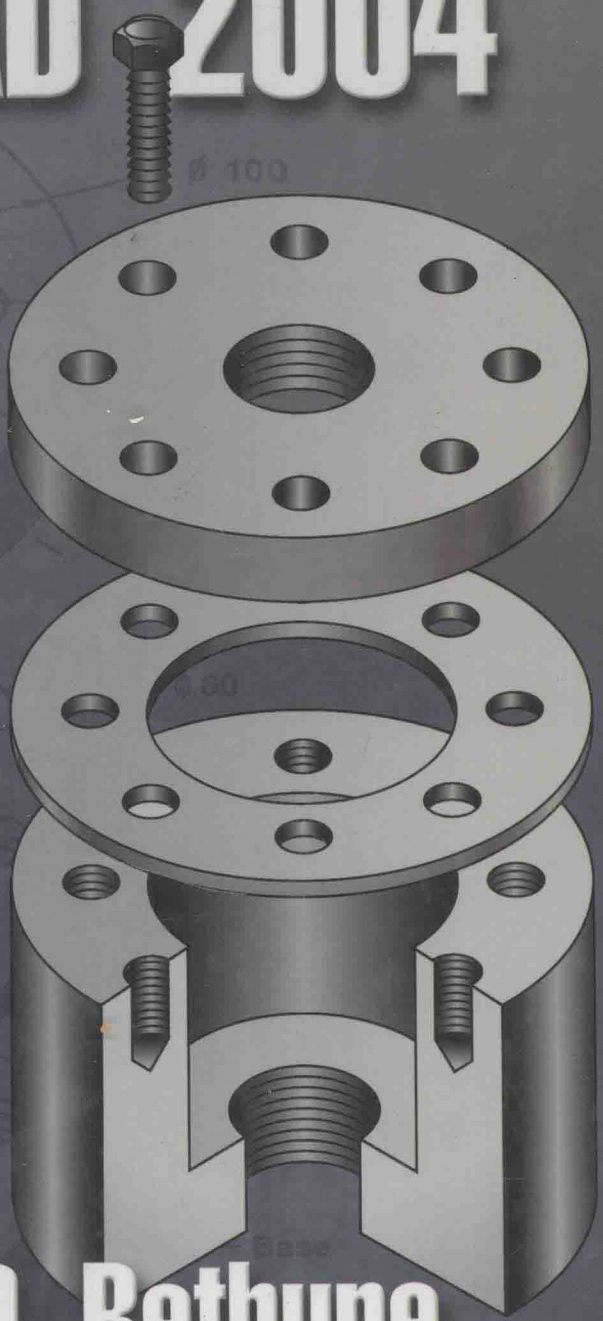
Engineering Graphics with AutoCAD® 2004



James D. Bethune

autodesk
authorized publisher

Engineering Graphics with AutoCAD® 2004

James D. Bethune
Boston University

PEARSON
Prentice Hall

Upper Saddle River, New Jersey
Columbus, Ohio

Library of Congress Cataloging-in-Publication Data
Bethune, James D.
Engineering graphics with AutoCAD 2004 / James D. Bethune.
p. cm.
ISBN 0-13-177983-4
1. Engineering graphics. 2. AutoCAD. I. Title.

T357.B45 2004
620′.0042′02855369–dc22 2003058145

Editor in Chief: Stephen Helba
Executive Editor: Debbie Yarnell
Managing Editor: Judith Casillo
Editorial Assistant: Jonathan Tenthoff
Production Editor: Louise N. Sette
Production Supervisor: Lisa Garboski, bookworks
Design Coordinator: Diane Ernsberger
Cover Designer: Rod Harris
Production Manager: Brian Fox
Marketing Manager: Jimmy Stephens

This book was set in Times and Arial by STELLARViSIONs and was printed and bound by Courier Kendallville, Inc. The cover was printed by Phoenix Color Corp.

10 9 8 7 6 5 4 3 2
ISBN: 0-13-177983-4

Preface

This book teaches technical drawing and uses AutoCAD® as its drawing instrument. This book, an update of *Engineering Graphics with AutoCAD® 2002,* for AutoCAD® 2004, follows the general format of many technical drawing texts and presents much of the same material about drawing conventions and practices, with emphasis on creating accurate, clear drawings. For example, the book shows how to locate dimensions on a drawing so that they completely define the object in accordance with current national standards, but the presentation centers on the Dimension toolbar and its associated tools and options. The standards and conventions are presented and their applications are shown using AutoCAD® 2004. This integrated teaching concept is followed throughout the book.

Most chapters include design problems. The problems are varied in scope and are open-ended, which means that there are several correct solutions. This is intended to encourage student creativity and increase their problem-solving abilities.

This edition does not include a disk with exercise problems from Chapter 8. The exercise problems for Chapter 8 are now presented on grids so that the dimensions can be easily derived.

Chapters 1 through 3 cover AutoCAD's Draw and Modify toolbars and other commands needed to set up and start drawings. The text starts with simple Line commands and proceeds through geometric constructions. The final sections of Chapter 3 describe how to bisect a line and how to draw a hyperbola, a parabola, a helix, and an ogee curve. These constructions are included in most on-the-board technical drawing books because they help students develop accuracy and an understanding of how to use their equipment. The same type of learning experience also occurs when the constructions are done using AutoCAD. Redrawing many of the classic geometric shapes will help students learn how to use the Draw and Modify toolbars, along with other associated commands, with accuracy and creativity.

Chapter 4 presents freehand sketching. Simply stated, there is still an important place for sketching in technical drawing. Many design ideas start as freehand sketches and are then developed on the computer. This chapter now includes extensive exercise problems associated with object orientation.

Chapter 5 presents orthographic views. Students are shown how to draw three views of an object using AutoCAD. The discussion includes projection theory, hidden lines, compound lines, oblique surfaces, rounded surfaces, holes, irregular surfaces, castings, and thin-walled objects. The chapter ends with several intersection problems. These problems serve as a good way to pull together orthographic views and projection theory.

Chapter 6 presents sectional views and introduces the Hatch command. The chapter includes multiple, bro-

ken-out, and partial sectional views and shows how to draw an S-break for a hollow cylinder.

Chapter 7 covers auxiliary views and shows how to use the Snap, Rotate command to create axes aligned with slanted surfaces. Secondary auxiliary views are also discussed. Solid modeling greatly simplifies the determination of the true shape of a line or plane, but a few examples of secondary auxiliary views help students refine their understanding of orthographic views and eventually the application of UCSs.

Chapter 8 shows how to dimension both two-dimensional shapes and orthographic views. The Dimension command and its associated commands are demonstrated, including how to use the Dimension Styles tool. The commands are presented as needed to create required dimensions. The conventions demonstrated are in compliance with ANSI Y32. The exercise problems for Chapter 8 have been extensively revised and are all presented on grids so that the dimensions can be easily derived.

