Visibility of the 3D Face Edges	2-27

Creating Planar Surfaces	2-27
The 3DMESH Command	2-28
Editing the Surface Mesh	2-28
The Edit Polyline Tool	2-29
Dynamic Viewing of 3D Objects	2-31
Using the SteeringWheels	2-31
Dynamically Rotating the View of a Model	2-35
Clipping the View of a Model Dynamically	2-42
Nudge Functionality	2-43
Self-Evaluation Test	2-43
Review Questions	2-44

Chapter 3: Creating Solid Models

What is Solid Modeling?	3-2
Creating Predefined Solid Primitives	3-2
Creating a Solid Box	3-2
Creating a Solid Cone	3-5
Creating a Solid Cylinder	3-7
Creating a Solid Sphere	3-8
Creating a Solid Torus	3-9
Creating a Solid Wedge	3-10
Creating a Pyramid	3-10
Creating a Polysolid	3-11
Creating a Helix	3-14
Modifying the Visual Styles of Solids	3-16
Controlling the Settings of Edges	3-21
Controlling the Face Display	3-23
Controlling the Backgrounds	3-24
Creating Complex Solid Models	3-24
Creating Regions	3-24
Creating Complex Solid Models by Applying Boolean Operations	3-25
Combining Solid Models	3-25
Subtracting One Solid From the Other	3-25
Intersecting Solid Models	3-26
Checking Interference in Solids	3-26
Dynamic UCS	3-32
Defining the New UCS Using the ViewCube and the Ribbon	3-33
Creating Extruded Solids	3-33
Extruding along the Normal	3-34
Extruding with a Taper Angle	3-34
Extruding along a Direction	3-35
Extruding along a Path	3-35
Extruding using Expressions	3-36
Creating Revolved Solids	3-36
Creating Swept Solids	3-37
Creating Lofted Solids	3-41

Creating Presspull Solids	3-51
Self-Evaluation Test	3-60
Review Questions	3-61

Chapter 4: Editing 3D Objects-I

Filleting Solid Models	4-2
Chamfering Solid Models	4-3
Rotating Solid Models in 3D Space	4-4
Rotating Solid Models about an Axis	4-6
Mirroring Solid Models in 3D Space	4-7
Moving Models in 3D Space	4-13
Creating Arrays in 3D Space	4-13
Aligning Solid Models	4-15
Aligning Solids by Defining an Alignment Plane	4-17
Extracting Edges of a Solid Model	4-19
Converting Objects to Surfaces	4-20
Converting Objects to Solids	4-20
Converting Surfaces to Solids	4-21
Point Cloud	4-21
Attaching the Point Cloud	4-21
Autodesk ReCap	4-23
Slicing Solid Models	4-29
Creating the Cross-Sections of Solids	4-32
Self-Evaluation Test	4-37
Review Questions	4-38

Chapter 5: Editing 3D Objects-II

Editing Solid Models	5-2
Editing Faces of a Solid Model	5-2
Editing Edges of a Solid Model	5-7
Editing Entire Body of a Solid Model	5-9
Generating a Section by Defining a Section Plane	5-12
Solid History	5-18
Generating Drawing Views of a Solid Model	5-19
Solid View	5-20
Solid Drawing	5-22
Solid Profile	5-23
Drawing Views	5-23
Base	5-23
Projected View	5-25
Edit View	5-25
Update View	5-26
Auto Update	5-26
Drafting Standard	5-26
Generating Section Views	5-27

Creating Flatshot	5-31
Calculating the Mass Properties of Solid Models	5-34
Recording the Drawing Steps by Using the Action Recorder	5-36
Using ShowMotion for Presentation	5-38
Playing the Animation	5-39
Self-Evaluation Test	5-40
Review Questions	5-41

