

Technical Drawing 101 with AutoCAD® 2023

A Multidisciplinary Guide to Drafting Theory and Practice
with Video Instruction



Douglas Smith
Antonio Ramirez
Ashleigh Congdon-Fuller

Visit the following websites to learn more about this book:



[amazon.com](https://www.amazon.com)

[Google books](https://books.google.com)

[BARNES & NOBLE](https://www.barnesandnoble.com)

TABLE OF CONTENTS

PREFACE	I
About This Book	i
The Curriculum	i
High School Stem and Tech Prep Programs	ii
Features New to the TWELFTH Edition	ii
Supplements and Online Resources for Instructors and Students	ii
A Final Word	iii
Acknowledgments	iv
 CHAPTER 1 - TECHNICAL DRAWING	 13
Chapter Objectives:	13
1.1 The Origins of Technical Drawing	15
1.2 The Role of Technical Drawing in the Design Process	15
1.3 Training for Careers in Technical Drawing	17
Career Paths in Technical Drawing	18
Qualities That Employers Look for in Drafters	22
Salary Information for Drafters, Architects, and Engineers	23
Job Prospects for Drafters	23
Chapter Review	24
Short Answer	24
Matching	24
Multiple Choice	25
Exercises	26
Locate Bachelor Degree Programs in Architecture or Engineering	26
Locate Associate Degree Programs in CAD	26
 CHAPTER 2 - MULTIVIEW DRAWING	 27
Chapter Objectives:	27
2.1 The Terminology of Multiview Drawing	29
2.2 Points, Planes, Coordinate Systems, Lines, and Angles	29
Points	29
Locating Points in Two Dimensional (2D) Coordinate Systems	29
Three Dimensional (3D) Coordinate Systems	31
Lines	31
Angles	31
Vertex	32
Adjacent Angles	33
2.3 Terminology of Geometric Shapes	33
Circles	33
Tangency	34
Concentricity and Eccentricity of Circles	34
Polygons	34
Cylinders	35
2.4 Multiview Drawings	36
2.5 View Selection and Alignment of Multiview Drawings	37
2.6 Using Projection Planes to Visualize Multiviews	37
2.7 Projection Planes	39
Visualizing the Front View	39
Visualizing the Top View	40
Visualizing the Side View	41
2.8 Normal, Inclined, and Oblique Surfaces	41

TABLE OF CONTENTS

Normal Surfaces	41
Projecting Normal Surfaces to the Projection Plane	42
Inclined Surfaces	43
Projecting Inclined Surfaces to the Projection Plane	43
Oblique Surfaces	44
Projecting Oblique Surfaces to Projection Planes	45
Visualizing the True Size and Shape of an Oblique Surface	47
Labeling Points and Vertices of Features to Aid in Visualizing the Multiviews of Objects	48
2.9 Linetypes and Lineweights in Multiview Drawings	51
2.10 Hidden Features and Centerlines in Multiview Drawings	52
2.11 Use Your Imagination!	52
2.12 Visualizing the Multiviews of Basic Geometric Shapes	57
2.13 Orthographic Projection	60
2.14 Drawing Objects to Scale	63
2.15 Drawing Architectural Plans to Scale	64
2.16 Drawing Sheet Sizes	64
2.17 Third-Angle Projection Versus First-Angle Projection	66
Chapter Review	68
Short Answer	68
Matching	68
Multiple Choice	69
Exercises	70
Directions	70
Exercise 2.1	70
Exercise 2.2	72
Exercise 2.3	74
Exercise 2.4	76
Exercise 2.5	78
Exercise 2.6	80
CHAPTER 3 - TRADITIONAL DRAFTING TOOLS AND TECHNIQUES	83
Chapter Objectives:	83
3.1 Traditional Drafting Tools and Techniques	85
3.2 Technical Pencils and Pens	85
3.3 Beginning a Traditional Drafting Project	86
3.4 Drafting Triangles	86
3.5 Drawing Lines with Triangles and Parallel Straightedges	87
3.6 Making Measurements with the Engineer's, Architect's, and Metric Scales	89
Reading the Engineer's Scale	90
Reading the Metric Scale	90
Reading the Architect's Scale	91
3.7 Converting Units of Measurement	92
3.8 Reading the Protractor	92
3.9 Circle Template	94
3.10 Isometric Ellipse Template	94
3.11 Spacing Views Equally on a Sheet	99
3.12 Adding Text to Drawings and Sketches	102
Developing a Technical Lettering Style	103
Chapter Review	104
Short Answer	104
Exercises	105
Technical Lettering Practice	105