Chapter 9 introduces tolerances. First, the chapter shows how to draw dimensions and tolerances using the Dimension and Tolerance commands, among others. The chapter ends with an explanation of fits and shows how to use the tables included in the appendix to determine the maximum and minimum tolerances for matching holes and shafts.

Chapter 10 continues the discussion of tolerancing using geometric tolerances and explains how AutoCAD® 2004 can be used to create geometric tolerance symbols directly from dialog boxes. Both profile and positional tolerances are explained. The overall intent of the chapter is to teach students how to make parts fit together. Fixed and floating fastener applications are discussed, and design examples are given for both conditions.

Chapter 11 covers how to draw and design using standard fasteners, including bolts, nuts, machine screws, washers, hexagon heads, square heads, set screws, rivets, and springs. Students are shown how to create wblocks of the individual thread representations and how to use them for different size requirements.

Chapter 12 discusses assembly drawings, detail drawings, and parts lists. Instructions for drawing title blocks, tolerance blocks, release blocks, and revision blocks, and for inserting drawing notes are also included to give students better preparation for industrial practices. Several new exercise problems have been added to the chapter.

Chapter 13 presents gears, cams, and bearings. The intent of the chapter is to teach how to design using gears selected from a manufacturer's catalog. The chapter shows how to select bearings to support gear shafts and how to tolerance holes in support plates to maintain the desired center distances of meshing gears. The chapter also shows how to create a displacement diagram and then draw the appropriate cam profile.

Chapter 14 introduces AutoCAD®'s 3-D capabilities. It teaches students about AutoCAD®'s 3-D commands and coordinate system definition before introducing them to surface and solid models. Both WCS and UCS are explained and demonstrated along with Preset and View commands. 3-D primitives are introduced and used to create simple shapes. The chapter concludes by showing how to create orthographic views from the drawn 3-D shapes.

Chapter 15 extends the discussion of Chapter 14 to cover surface modeling. The basic geometric shapes of the Surfaces toolbar are presented as well as the Revsurf, Tabsurf, Rulesurf, 3D Face, and 3D Mesh commands. All the surface commands are demonstrated and used to create 3-D shapes.

Chapter 16 introduces solid modeling and includes the Solids Editing commands. The Solid and Solids Editing toolbars are demonstrated and used with the Union and Subtract commands to create 3-D shapes. Orthographic views are then created from the solid shapes. More complex shapes are created using the Extrude, Section, and Slice commands. The chapter concludes with several exercise problems that demonstrate a solid modeling approach to intersection problems as originally introduced at the end of Chapter 5. The chapter also includes several design exercise problems.

Chapter 17 presents a solid modeling approach to descriptive geometry. For example, a plane is drawn as a solid that is 0.00001 inch thick. AutoCAD®'s solid modeling and other commands are then used to manipulate the plane. The true lengths of lines and shapes of planes, point and plane locations, and properties between lines and planes are discussed. Piercing points and line visibility are also covered.

I would like to thank the following reviewers. Their comments and suggestions were most helpful in creating this edition: Anthony Duva, Wentworth Institute of Technology; Dale M. Gerstenecker, St. Louis Community College at Florissant; N.S. Malladi, Ph.D., University of South Alabama; and Jack Zhou, Drexel University.

Thanks to Debbie Yarnell and Judy Casillo, the managing editor who pulled it all together; and to David, Maria, Randy, Lisa, Hannah, Wil, Madison, Jack, and Cheryl for their continued support.

James D. Bethune
Boston University

Contents

Chapter 1 — Getting Started

1-1 Introduction 2
1-2 Toolbars 3
1-3 The Command: Line Box 7
1-4 Command Tools 8
1-5 Starting a New Drawing 8
1-6 Naming a Drawing 8
1-7 Drawing Units 10
1-8 Drawing Limits 12
1-9 Grid and Snap 13
1-10 Sample Problem SP1-1 15
1-11 Save and Save As 16
1-12 Open 16
1-13 Exit 16
1-14 Exercise Problems 18

Chapter 2 — Fundamentals of 2-D Construction

2-1 Introduction 21
2-2 Line—Random Points 21
2-3 Erase 23
2-4 Line—Snap Points 25
2-5 Line—Coordinate Values 25
2-6 Line—Polar Values 26
2-7 Construction Line 27
2-8 Circle 30
2-9 Circle Centerlines 32
2-10 Polyline 34
2-11 Spline 37
2-12 Ellipse 38
2-13 Rectangle 40
2-14 Polygon 40
2-15 Point 41
2-16 Text 42
2-17 Move 46
2-18 Copy 46
2-19 Offset 47
2-20 Mirror 48
2-21 Array 48
2-22 Rotate 50
2-23 Trim 50
2-24 Extend 51
2-25 Break 52
2-26 Chamfer 53
2-27 Fillet 54
2-28 Exercise Problems 55

Chapter 3 — More Advanced Commands

3-1 Introduction 65
3-2 Osnap 65
3-3 Osnap—Endpoint 67
3-4 Osnap—Snap From 67
3-5 Osnap—Midpoint 68
3-6 Osnap—Intersection 68
3-7 Osnap—Apparent Intersection 69
3-8 Osnap—Center 70
3-9 Osnap—Quadrant 70
3-10 Osnap—Perpendicular 70
3-11 Osnap—Tangent 71
3-12 Osnap—Nearest 72
3-13 Sample Problem SP3-1 72
3-14 Sample Problem SP3-2 73
3-15 Grips 74
3-16 Grips—Extend 75
3-17 Grips—Move 76
3-18 Grips—Rotate 76
3-19 Grips—Scale 77
3-20 Grips—Mirror 77
3-21 Blocks 78
3-22 Working with Blocks 80
3-23 Wblock 83
3-24 Layers 85
3-25 Attributes 93
3-26 Title Blocks with Attributes 98
3-27 Edit Polyline 101
3-28 Edit Spline 101
3-29 Edit Text 101
3-30 Constructing the Bisector of an Angle—Method I 102
3-31 Constructing the Bisector of an Angle—Method II 103
3-32 Constructing an Ogee Curve (S-Curve) with Equal Arcs 103
3-33 Constructing a Parabola 104
3-34 Constructing a Hyperbola 104
3-35 Constructing a Spiral 105
3-36 Constructing a Helix 106
3-37 Designing Using Shape Parameters 106
3-38 Exercise Problems 109

Chapter 4 — Sketching

4-1 Introduction 127
4-2 Establishing Your Own Style 127
4-3 Graph Paper 127
4-4 Pencils 128
4-5 Lines 128
4-6 Proportions 129
4-7 Curves 130
4-8 Sample Problem SP4-1 131
4-9 Isometric Sketches 132
4-10 Sample Problem SP4-2 134
4-11 Oblique Sketches 135
4-12 Perspective Sketches 136
4-13 Working in Different Orientations 138
4-14 Exercise Problems 139