Chapter 6: Surface Modeling

Surface Modeling	6-2
Creating Wireframe Elements	6-2
Spline CV	6-2
Spline Fit	6-3
Spline Freehand	6-3
Extract Isoline Curves	6-3
Creating Surfaces by Using Profiles	6-4
Creating an Extruded Surface	6-4
Creating a Revolved Surface	6-5
Creating a Loft Surface	6-6
Creating a Sweep Surface	6-6
Creating a Planar Surface	6-6
Creating a Network Surface	6-7
Creating Surfaces from other Surfaces	6-7
Creating a Blend Surface	6-8
Creating a Patch Surface	6-10
Creating an Offset Surface	6-11
Editing Surfaces	6-12
Creating Fillets	6-12
Trimming Surfaces	6-13
Untrimming Surfaces	6-15
Extending Surfaces	6-15
Sculpting Surfaces	6-16
Extracting Intersections	6-17
NURBS Surfaces	6-27
Projecting Geometries	6-31
Performing Surface Analysis	6-40
Zebra	6-41
Analysis Curvature	6-42
Analysis Draft	6-43
Self-Evaluation Test	6-43
Review Questions	6-44

Chapter 7: Mesh Modeling

Introduction	7-2
Creating Mesh Primitives	7-2

Creating a Mesh Box	7-2
Creating Surface Meshes	7-4
Creating Revolved Surface Meshes	7-5
Creating Edge Surface Meshes	7-6
Creating Ruled Surface Meshes	7-7
Creating Tabulated Surface Meshes	7-8
Modifying Mesh Objects	7-9
Adding Smoothness to Meshes	7-10
Refining the Meshes	7-13
Adding Crease to Meshes	7-15
Editing Mesh Faces	7-16
Splitting the Mesh Faces	7-16
Extruding the Mesh Faces	7-17
Merging the Mesh Faces	7-18
Closing the Gaps	7-18
Collapsing the Mesh Vertices	7-19
Spinning the Edges of Triangular Faces	7-19
Converting Mesh Objects	7-25
Converting Mesh Objects into Solids	7-25
Converting Mesh Objects into Surfaces	7-27
Working with Gizmos	7-29
Move Gizmo	7-29
Rotate Gizmo	7-29
Scale Gizmo	7-30
Self-Evaluation Test	7-39
Review Questions	7-40

Chapter 8: Rendering and Animating Designs

Understanding the Concept of Rendering	8-2
Assigning Materials	8-2
Materials Browser	8-3
Assigning Selected Materials to Objects	8-5
Attaching Material by Layers	8-6
Creating and Editing Materials	8-6
Basic Rendering	8-8
Creating New Materials	8-10
Mapping Materials on Objects	8-16
Converting Materials Created in Previous AutoCAD Release into AutoCAD 2017 Format	8-20
Adding Lights to the Design	8-20
Default Light	8-21
Point Light	8-22
Spotlight	8-31
Distant Light	8-32
Web Light	8-33
Sun Light	8-34

Converting Lights Created in AutoCAD's Previous Release into AutoCAD 2017 Format	8-41
Modifying Lights	8-42
Understanding Rendering Presets	8-43
Controlling the Rendering Environment	8-45
Rendering with a Background	8-45
Adjusting the Lighting Exposure to Rendered Image	8-46
Rendering a Model with Different Render Settings	8-46
Obtaining Rendering Information	8-49
Saving a Rendered Image	8-49
Saving the Rendered Image to a File	8-49
Saving the Viewport Rendering	8-50
Saving the Rendered Image from the Render Window	8-50
Plotting Rendered Images	8-51
Unloading AutoCAD Render	8-51
Working with Cameras	8-51
Create Camera	8-51
Editing the Cameras	8-54
Creating Animations	8-54
Creating Animation of 3D Navigations	8-55
Creating Animation by Defining the Path of the Camera Movement	8-56
Self-Evaluation Test	8-61
Review Questions	8-62

Chapter 9: AutoCAD on Internet and 3D Printing

Introduction	9-2
BROWSER	9-2
HYPERLINK	9-2
HYPERLINKFWD	9-2
HYPERLINKBACK	9-2
HYPERLINKSTOP	9-2
PASTEASHYPERLINK	9-2
HYPERLINKBASE	9-2
Internet Commands	9-2
Understanding URLs	9-3
Launching a Web Browser	9-5
Changing the Default Website	9-6
Drawings on the Internet	9-6
Opening Drawings from the Internet	9-6
Inserting a Block from the Internet	9-9
Accessing Other Files on the Internet	9-10
Saving a Drawing on the Internet	9-10
Online Resources	9-11
Using Hyperlinks with AutoCAD	9-12
Pasting as Hyperlink	9-18
Editing Hyperlinks	9-18