Exercise 3.1 Architectural Lettering	105
Exercise 3.2 Mechanical Lettering	105
Projects	106
Directions for Optional Projects	110
CHAPTER 4 - COMPUTER-AIDED DESIGN BASICS	113
Chapter Objectives:	113
4.1 Beginning an AutoCAD Drawing	115
4.2 Adding Toolbars to the Ribbon Interface	117
4.3 Creating, Opening, and Saving AutoCAD Drawing Files	119
Beginning a New Drawing from the Application Menu	120
Opening an Existing Drawing	120
Saving a Drawing	120
Performing a Save As	120
4.4 Locating Points on the Cartesian Coordinate System	123
The User Coordinate System (UCS) Icon	124
Absolute Coordinates	124
4.5 Drawing Lines Using Absolute Coordinates	124
4.6 Drawing Horizontal and Vertical Lines	126
4.7 Drawing Lines With Relative Coordinates	127
4.8 Drawing Lines With Polar Coordinates	128
Exercise 4.1	131
4.9 Setting the Environment for AutoCAD Drawings	132
Setting Angle Type	135
Setting the Direction of Angle Measurement	135
Drawing Limits	136
Setting the Current Layer	143
Controlling Layer Visibility	143
Turning Layers Off	143
Freezing Layers	143
4.10 Zoom and Pan Commands	144
4.11 AutoCAD Commands	145
Essential Draw Commands	146
Essential Modify Commands	163
Placing and Editing Text	185
Controlling Text Style	188
4.12 Drafting Settings Dialog Box	190
Snap and Grid Tab	191
Polar Tracking Tab	193
Dynamic Input Tab	194
The Dimension Input Pane	194
The Dynamic Prompts Pane	196
Object Snap Tab	196
4.13 Object Snap Tools	197
Directions	203
4.14 Properties Command	204
4.15 Inquiry Toolbar	206
4.16 Preparing to Plot	207
Toggling Between Paper Space and Model Space	208
4.17 Plotting With AutoCAD	210
4.18 Creating a Page Setup for Plotting	212
Chapter Review	214
Short Answer	215
Matching	215

TABLE OF CONTENTS

Projects	216
CHAPTER 5 - DIMENSIONING MECHANICAL DRAWINGS	245
Chapter Objectives:	245
5.1 Dimensioning Fundamentals	247
Dimensioning Terminology	248
Guidelines for Dimension Placement	249
5.2 Dimension Standards for Mechanical Drawings	249
Recommended Size and Spacing of Dimension Features	250
Text Height and Style	251
Alignment of Dimension Text	252
Notating Holes and Arcs	252
Dimensioning Cylindrical Shapes	253
Dimensioning Angles	253
Ordinate Dimensioning	253
Notes for Drilling and Machining Operations	254
5.3 Do's and Don'ts of Mechanical Dimensioning (ASME Y14.5)	256
5.4 Role of Drafters in the Preparation of Dimensioned Mechanical Drawings	257
5.5 Checking Dimensions on the Finished Drawing	257
5.6 Design Basics: How Designers Calculate Dimensions	258
5.7 Tolerances	259
Displaying Tolerances on Mechanical Drawings	259
Interpreting Tolerances on Technical Drawings	260
Comparison of Continuous Dimensioning and Baseline Dimensioning	262
Tolerancing Terminology	263
Interpreting Design Sketch 1	264
Analyzing Design Sketch 1	264
Calculating Maximum Material Condition (MMC) for Design Sketch 1	264
Calculating Least Material Condition (LMC) for Design Sketch 1	264
Interpreting Design Sketch 2	264
Analyzing Design Sketch 2	265
Calculating Maximum Material Condition (MMC) for the Hole in Design Sketch 2	265
Calculating Least Material Condition (LMC) for the Hole in Design Sketch 2	265
Calculating the Fit between the Parts in Design Sketches 1 and 2	266
Best-Case Scenario for Assembly	266
Worst-Case Scenario for Assembly	266
Reference Dimensions	266
Confirming the Tolerances of Manufactured Parts	267
Tolerance Costs	268
5.8 Dimensioning With AutoCAD	268
5.9 Defining Dimension Settings With the Dimension Style Manager	281
Tabs of the New Dimension Style Dialog Box	284
Lines Tab	284
Symbols and Arrows Tab	285
Text Tab	286
Fit Tab	287
Primary Units Tab	288
Alternate Units Tab	288
Tolerances Tab	288
5.10 Overriding A Dimension Setting	290
Updating a Dimension	291
5.11 Adding a Leader to a Drawing	291
Chapter Review	294