Chapter 5 — Orthographic Views

5-1 Introduction 151
5-2 Three Views of an Object 151
5-3 Visualization 152
5-4 Hidden Lines 154
5-5 Hidden Line Conventions 154
5-6 Drawing Hidden Lines 155
5-7 Precedence of Lines 159
5-8 Slanted Lines 159
5-9 Projection Between Views 160
5-10 Sample Problem SP5-1 160
5-11 Compound Lines 161
5-12 Sample Problem SP5-2 162
5-13 Oblique Surfaces 163
5-14 Sample Problems SP5-3 164
5-15 Rounded Surfaces 165
5-16 Sample Problem SP5-4 166
5-17 Holes 166
5-18 Holes in Slanted Surfaces 169
5-19 Cylinders 171
5-20 Sample Problem SP5-5 172
5-21 Cylinders with Slanted and Rounded Surfaces 173
5-22 Sample Problem SP5-6 174
5-23 Drawing Conventions and Cylinders 175
5-24 Irregular Surfaces 176
5-25 Sample Problem SP5-7 176
5-26 Hole Callouts 179
5-27 Castings 180
5-28 Sample Problem SP5-8 182
5-29 Thin-Walled Objects 183
5-30 Sample Problem SP5-9 184
5-31 Intersections 185
5-32 Sample Problem SP5-10 185
5-33 Sample Problem SP5-11 187
5-34 Sample Problem SP5-12 187
5-35 Designing by Modifying an Existing Part 190
5-36 Exercise Problems 192

Chapter 6 — Sectional Views

6-1 Introduction 223
6-2 Cutting Plane Lines 225
6-3 Section Lines 228
6-4 Hatch 229
6-5 Sample Problem SP6-1 231
6-6 Styles of Section Lines 232
6-7 Sectional View Location 232
6-8 Holes in Sections 233
6-9 Hatch Styles 234
6-10 Offset Sections 235
6-11 Multiple Sections 236
6-12 Aligned Sections 236
6-13 Drawing Conventions in Sections 236
6-14 Half, Partial, and Broken-out Sectional Views 237
6-15 Removed Sectional 238
6-16 Breaks 238
6-17 Sectional Views of Castings 240
6-18 Exercise Problems 242

Chapter 7 — Auxiliary Views

7-1 Introduction 255
7-2 Projection Between Normal and Auxiliary Views 256
7-3 Sample Problem SP7-1 259
7-4 Transferring Lines Between Views 260
7-5 Sample Problem SP7-2 261
7-6 Projecting Rounded Surfaces 261
7-7 Sample Problem SP7-3 262
7-8 Projecting Irregular Surfaces 263
7-9 Sample Problem SP7-4 263
7-10 Sample Problem SP7-5 265
7-11 Partial Auxiliary Views 266
7-12 Sectional Auxiliary Views 267
7-13 Auxiliary Views of Oblique Surfaces 267
7-14 Secondary Auxiliary Views 268
7-15 Sample Problem SP7-6 270
7-16 Secondary Auxiliary View of an Ellipse 272
7-17 Exercise Problems 273

Chapter 8 — Dimensioning

8-1 Introduction 288
8-2 Terminology and Conventions 288
8-3 Linear Dimension 290
8-4 Dimension Styles 294
8-5 Units 297
8-6 Aligned Dimensions 299
8-7 Radius and Diameter Dimensions 299
8-8 Angular Dimensions 303
8-9 Ordinate Dimensions 304
8-10 Baseline Dimensions 306
8-11 Continue Dimension 308
8-12 Quick Dimension 309
8-13 Center Mark 310
8-14 Quick Leader 310
8-15 Dimension Edit 313
8-16 Tolerances 314
8-17 Dimensioning Holes 314
8-18 Placing Dimensions 317
8-19 Fillets and Rounds 317
8-20 Rounded Shapes (Internal) 317
8-21 Rounded Shapes (External) 318
8-22 Irregular Surfaces 318
8-23 Polar Dimensions 320
8-24 Chamfers 320
8-25 Knurling 321
8-26 Keys and Keyseats 322
8-27 Symbols and Abbreviations 323
8-28 Symmetry and Centerline 323
8-29 Dimensioning to Points 323
8-30 Coordinate Dimensions 324
8-31 Sectional Views 325
8-32 Orthographic Views 325
8-33 Very Large Radii 326
8-34 Exercise Problems 327

Chapter 9 — Tolerancing

9-1 Introduction 345
9-2 Direct Tolerance Methods 345
9-3 Tolerance Expressions 346
9-4 Understanding Plus and Minus Tolerances 346
9-5 Creating Plus and Minus Tolerances Using AutoCAD 347
9-6 Limit Tolerances 349
9-7 Creating Limit Tolerances Using AutoCAD 360
9-8 Angular Tolerances 351
9-9 Standard Tolerances 352
9-10 Double Dimensioning 352
9-11 Chain Dimensions and Baseline Dimensions 353
9-12 Tolerance Studies 355
9-13 Rectangular Dimensions 355
9-14 Hole Locations 356
9-15 Choosing a Shaft for a Toleranced Hole 356

9-16 Sample Problem SP9-1 357
9-17 Sample Problem SP9-2 358
9-18 Standard Fits (Metric Values) 358
9-19 Nominal Sizes 360
9-20 Hole and Shaft Basis 360
9-21 Sample Problem SP9-3 361
9-22 Standard Fits (Inch Values) 361
9-23 Sample Problem SP9-4 361
9-24 Preferred and Standard Sizes 362
9-25 Surface Finishes 362
9-26 Surface Control Symbols 365
9-27 Design Problems 366
9-28 Exercise Problems 370

Chapter 10 — Geometric Tolerances

10-1 Introduction 383
10-2 Tolerances of Form 384
10-3 Flatness 384
10-4 Straightness 384
10-5 Straightness (RFS and MMC) 385
10-6 Circularity 387
10-7 Cylindricity 388
10-8 Geometric Tolerances Using AutoCAD 389
10-9 Tolerances of Orientation 395
10-10 Datums 395
10-11 Perpendicularity 396
10-12 Parallelism 398
10-13 Angularism 398
10-14 Profiles 398
10-15 Runouts 400
10-16 Positional Tolerances 401
10-17 Virtual Condition 402
10-18 Floating Fasteners 403
10-19 Sample Problem SP10-1 404
10-20 Sample Problem SP10-2 404
10-21 Fixed Fasteners 405
10-22 Sample Problem SP10-3 406
10-23 Design Problems 407
10-24 Exercise Problems 409