Removing Hyperlinks from Objects	9-18
The Drawing Web Format	9-18
Creating a DWF File	9-19
AutoCAD 360 <i>Enhanced</i>	9-27
Setting Sync	9-29
Online Options	9-30
3D Printing <i>New</i>	9-31
Self-Evaluation Test	9-35
Review Questions	9-35

Chapter 10: Script Files and Slide Shows

What Are Script Files?	10-2
Running Script Files	10-4
Repeating Script Files	10-10
Introducing Time Delay in Script Files	10-11
Resuming Script Files	10-12
Command Line Switches	10-12
Running a Script File while Loading AutoCAD	10-12
What is a Slide Show?	10-22
What are Slides?	10-22
Creating Slides	10-22
Viewing Slides	10-23
Preloading Slides	10-26
Slide Libraries	10-28
Self-Evaluation Test	10-32
Review Questions	10-32

Chapter 11: Creating Linetypes and Hatch Patterns

Standard Linetypes	11-2
Linetype Definitions	11-2
Elements of Linetype Specification	11-3
Creating Linetypes	11-3
Alignment Specification	11-9
LTSCALE Command	11-9
LTSCALE Factor for Plotting	11-12
Current Linetype Scaling (CELTSCALE)	11-12
Alternate Linetypes	11-13
Modifying Linetypes	11-14
Complex Linetypes	11-17
Creating a String Complex Linetype	11-17
Hatch Pattern Definition	11-26
How Hatch Works?	11-28
Simple Hatch Pattern	11-29
Effect of Angle and Scale Factor on Hatch	11-30
Hatch Pattern with Dashes and Dots	11-31
Hatch with Multiple Descriptors	11-33

Saving Hatch Patterns in a Separate File	11-37
Custom Hatch Pattern File	11-37
Self-Evaluation Test	11-38
Review Questions	11-39

Chapter 12: Customizing the acad.pgp File

What is the acad.pgp File?	12-2
Sections of the acad.pgp File	12-8
Reinitializing the acad.pgp File	12-10
Self-Evaluation Test	12-12
Review Questions	12-13

Chapter 13: Conventional Dimensioning and Projection Theory Using AutoCAD

Dimensioning	13-2
Dimension Units	13-2
Dimensioning Components	13-3
Common Rules for Dimensioning	13-4
Working Drawings	13-14
Detail Drawing	13-15
Assembly Drawing	13-16
Bill of Materials	13-16
Multiview Drawings	13-17
Understanding the X, Y, and Z Axes	13-18
Orthographic Projections	13-18
Positioning Orthographic Views	13-21
Sectional Views	13-27
Full Section	13-27
Half Section	13-28
Broken Section	13-29
Revolved Section	13-29
Removed Section	13-30
Offset Section	13-31
Aligned Section	13-31
Cutting Plane Lines	13-32
Spacing for Hatch Lines	13-34
Direction of Hatch Lines	13-34
Points to Remember	13-35
Auxiliary Views	13-38
Self-Evaluation Test	13-42
Review Questions	13-43

Chapter 14: Isometric Drawings

Isometric Drawings	14-2
Isometric Projections	14-2

Table of Contents**xiii**

Isometric Axes and Planes	14-3
Setting the Isometric Grid and Snap	14-3
Drawing Isometric Circles	14-7
Creating Fillets in Isometric Drawings	14-8
Dimensioning Isometric Objects	14-9
Isometric Text	14-10
Self-Evaluation Test	14-11
Review Questions	14-12
Index	I-1

This page is intentionally left blank

Preface

AutoCAD 2017

AutoCAD, developed by Autodesk Inc., is the most popular PC-CAD system available in the market. Today, over 7 million people use AutoCAD and other AutoCAD-based design products. 100% of the Fortune 100 firms and 98% of the Fortune 500 firms are Autodesk customers. AutoCAD's open architecture allows third-party developers to write application software that has significantly added to its popularity. For example, the author of this book has developed a software package “**SMLayout**” for sheet metal products that generates a flat layout of various geometrical shapes such as transitions, intersections, cones, elbows, tank heads, and so on. Several companies in Canada and United States are using this software package with AutoCAD to design and manufacture various products. AutoCAD also facilitates customization that enables the users to increase their efficiency and improve their productivity.

