

AutoCAD 2024

Scaling & Units

Complete Reference Manual

Beginner to Advanced

Imperial | Metric | Architectural

Engineering | Civil | Survey

Complete Math & Conversion Tables

BEGINNER

INTERMEDIATE

ADVANCED

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Introduction to AutoCAD Units

Before you draw the first line, AutoCAD needs to know what one unit means in the real world. That decision drives everything — text height, dimension appearance, plot scale, block insertion, and file exchange with other disciplines. Getting it right at the start saves hours of rescaling later.

What Are Drawing Units?

In AutoCAD, all geometry is stored as pure numbers. When you draw a line that is 12 units long, AutoCAD does not inherently know whether those 12 units represent 12 inches, 12 millimeters, or 12 feet. Drawing units are your agreement with AutoCAD about what those numbers mean.

Think of it like a spreadsheet: the cell holds the number 100. Whether that number represents dollars, kilograms, or miles per hour depends entirely on what you and the spreadsheet agree it means. AutoCAD's UNITS setting is that agreement.

WARNING

GOLDEN RULE: Decide your unit system before drawing anything. Changing units mid-project does NOT rescale existing geometry — it only changes how new input is interpreted.

The UNITS Command

Type UNITS (or UN) at the command line to open the Drawing Units dialog. This is the primary control panel for your unit system.

Length Type

Controls the format AutoCAD uses to display and accept linear measurements:

Type	Display Format	Typical Use
Architectural	Feet and fractional inches — e.g., 1'-6 3/4"	Buildings, residential, structural
Engineering	Feet and decimal inches — e.g., 1.5625'	Civil site plans, roads, survey
Fractional	Fractional units, no feet — e.g., 18 3/4	Woodworking, fractional mechanical
Decimal	Decimal units — e.g., 18.75	Metric, mechanical, general
Scientific	Scientific notation — e.g., 1.875E+01	Astronomy, nano-scale, scientific

Precision

Precision controls how many decimal places (or what fractional denominator) AutoCAD displays. It does NOT affect stored precision — AutoCAD always stores full floating-point numbers internally. Precision only affects what you see on screen and on dimensions.

Angle Settings

Angle Type	Format	Use
Decimal Degrees	45.0000	Most common — mechanical, architectural
Degrees/Min/Sec	45d0'0"	Survey and civil work
Grads	50g	European civil / road design
Radians	0.7854r	Mathematical / programming
Surveyor Units	N 45d0'0" E	Land survey bearings

INSUNITS System Variable

INSUNITS is the most important variable for file exchange. It tells AutoCAD what unit system the current drawing uses, so that when you INSERT a block or XREF another drawing, AutoCAD can automatically scale it to match.

Type INSUNITS at the command line and enter the appropriate code:

Code	Unit	Code	Unit
0	Unspecified (no auto-scale)	5	Centimeters
1	Inches	6	Meters
2	Feet	7	Kilometers
3	Miles	8	Microinches
4	Millimeters	13	Yards

TIP

Imperial drawings: Set INSUNITS = 1 (inches) for architectural work or INSUNITS = 2 (feet) for civil. Metric drawings: Set INSUNITS = 4 (millimeters) for mechanical/structural or INSUNITS = 6 (meters) for civil.

Unit Precision Settings

Precision is set separately for display and for dimensions. The UNITS command sets the display precision. Dimension precision is set independently in each dimension style (DIMSTYLE command). These two can — and often should — differ.

Example: An architectural drawing might display coordinates to the nearest 1/8 inch on screen, but dimension text might show 1/16 inch for detailed joinery dimensions.

Imperial Unit Systems

The United States uses three distinct imperial unit formats in professional drafting. Choosing the wrong one for your discipline creates confusion, mismatched dimensions, and errors when files are exchanged between offices. Here is exactly how each system works.

Architectural Units

Architectural units express length in feet and fractional inches. This is the standard for all building design — residential, commercial, and structural. The key characteristic is the fractional inch denominator, which matches how the construction industry communicates.