Chapter 11 — Threads and Fasteners

11-1 Introduction 429
11-2 Thread Terminology 429
11-3 Thread Callouts (Metric Units) 429
11-4 Thread Callouts (English Units) 430
11-5 Thread Representations 431
11-6 Orthographic Views of Internal Threads 436
11-7 Sectional Views of Internal Thread Representations 436
11-8 Types of Threads 437
11-9 How to Draw an External Square Thread 438
11-10 How to Draw an Internal Square Thread 439
11-11 How to Draw an External Acme Thread 439
11-12 Bolts and Nuts 441
11-13 Screws 441
11-14 Studs 441
11-15 Head Shapes 442
11-16 Nuts 445
11-17 Sample Problem SP11-1 448
11-18 Sample Problem SP11-2 448
11-19 Standard Screws 449
11-20 Set Screws 450
11-21 Washers 451
11-22 Keys 452
11-23 Rivets 452
11-24 Springs 454
11-25 Exercise Problems 457

Chapter 12 — Working Drawings

12-1 Introduction 465
12-2 Assembly Drawings 466
12-3 Drawing Formats (Templates) 468
12-4 Title Block 471
12-5 Revision Block 472
12-6 Tolerance Block 473
12-7 Release Block 473
12-8 Parts List (Bill of Materials) 474
12-9 Detail Drawings 475
12-10 First-Angle Projection 476
12-11 Drawing Notes 477
12-12 Design Layouts 477
12-13 Sample Problem SP12-1 478
12-14 Exercise Problems 482

Chapter 13 — Gears, Bearings, and Cams

13-1 Introduction 505
13-2 Types of Gears 505
13-3 Gear Terminology—Spur 505
13-4 Spur Gear Drawings 507
13-5 Sample Problem SP13-1 508
13-6 Sample Problem SP13-2 510
13-7 Sample Problem SP13-3 512
13-8 Selecting Spur Gears 512
13-9 Center Distance between Gears 512
13-10 Sample Problem SP13-4 512

13-11 Combining Spur Gears 515
13-12 Gear Terminology—Bevel 517
13-13 How to Draw Bevel Gears 518
13-14 Worn Gears 519
13-15 Helical Gears 521
13-16 Racks 522
13-17 Ball Bearings 523
13-18 Sample Problem SP13-5 523
13-19 Bushings 525
13-20 Sample Problem SP13-6 526
13-21 Cam Displacement Diagrams 527
13-22 Cam Motions 528
13-23 Cam Followers 531
13-24 Sample Problem SP13-7 532
13-25 Exercise Problems 534

Chapter 14 — Fundamentals of 3D Drawing

14-1 Introduction 541
14-2 The World Coordinate System 541
14-3 Viewpoints 543
14-4 User Coordinate Systems (UCSs) 546
14-5 Working with UCSs 548
14-6 Sample Problem SP14-1 550
14-7 Orthographic Views 555
14-8 Elev 558
14-9 Using the Elev Command to Create Objects 559
14-10 Exercise Problems 563

Chapter 15 — Surface Modeling

15-1 Introduction 569
15-2 Box 571
15-3 Wedge 571
15-4 Pyramid 572
15-5 Cone 575
15-6 Sphere 576
15-7 Dome 577
15-8 Dish 578
15-9 Torus 578
15-10 3-D Face 579
15-11 3-D Mesh 580
15-12 Revolved Surface 581
15-13 Tabulated Suface 583
15-14 Ruled Surface 584
15-15 Edge Surface 586
15-16 Combining Surfaces 587
15-17 Using Surfaces with a UCS 588
15-18 Sample Problem SP15-1 593
15-19 Exercise Problems 600

Chapter 16 — Solid Modeling

16-1 Introduction 612
16-2 Box 612
16-3 Sphere 614
16-4 Cylinder 614
16-5 Cone 615
16-6 Wedge 616
16-7 Torus 618
16-8 Extrude 619
16-9 Revolve 620
16-10 Slice 621
16-11 Section 622
16-12 Interfere 625
16-13 Union and Subtract 626
16-14 Solid Modeling and UCSs 627
16-15 Combining Solid Objects 629
16-16 Intersecting Solids 634
16-17 Solid Models of Castings 638
16-18 Thread Representations in Solid Models 643
16-19 List 643
16-20 Massprop 645
16-21 Face and Edge Editing 645
16-22 Design Problem 650
16-23 Exercise Problems 657

Chapter 17 — Descriptive Geometry

17-1 Introduction 683
17-2 Orthographic Projection 683
17-3 The True Length of a Line 686
17-4 The True Shape of a Plane 690
17-5 Locating a Line in a Plane 694
17-6 Locating a Point in a Plane 696
17-7 Visibility of a Line 698
17-8 Piercing Points 699
17-9 Distance Between a Line and a Point 703
17-10 Distance Between Two Lines 705
17-11 Angle Between a Plane and a Line 706
17-12 Angle Between Two Planes 708
17-13 Intersection 710
17-14 Further Study 710
17-15 Exercise Problems 712