The **AutoCAD 2017 for Engineers and Designers - 3D and Advanced** textbook contains detailed explanation of AutoCAD commands and their applications to solve design problems. Every AutoCAD command is thoroughly explained with the help of examples and illustrations. This makes it easy for the users to understand the functions and applications of the tools and commands. After reading this textbook, you will be able to create 3D objects, apply materials to objects, generate drafting views of a model, create surface or mesh objects, and render and animate designs.

The book covers designing concepts in detail as well as provides elaborative description of technical drawing in AutoCAD including orthographic projections, dimensioning principles, sectioning, auxiliary views, and assembly drawings. While going through this textbook, you will discover some new unique applications of AutoCAD that will have a significant effect on your drawings and designs. In addition, you will be able to understand why AutoCAD has become such a popular software package and an international standard in PC-CAD.

Symbols Used in the Textbook

Note



The author has provided additional information to the users about the topic being discussed in the form of notes.

Tip



Special information and techniques are provided in the form of tips that will increase the efficiency of the users.

New



This symbol indicates that the command or tool being discussed is new.


Enhanced



This symbol indicates that the command or tool being discussed has been enhanced in AutoCAD 2017.

Formatting Conventions Used in the Textbook

Refer to the following list for the formatting conventions used in this textbook.

- Command names are capitalized and written in boldface letters. Example: The **MOVE** command
- A key icon appears when you have to respond by pressing the ENTER or the RETURN key. 
- Command sequences are indented. The responses are indicated in boldface. The directions are indicated in italics and the comments are enclosed in parentheses. Command: **MOVE**
Select object: **G**
Enter group name: *Enter a group name (the group name is group1)*
- The methods of invoking a tool/option from the **Ribbon**, **Menu Bar**, **Quick Access Toolbar**, **Tool Palettes**, **Application menu**, toolbars, Status Bar, and Command prompt are enclosed in a shaded box.

Ribbon:	Draw > Line
Menu Bar:	Draw > Line
Tool Palettes:	Draw > Line
Toolbar:	Draw > Line
Command:	LINE or L

Naming Conventions Used in the Textbook

Tool

If you click on an item in a toolbar or a panel of the **Ribbon** and a command is invoked to create/edit an object or perform some action, then that item is termed as **tool**, refer to Figure 1.

For example:

To Create: **Line** tool, **Circle** tool, **Extrude** tool

To Edit: **Fillet** tool, **Array** tool, **Stretch** tool

Action: **Zoom** tool, **Move** tool, **Copy** tool

If you click on an item in a toolbar or a panel of the **Ribbon** and a dialog box is invoked wherein you can set the properties to create/edit an object, then that item is also termed as **tool**, refer to Figure 1.

For example:

To Create: **Define Attributes** tool, **Create** tool, **Insert** tool

To Edit: **Edit Attributes** tool, **Block Editor** tool

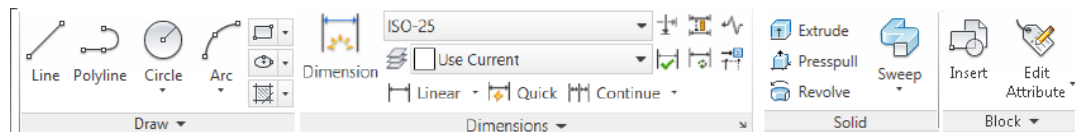


Figure 1 Various tools in the Ribbon

Button

If you click on an item in a toolbar or a panel of the **Ribbon** and the display of the corresponding object is toggled on/off, then that item is termed as **Button**. For example, **Grid** button, **Snap** button, **Ortho** button, **Properties** button, **Tool Palettes** button, and so on; refer to Figure 2.



Figure 2 Various buttons displayed in the Status Bar and Ribbon

The item in a dialog box that has a 3d shape like a button is also termed as **Button**. For example, **OK** button, **Cancel** button, **Apply** button, and so on.