Format and Display

Architectural dimensions display in the form: **feet ' – inches – fraction"**

Decimal Value	Architectural Display	What It Means
18.0 units	1'-6"	1 foot, 6 inches
18.75 units	1'-6 3/4"	1 foot, 6 and 3/4 inches
0.5 units	1/2"	Half an inch (less than one foot)
36.0 units	3'-0"	3 feet exactly
100.0 units	8'-4"	8 feet, 4 inches
0.0625 units	1/16"	One-sixteenth of an inch

Input Rules

When typing architectural distances:

- Use an apostrophe ' for feet and a quote " for inches
- AutoCAD assumes inches if no foot mark — 6 = 6 inches, 6' = 6 feet
- Fractions use a hyphen: type 1'6-3/4 for 1 foot 6 and 3/4 inches
- No spaces between feet, inches, and fractions in command input

Command-line input examples:

6'-8" → Six feet, eight inches

6'8" → Same result (quote optional if using feet)

6'8-1/2 → Six feet, eight and one-half inches

80 → 80 inches (6'-8") – AutoCAD assumes inches

Fraction Precision Options

Denominator	Smallest Increment	Typical Use
1/2	0.5"	Rough layouts, site plans
1/4	0.25"	General architectural
1/8	0.125"	Standard construction drawings
1/16	0.0625"	Finish carpentry, millwork
1/32	0.03125"	Detailed joinery, cabinetry
1/64	0.015625"	Precision machining in architectural context

Engineering Units

Engineering units use feet and decimal inches — NOT fractional inches. The foot is the primary unit but distances less than one foot are expressed as a decimal fraction of a foot, not as inches. This aligns with how civil engineers, surveyors, and road designers work.

Format and Display

Decimal Value	Engineering Display	What It Means
18.0 units	1.5000'	1.5 feet = 1 foot 6 inches
18.75 units	1.5625'	1.5625 feet = 1'-6 3/4"
100.0 units	8.3333'	8.333 feet = 8'-4"
1.0 unit	0.0833'	0.0833 feet = 1 inch
12.0 units	1.0000'	Exactly 1 foot

WARNING

KEY DIFFERENCE: In Engineering units, 1.5' means 1 foot 6 inches ($1.5 \times 12 = 18$ inches). In Architectural units, 1.5 units means 1.5 inches — completely different! Always confirm which system a received file uses before taking measurements.

Fractional Units

Fractional units display as pure fractions with no feet — just a number and a fraction. This format is used in woodworking, some mechanical drafting, and anywhere the foot convention is not needed. One unit equals one inch in most workflows.

Display example: 18 3/4 (meaning 18.75 inches)

Decimal Units

Decimal units are the most flexible and are the default for metric work and general mechanical design. One unit can equal anything — an inch, a millimeter, a foot, or a meter — which is why INSUNITS is so critical when using decimal units.

When to Use Which System

Discipline	Recommended Units	INSUNITS
Residential Architecture	Architectural	1 (Inches)
Commercial Architecture	Architectural	1 (Inches)
Structural Engineering	Architectural	1 (Inches)
Civil / Site / Roads	Engineering (Decimal Feet)	2 (Feet)
Land Survey	Engineering (Decimal Feet)	2 (Feet)
Mechanical (Imperial)	Decimal (inches)	1 (Inches)
Mechanical (Metric)	Decimal (mm)	4 (Millimeters)
Electrical Utility (US)	Architectural or Engineering	1 or 2
MEP (Mech/Elec/Plumb)	Architectural	1 (Inches)

Metric Unit Systems

The metric system is the global standard outside the United States, and even within US firms that work on international projects. AutoCAD handles metric natively — the key is setting INSUNITS correctly and understanding which metric unit fits your scale of work.

Millimeters — The Default Metric Unit

Millimeters (mm) are the standard metric unit for architectural and structural drawings outside the US. A typical door is 2100mm tall, a structural beam might be 300mm deep. Drawing in millimeters at 1:1 scale means your model accurately represents real-world dimensions in millimeters.

Set INSUNITS = 4 for millimeter drawings.

Real Object	Dimension in mm	Notes
Standard door height	2100 mm	7 feet = 2133 mm rounded
A4 sheet width	210 mm	ISO paper standard
Brick (modular)	230 x 110 x 76 mm	Standard metric brick
Structural beam depth	200–600 mm	Common range
Reinforcing bar dia.	10–32 mm	N10 to N32 in metric
Concrete slab thickness	100–250 mm	Common residential-commercial

Meters — Civil and Site Work

Meters are used for large-scale site plans, land surveys, infrastructure, and GIS work. A site boundary might be 450.25 meters wide. Drawing in meters allows you to work comfortably with large distances without dealing with very large millimeter values.

Set INSUNITS = 6 for meter drawings.

Centimeters

Centimeters are rarely used in professional drafting — they fall awkwardly between mm and m. Some European architectural offices use cm, but mm is far more common. If you receive a drawing in cm, you will need to scale it by 10 to convert to mm or by 0.01 to convert to m.

Set INSUNITS = 5 for centimeter drawings.