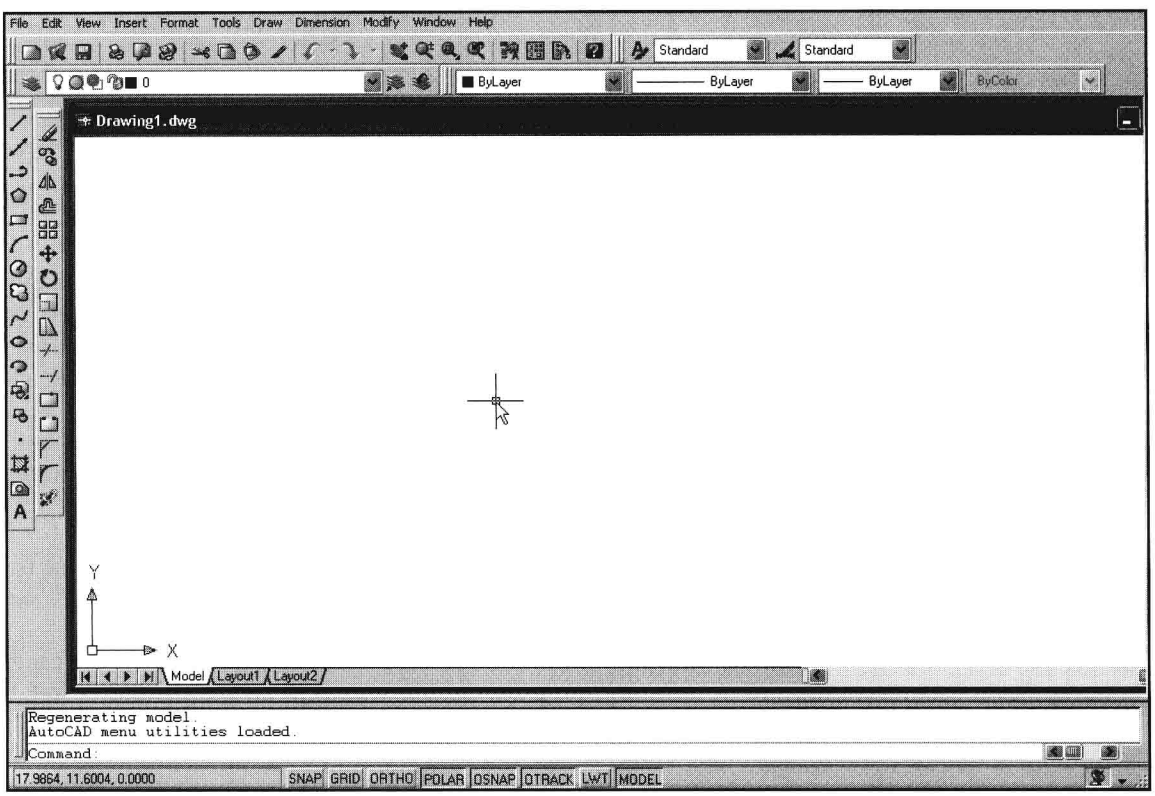
Appendix

A-1 Wire and Sheet Metal Gauges 723
A-2 American Standard Clearance Locational Fits 724
A-3 American Standard Running and Sliding Fits 725
A-4 American Standard Transition Locational Fits 726
A-5 American Standard Interference Locational Fits 727
A-6 American Standard Force and Shrink Fits 728
A-7 Preferred Clearance Fits—Cylindrical Fits 729
A-8 Preferred Transition and Interference Fits—Cylindrical Fits 730
A-9 Preferred Clearance Fits—Cylindrical Fits 731
A-10 Preferred Transition and Interference Fits—Cylindrical Fits 732
A-11 American National Standard Type A Plain Washers 733
A-12 American National Standard Helical Spring Lock Washers 734
A-13 American National Standard Internal–External Tooth Lock Washers 735
A-14 British Standard Bright Metal Washers—Metric Series 736
A-15 American National Standard and Unified Standard Square Bolts 737
A-16 American National Standard and Unified Standard Hex Head Screws 738
A-17 Coarse-Thread Series, UNC, UNRC, and NC—Basic Dimensions 739
A-18 Fine-Thread Series, UNC, UNRC, and NC—Basic Dimensions 740
A-19 American National Standard General-Purpose Acme Thread Form—Basic Dimensions 741
A-20 60° Stub Threads 741
A-21 American National Standard Slotted 100° Flat Countersunk Head Machine Screws 742
A-22 American National Standard Slotted Truss Head Machine Screws 743
A-23 American National Standard Plain and Slotted Hexagon Head Machine Screws 744
A-24 Slotted Round Head Machine Screws 745
A-25 American National Standard Square Head Setscrews 746
A-26 American National Standard Square Head Setscrews 747
A-27 American National Standard Slotted Headless Setscrews 748
A-28 Lengths for Threaded Fasteners 749
A-29 Lengths for Metric Threaded Fasteners 749
A-30 American National Standard Square and Hexagon Machine Screw Nuts 750
A-31 Standard Twist Drill Sizes (Inches) 751
A-32 Standard Twist Drill Sizes (Millimeters) 751

Index 753

CHAPTER 1

Getting Started



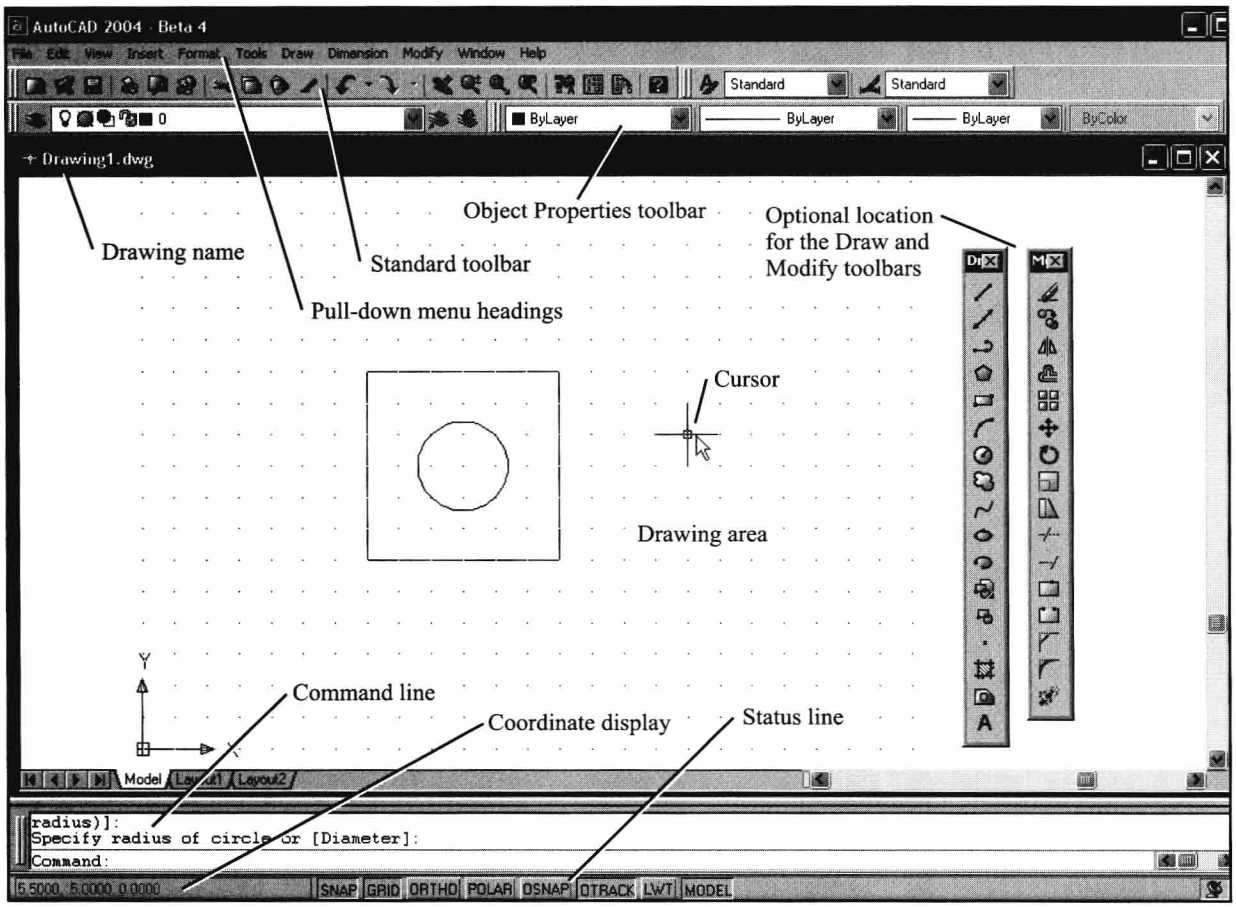


Figure 1-1

1-1 INTRODUCTION

This chapter explains the various aspects of the AutoCAD 2004 for Windows drawing screen and shows how they can be manipulated. Figure 1-1 shows a typical initial AutoCAD Windows screen. Your screen may look slightly different because of your selected screen resolution values.