Dialog Box

In this textbook, different terms are used for referring to the components of a dialog box. Refer to Figure 3 for the terminology used.

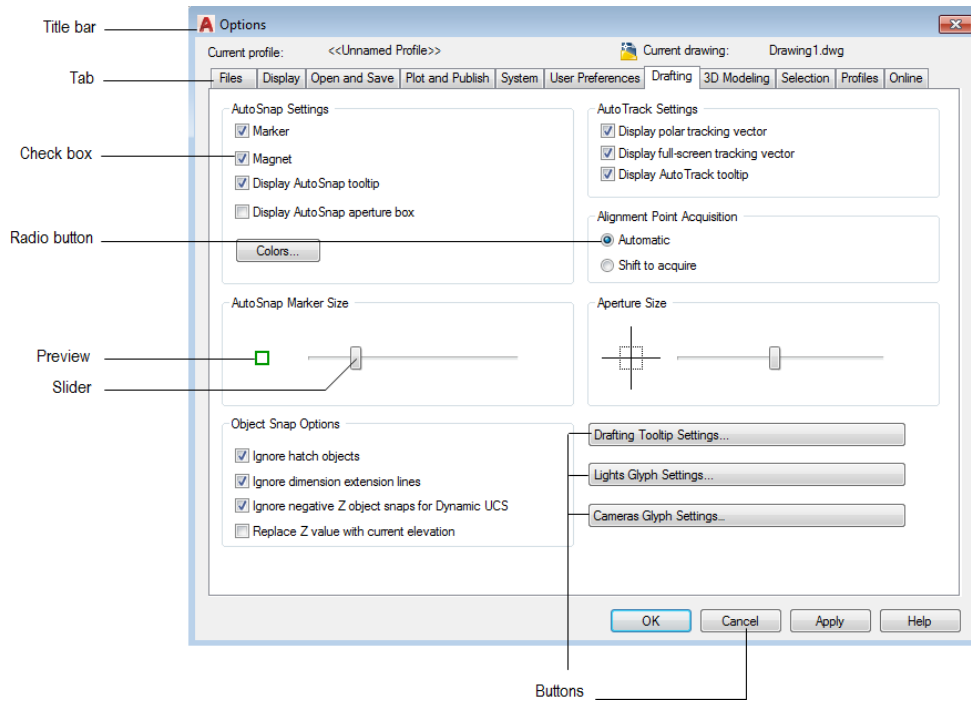


Figure 3 The components of a dialog box

Drop-down

A drop-down is the one in which a set of common tools are grouped together. You can identify a drop-down with a down arrow on it. These drop-downs are given a name based on the tools grouped in them. For example, **Circle** drop-down, **Fillet/Chamfer** drop-down, **Create Light** drop-down, and so on; refer to Figure 4.