Metric Standards in AutoCAD

AutoCAD ships with metric template files (acadiso.dwt, acadiso3D.dwt). These templates set the unit system, limits, text styles, and dimension styles for metric work. Always start a metric project from an ISO template rather than modifying an imperial one.

Template File	Units	Limits	Best For
acad.dwt	Inches (Imperial)	12" x 9"	US Imperial work
acadiso.dwt	Millimeters	420 x 297 mm (A3)	International metric
acad3D.dwt	Inches (Imperial)	Model space 3D	US 3D mechanical
acadiso3D.dwt	Millimeters	Model space 3D	International 3D

TIP

METRIC SETUP CHECKLIST: (1) Start from acadiso.dwt, (2) Set INSUNITS=4, (3) Set DIMSCALE to match your plot scale, (4) Use ISO-standard text heights (2.5mm, 3.5mm, 5mm), (5) Set LTSCALE appropriately for mm drawing.

CHAPTER 4

INTERMEDIATE

The Math Behind Units

Understanding the math is what separates a drafter who struggles with unit conversions from one who can confidently switch between systems on any project. These are the numbers you need to have committed to memory.

Core Conversion Factors

The single most important conversion in imperial-metric work:

$$1 \text{ inch} = 25.4 \text{ mm (exact, by international definition)}$$

All other conversions derive from this:

Conversion	Factor	Inverse	Example
Inches → Millimeters	× 25.4	÷ 25.4	6" = 152.4 mm
Millimeters → Inches	÷ 25.4	× 25.4	300 mm = 11.811"
Feet → Millimeters	× 304.8	÷ 304.8	8' = 2438.4 mm
Millimeters → Feet	÷ 304.8	× 304.8	2400 mm = 7.874'
Feet → Meters	÷ 3.2808	× 3.2808	10' = 3.048 m
Meters → Feet	× 3.2808	÷ 3.2808	3 m = 9.843'
Inches → Centimeters	× 2.54	÷ 2.54	12" = 30.48 cm
Yards → Meters	× 0.9144	÷ 0.9144	10 yd = 9.144 m

Inch-to-Millimeter Math in Detail

Breaking down common architectural dimensions:

Converting feet and inches to millimeters — two-step process:

Step 1: Convert everything to decimal inches

Step 2: Multiply by 25.4

Imperial	Step 1: Decimal Inches	Step 2: × 25.4 = mm
8' - 0"	8 × 12 = 96 inches	96 × 25.4 = 2438.4 mm
6' - 8"	6 × 12 + 8 = 80 inches	80 × 25.4 = 2032.0 mm

3' - 6 1/2"	$3 \times 12 + 6.5 = 42.5$ inches	$42.5 \times 25.4 = 1079.5$ mm
1' - 0 3/4"	$12 + 0.75 = 12.75$ inches	$12.75 \times 25.4 = 323.85$ mm
10' - 4 3/8"	$10 \times 12 + 4.375 = 124.375$ inches	$124.375 \times 25.4 = 3159.125$ mm

Fractional Inch Decimal Equivalents

Reference table — fractions in sixteenths and thirty-seconds:

Fraction	Decimal"	mm	Fraction	Decimal"	mm
1/32	0.03125	0.7937	1/16	0.06250	1.5875
3/32	0.09375	2.3812	1/8	0.12500	3.1750
5/32	0.15625	3.9688	3/16	0.18750	4.7625
7/32	0.21875	5.5562	1/4	0.25000	6.3500
9/32	0.28125	7.1437	5/16	0.31250	7.9375
11/32	0.34375	8.7312	3/8	0.37500	9.5250
13/32	0.40625	10.3187	7/16	0.43750	11.1125
15/32	0.46875	11.9062	1/2	0.50000	12.7000
17/32	0.53125	13.4937	9/16	0.56250	14.2875
19/32	0.59375	15.0812	5/8	0.62500	15.8750
21/32	0.65625	16.6687	11/16	0.68750	17.4625
23/32	0.71875	18.2562	3/4	0.75000	19.0500
25/32	0.78125	19.8438	13/16	0.81250	20.6375
27/32	0.84375	21.4312	7/8	0.87500	22.2250
29/32	0.90625	23.0187	15/16	0.93750	23.8125
31/32	0.96875	24.6062	1	1.00000	25.4000

Engineering Unit Math

Engineering units express everything in decimal feet. To convert from feet-and-inches to decimal feet, divide the inch portion by 12:

$$\text{Decimal feet} = \text{Whole feet} + (\text{Inches} \div 12) + (\text{Fraction} \div 12)$$

Imperial	Calculation	Decimal Feet
5'-6"	$5 + (6 \div 12)$	5.5000'

8'-4"	$8 + (4 \div 12)$	8.3333'
10'-9 1/2"	$10 + (9.5 \div 12)$	10.7917'
3'-0 3/4"	$3 + (0.75 \div 12)$	3.0625'
100'-0"	$100 + (0 \div 12)$	100.0000'

Scale Factors and Drawing Scales

Scale factor is the number you multiply by to convert between model space dimensions and paper space dimensions. Master this and plotting becomes mechanical rather than guesswork.