The top line displays the Windows pull-down menus for exiting a program and changing a program. It is assumed that the reader is familiar with basic Windows operations.

The second line is the Standard toolbar and contains a group of the most commonly used commands.

The third line contains some command icons and an area that shows the current, or docked, object properties that are active.

The line just above the drawing portion of the screen displays the name of the current drawing. Since no drawing has been named, the line reads "Drawing1.dwg" Once a drawing name has been defined, it will appear at the top of the screen.

The bottom left corner of the screen shows the coordinate display position of the horizontal, vertical crosshairs in terms of an X,Y coordinate value, whose origin is the lower left corner of the drawing screen.

The commands listed on the bottom line (status line) are displayed in light gray when they are off, and in black when they are on.

The horizontal and vertical scroll bars can be used to move the drawing screen up, down, right, or left; they function as they do with other Windows applications.

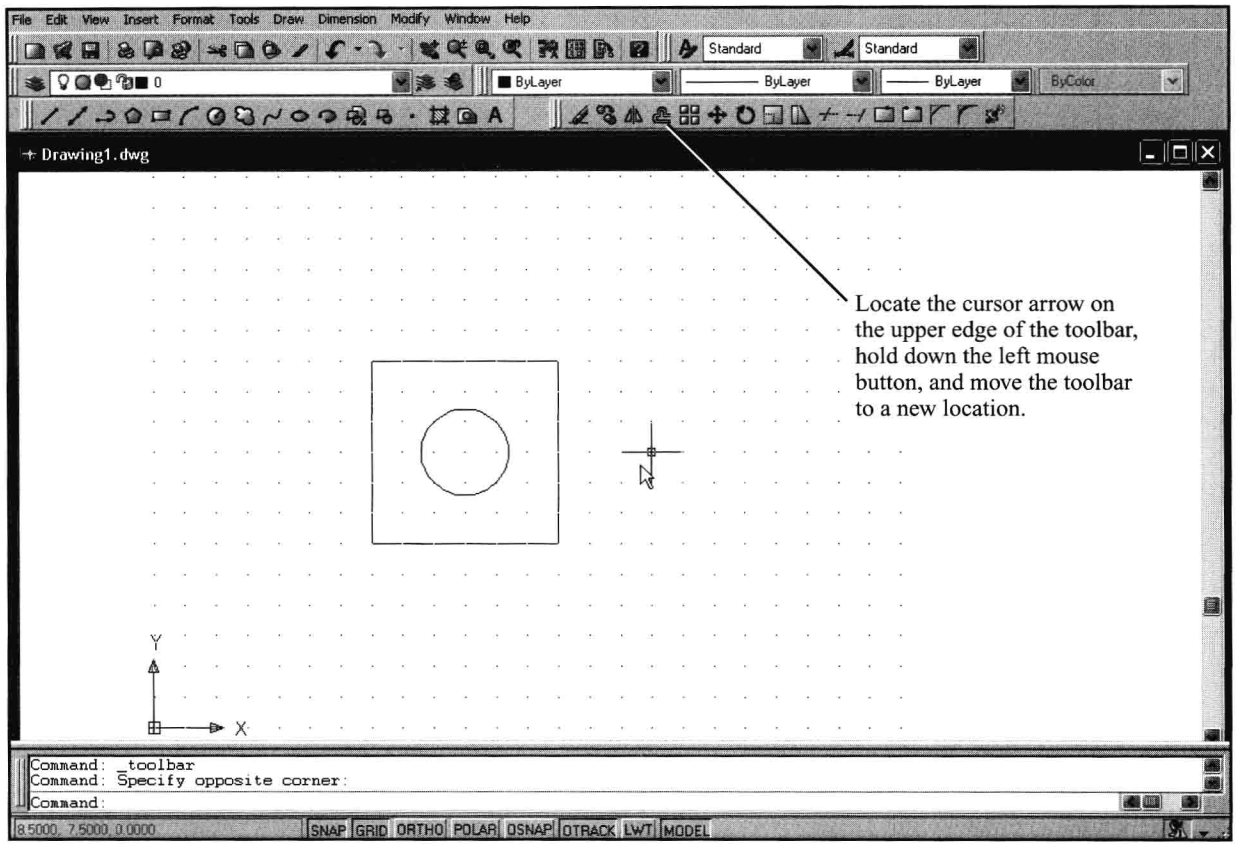


Figure 1-2

The large open area in the center of the screen is called the *drawing screen,* or *drawing editor.* The two rectangular boxes of command icons located along the left edge of the drawing screen are the Draw and Modify toolbars. They can be moved around the screen as shown in Figure 1-2.

1-2 TOOLBARS

An AutoCAD toolbar contains a group of command icons located under a common heading. The initial AutoCAD as screen, shown in Figure 1-1, contains four toolbars: Standard, Object Properties, Draw, and Modify. There are 24 additional predefined toolbars, and you can create your own user-specific toolbars as needed.

To move a toolbar

See Figure 1-2

1. Locate the cursor arrow on the heading Modify.
2. Press and hold down the left mouse button.

A light gray broken-line box appears around the edge of the toolbar.

3. Still holding the left mouse button down, move the gray outline box to a new location on the screen.
4. Release the left button.

The toolbar will appear in the new location.