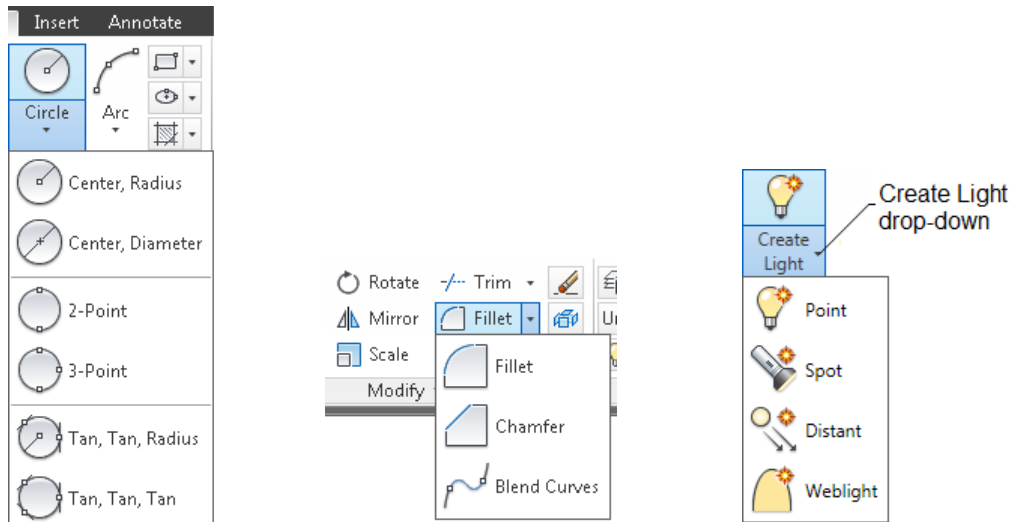


Figure 4 The Circle, Fillet/Chamfer, and Create Light drop-downs

Drop-down List

A drop-down list is the one in which a set of options are grouped together. You can set various parameters using these options. You can identify a drop-down list with a down arrow on it. To know the name of a drop-down list, move the cursor over it; its name will be displayed as a tool tip. For example, **Lineweight** drop-down list, **Linetype** drop-down list, **Object Color** drop-down list, **Visual Styles** drop-down list, and so on; refer to Figure 5.

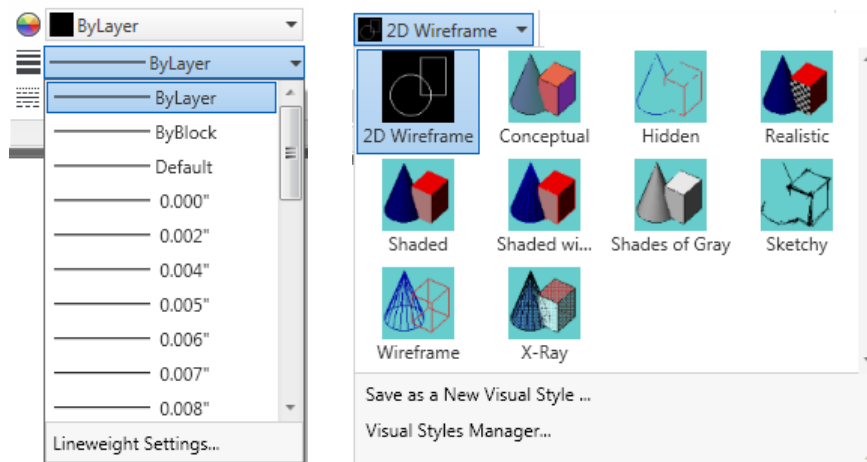


Figure 5 The Lineweight and Visual Styles drop-down lists

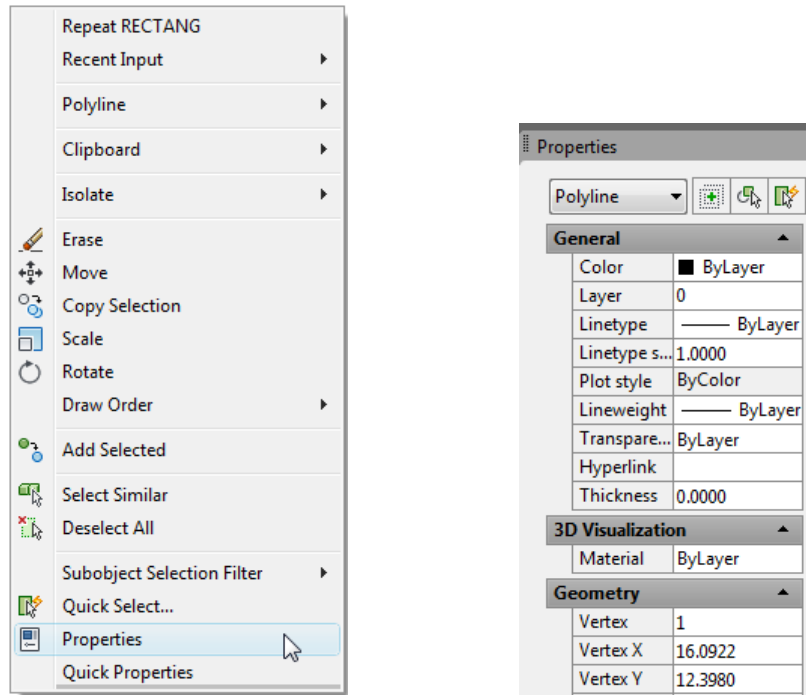
Options

Options are the items that are available in shortcut menu, drop-down list, Command prompt, **Properties** panel, and so on. For example, choose the **Properties** option from the shortcut menu displayed on right-clicking in the drawing area, refer to Figure 6.