Projects	296
CHAPTER 6 - DIMENSIONING ARCHITECTURAL DRAWINGS	305
Chapter Objectives:	305
6.1 Dimensioning Architectural Drawings	307
6.2 Determining Dimensions on Architectural Drawings	307
6.3 Architectural Drafting Conventions	308
6.4 Alignment of Dimension Text	309
6.5 Architectural Dimensioning Guidelines	309
6.6 Architectural Dimension Spacing	310
6.7 Adding a Leader to a Drawing	310
Chapter Review	312
Projects	313
CHAPTER 7 - ISOMETRIC DRAWINGS	317
Chapter Objectives:	317
7.1 Orientation of Lines in Isometric Drawings	319
7.2 Orientation of Ellipses in Isometric Drawings	319
7.3 Creating Isometric Drawings With AutoCAD	322
Chapter Review	328
Projects	330
CHAPTER 8 - SECTIONS	339
Chapter Objectives:	339
8.1 Sections in Mechanical Drawings	341
8.2 Sections in Architectural Drawings	342
8.3 Sections in Civil Drawings	342
8.4 Types of Sections	343
Half Sections	344
Broken-Out Sections	346
Revolved Sections	347
Removed Sections	347
Offset Sections	348
The Boundaries Panel	350
The Pattern Panel	351
The Properties Panel	351
Chapter Review	353
Projects	355
Interpreting the Counterbored Hole Note	358
Interpreting a Countersunk Hole Note	361
Steps in Constructing a Countersunk Hole	361
CHAPTER 9 - BLOCKS	365
Chapter Objectives:	365
9.1 Considerations for Creating Blocks	367
Chapter Review	372
Projects	374
CHAPTER 10 - 3D MODELING BASICS	385
Chapter Objectives:	385

TABLE OF CONTENTS

10.1 2D Versus 3D	387
10.2 Changing the Point of View of an AutoCAD Drawing	388
10.3 AutoCAD's 3D Modeling Environment	389
10.4 3D Modeling Tools	391
Extruding 2D Entities to Create 3D Objects	391
Using the EXTRUDE Command	392
Using the REGION Command	392
Using the PRESSPULL Command	392
Unioning 3D Objects	393
Using the UNION Command	393
Subtracting 3D Objects	393
Using the SUBTRACT Command	393
10.5 Rotating 3D Objects	394
10.6 Viewing 3D Objects	394
Using the Free Orbit Tool	394
10.7 Representing 3D Objects as Shaded or Wireframe Models	395
Chapter Review	396
Projects	397
CAPSTONE PROJECT - MECHANICAL WORKING DRAWINGS	415
Project Objectives:	415
CP1.1 Preparing Mechanical Working Drawings	417
Assembly Drawings	417
Detail Drawings	421
Project Review	423
Threads and Fasteners in Mechanical Working Drawings	424
Representing External Screw Threads on Mechanical Drawings	425
Representing Internal Screw Threads on Mechanical Drawings	425
Projects	426
CAPSTONE PROJECT - ARCHITECTURAL WORKING DRAWINGS	445
Project Objectives:	445
CP2.1 Floor Plans	447
CP2.2 Electrical Plans	448
CP2.3 Elevations	449
Creating Elevations Using Multiview Drawing Techniques	449
Architectural Wall Sections	450
Roof Profiles on Architectural Elevations	450
Using the Floor Plan to Locate Features on Elevations	451
Project Review	452
Projects	453
Relating the Features on the Floor Plan to the Cabin's Elevation Views	475
Wall Framing 101	476
Constructing the Right-Side Elevation	478
Constructing the Front Elevation	482
APPENDIX A	487
ANSI/ASME Standards	487
Notes:	488
APPENDIX B	489

ISO Standards	489
Notes:	490
APPENDIX C	491
The United States National CAD Standard	491
Benefits to Clients and Owners	491
Benefits to Design Professionals	491
Benefits to Contractors and Subcontractors	491
Industry-Wide Benefits for NCS Adoption	492
Notes:	493
APPENDIX D	494
Geometric Dimensioning and Tolerancing Basics	494
Interpreting the Feature Control Frame	494
Geometric Characteristic Symbols	495
Interpreting GDT on a Drawing	495
Interpreting Parallelism	495
Adding GDT to an AutoCAD Drawing	496
Adding a Datum Feature Symbol	497
Learning to Apply GDT to Drawings	497
Notes:	498
APPENDIX E	499
E.1 Visualizing an Auxiliary View	500
E.2 Constructing an Auxiliary View with the Offset Command	509
Appendix Review	514
Projects	516
GLOSSARY	517