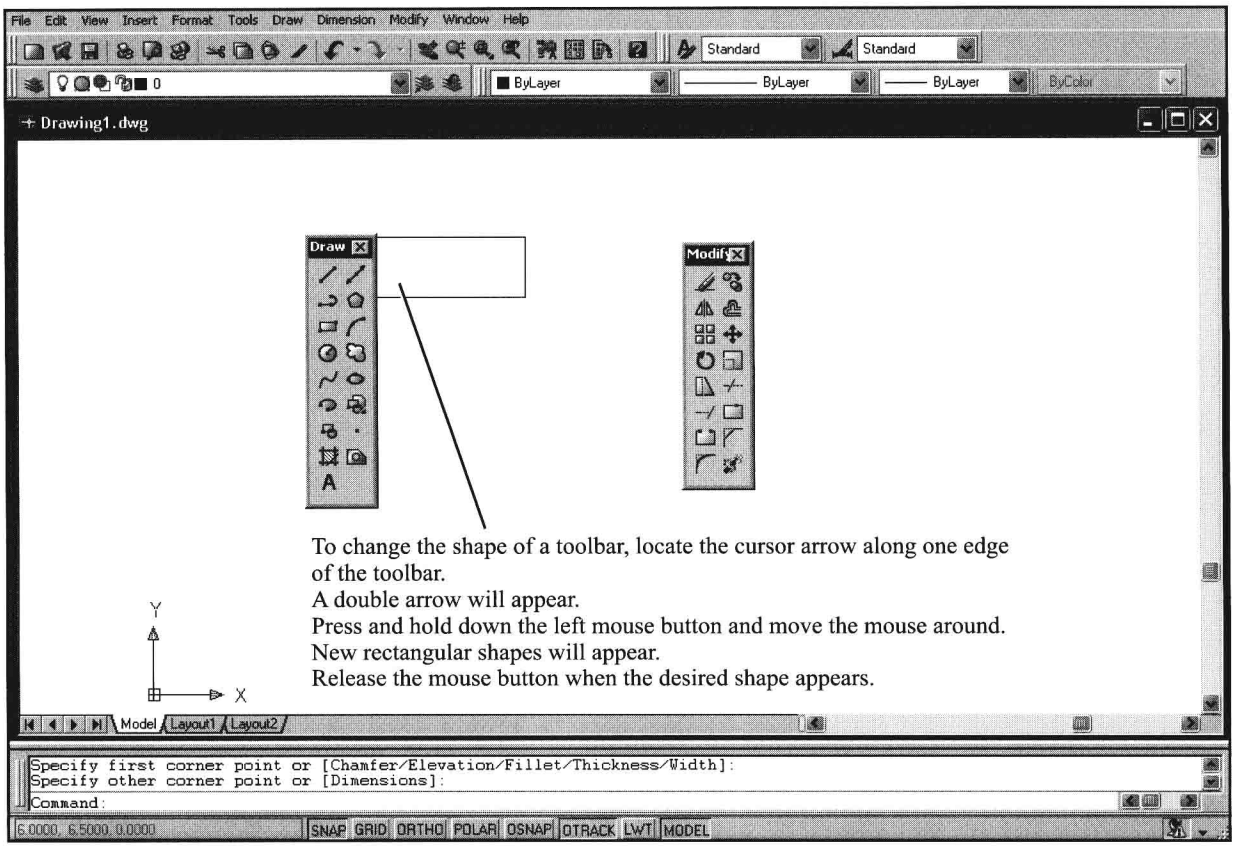


Figure 1-3

To change the shape of a toolbar

See Figure 1-3.

1. Locate the cursor arrow along the right edge of the Modify toolbox.

   A double arrow will appear.

2. Press and hold the left mouse button.

   A light gray broken-line box will appear around the outside of the toolbar.

3. Still holding the left mouse button down, move the mouse around and watch how the gray box changes shape.

4. When the gray toolbar shape is a long, vertical rectangle, release the left mouse button.

   A reshaped toolbar will appear.

To return the toolbar to its original location and shape

1. Locate the cursor arrow along the bottom or edge lines of the toolbar and return the toolbar to its original shape using the procedure outlined in Figure 1-3.
2. Move the reshaped toolbar to its original location along the left side of the drawing screen using the procedure outlined in Figure 1-2.

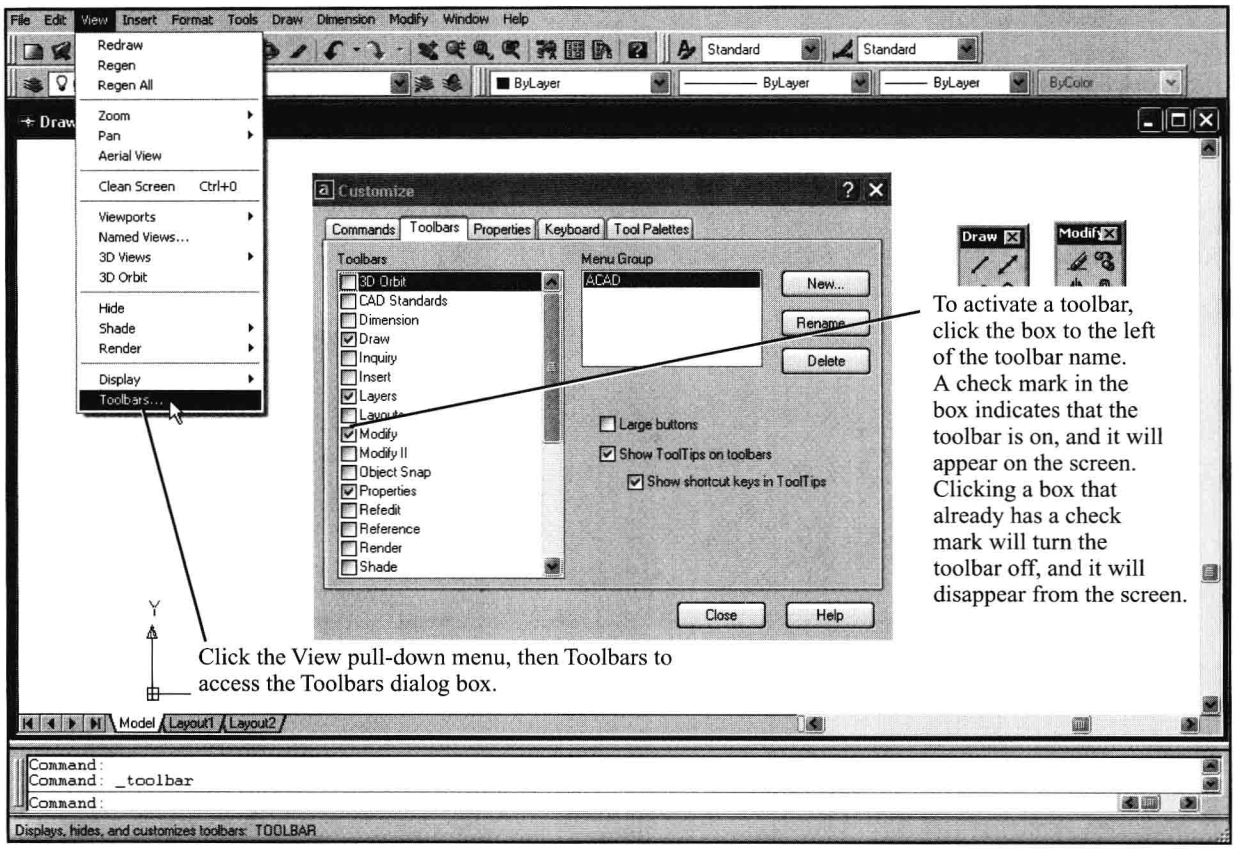


Figure 1-4

To add a new toolbar to the screen

See Figures 1-4 and 1-5.

1. Locate the cursor arrow on the View pull-down menu heading and press the left mouse button.
2. Select the item Toolbars (locate the cursor arrow on the word Toolbars and press the left mouse button).

The Toolbars dialog box will appear with a listing of all toolbars. See Figure 1-4.