Tools and Options in Menu Bar

A menu bar consists of both tools and options. As mentioned earlier, the term **tool** is used to create/edit something or to perform some action. For example, in Figure 7, the item Box has been used to create a box shaped surface, therefore it will be referred to as the **Box** tool.

Similarly, an option in the menu bar is the one that is used to set some parameters. For example, in Figure 7, the item Linetype has been used to set/load the linetype, therefore it will be referred to as an option.



*Figure 6 Options in the shortcut menu and the **Properties** palette*

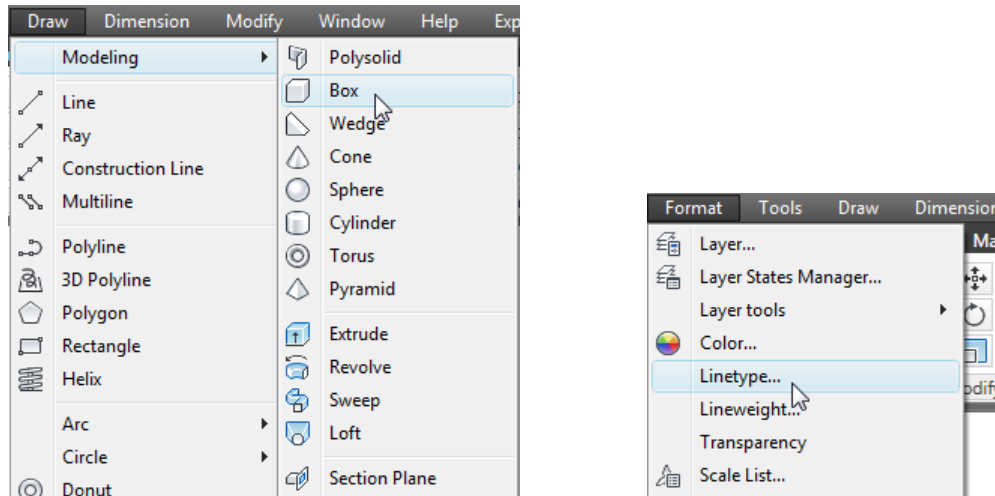


Figure 7 Tools and options in the menu bar

Free Companion Website

It has been our constant endeavor to provide you the best textbooks and services at affordable price. In this endeavor, we have come out with a Free Companion website that will facilitate the process of teaching and learning of AutoCAD 2017. If you purchase this textbook, you will get access to the files on the Companion website.

The following resources are available for the faculty and students in this website:

Faculty Resources

- **Technical Support**

The faculty can get online technical support by contacting *techsupport@cadcim.com*.

- **Instructor Guide**

Solutions to all review questions and exercises in the textbook are provided in this guide to help the faculty members test the skills of the students.

- **PowerPoint Presentations**

The contents of the book are arranged in PowerPoint slides that can be used by the faculty for their lectures.

- **Part Files**

The part files used in illustrations, examples, and exercises are available for free download.

- **Drawing Files**

The drawing files used in examples and exercises.

Student Resources

- **Technical Support**

You can get online technical support by contacting *techsupport@cadcim.com*.

- **Part Files**

The part files used in illustrations and examples are available for free download.

You can access additional learning resources by visiting *http://allaboutcadcam.blogspot.com*.

If you face any problem in accessing these files, please contact the publisher at *sales@cadcim.com* or the author at *stickoo@pnw.edu* or *tickoo525@gmail.com*.

Stay Connected

You can now stay connected with us through Facebook and Twitter to get the latest information about our textbooks, videos, and teaching/learning resources. To stay informed of such updates, follow us on Facebook (*www.facebook.com/cadcim*) and Twitter (*@cadcimtech*). You can also subscribe to our You Tube channel (*www.youtube.com/cadcimtech*) to get the information about our latest video tutorials.

This page is intentionally left blank