3. Select Dimension.

The Dimension toolbar will appear. See Figure 1-5. Any toolbar can be moved or have its shape changed as described in Figures 1-2 and 1-3.

To remove a toolbar from the screen

1. Locate the cursor arrow on the check mark located in the upper right corner of the toolbar and press the left mouse button.

Figure 1-5 shows the Draw and Modify toolbars docked horizontally at the top of the drawing screen. The Dimension toolbar will initally appear within the drawing area of the screen, as will any other toolbar activated. Toolbars can then be moved to different locations as explained. If the toolbar is located close to either the top or sides of the drawing screen, it will blend into the area surrounding the drawing area and will no longer be within the drawing area.

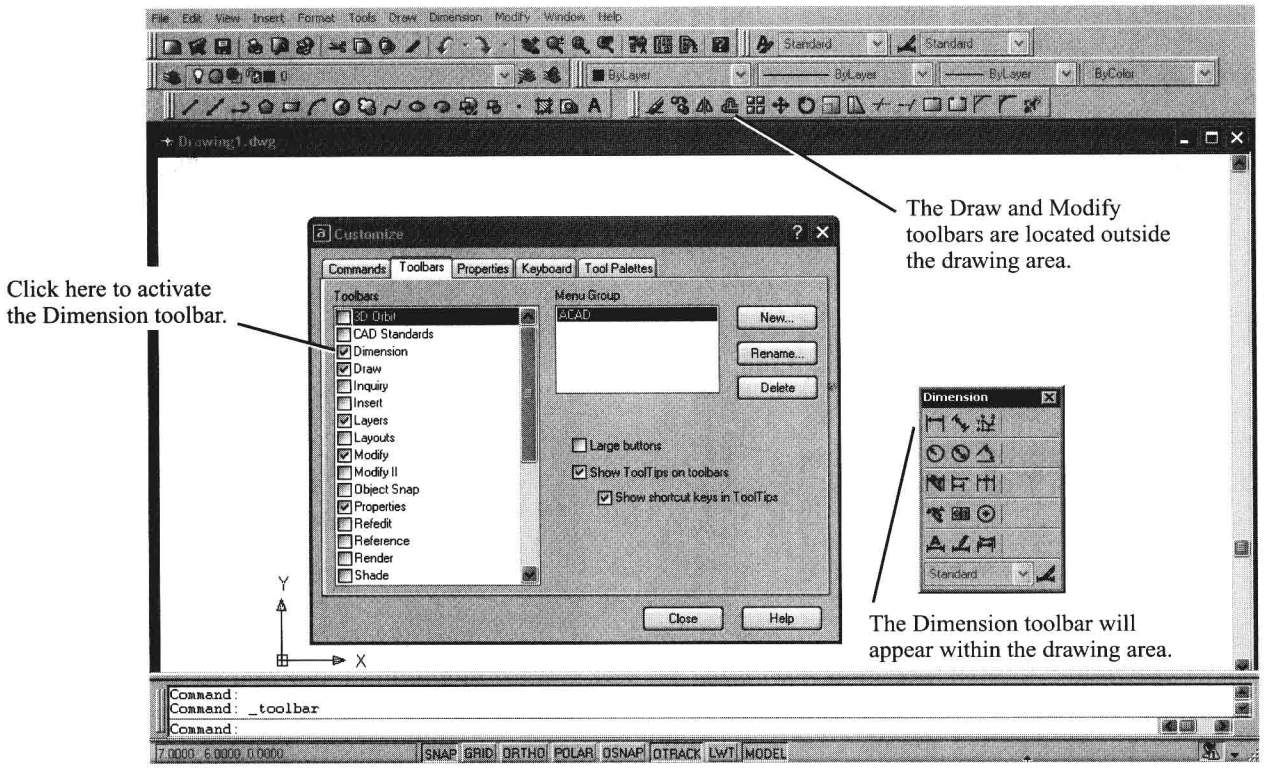


Figure 1-5

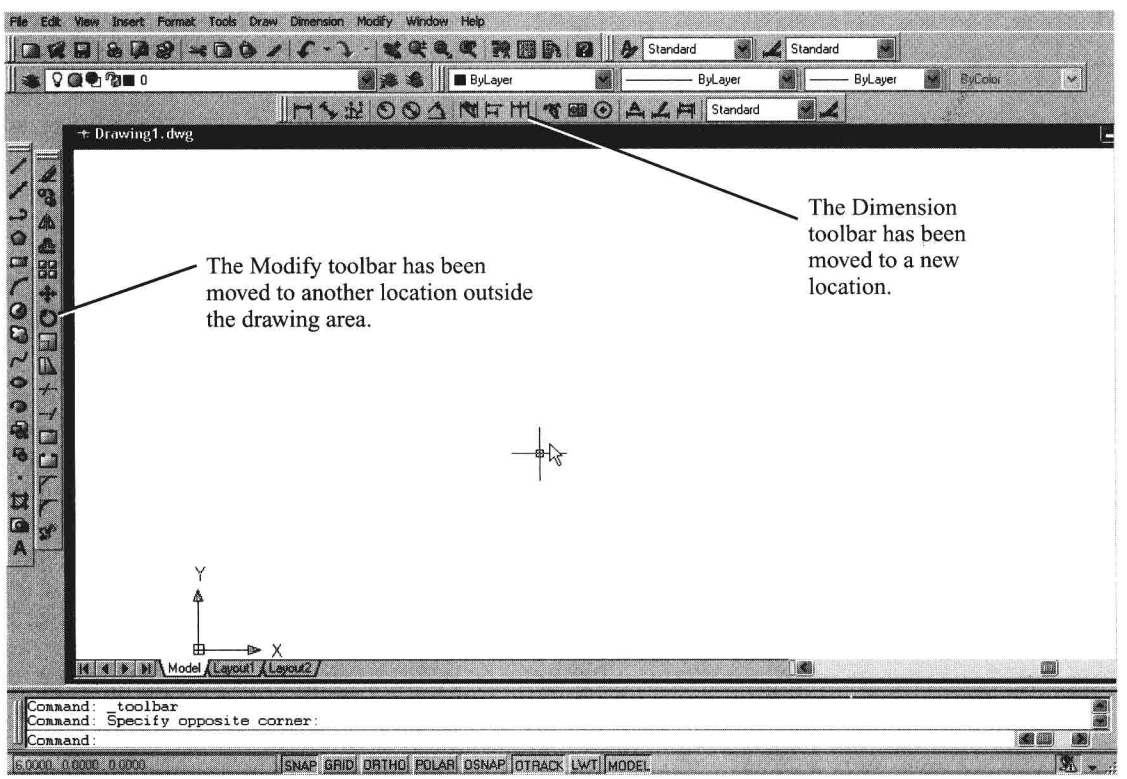


Figure 1-6