What Is a Scale Factor?

Scale factor answers this question: if I draw an object at real-world size in model space, by what number do I multiply everything to make it fit on paper at the desired scale?

For a drawing plotted at 1/4" = 1'-0" (quarter-inch scale):

$$\text{Scale Factor} = 12 \div (\text{numerator/denominator}) = 12 \div (1/4) = 12 \times 4 = 48$$

This means text that should appear 1/8" tall on paper must be drawn 6" tall in model space (1/8" × 48 = 6"). Dimensions and linetypes scale by the same factor.

Architectural Scale Factors

Drawing Scale	Ratio	Scale Factor	Text Height for 1/8" paper text	Dimension Scale (DIMSCALE)
3" = 1'-0"	1:4	4	0.5"	4
1-1/2" = 1'-0"	1:8	8	1"	8
1" = 1'-0"	1:12	12	1-1/2"	12
3/4" = 1'-0"	1:16	16	2"	16
1/2" = 1'-0"	1:24	24	3"	24
3/8" = 1'-0"	1:32	32	4"	32
1/4" = 1'-0"	1:48	48	6"	48
3/16" = 1'-0"	1:64	64	8"	64
1/8" = 1'-0"	1:96	96	1'-0"	96
3/32" = 1'-0"	1:128	128	1'-4"	128
1/16" = 1'-0"	1:192	192	2'-0"	192

Engineering Scale Factors

Engineering scales use a ratio format: 1"=X'. The scale factor is 12 × X (because there are 12 inches per foot).

$$\text{Scale Factor} = 12 \times (\text{Feet per inch on drawing})$$

Drawing Scale	Scale Factor	Viewport XP	Text Ht (1/8" paper)
1" = 1'	12	1/12xp	1.5"
1" = 2'	24	1/24xp	3"
1" = 5'	60	1/60xp	7.5"
1" = 10'	120	1/120xp	1'-3"
1" = 20'	240	1/240xp	2'-6"
1" = 30'	360	1/360xp	3'-9"
1" = 40'	480	1/480xp	5'-0"
1" = 50'	600	1/600xp	6'-3"
1" = 60'	720	1/720xp	7'-6"
1" = 100'	1200	1/1200xp	12'-6"
1" = 200'	2400	1/2400xp	25'-0"

Viewport Scale Math

In paper space, you control viewport zoom using the XP suffix (times paper). The formula is $1 \div \text{scale_factor}$. AutoCAD then locks the viewport to that exact ratio.

Viewport zoom for 1/4" = 1'-0" : zoom 1/48xp

Viewport zoom for 1" = 20' : zoom 1/240xp

TIP

ALWAYS use viewport scale locking after setting your zoom with XP. Right-click the viewport border → Display Locked → Yes. This prevents accidental pan/zoom from corrupting your plot scale.

Importing Metric into Imperial Drawings

This is one of the most common pain points in mixed-discipline projects: you receive a metric DWG from a vendor or international office and need to use it in your inch-based drawing. Here is the complete workflow.

The 25.4 Factor — Core Conversion

When inserting a metric block (drawn in mm) into an imperial drawing (working in inches), AutoCAD needs to know that 25.4 millimeters equals 1 inch. If INSUNITS is set correctly in both files, this happens automatically. If not, you scale manually.

To scale metric geometry down to imperial inches:

$$\text{Scale factor} = 1 \div 25.4 = 0.039370$$

To scale imperial inch geometry up to metric mm:

$$\text{Scale factor} = 25.4$$

Method 1 — INSUNITS Auto-Scale (Recommended)

If both drawings have INSUNITS set correctly, AutoCAD handles the conversion automatically when you INSERT a block or attach an XREF.

- Open the source metric file. Type INSUNITS. Confirm it is set to 4 (Millimeters).
- Open your imperial target file. Type INSUNITS. Confirm it is set to 1 (Inches).
- INSERT the metric block into the imperial drawing.
- AutoCAD multiplies all geometry by 1/25.4 automatically — no manual scaling needed.
- Verify: a 1000mm object should appear as 39.37" in your imperial drawing.

WARNING

If INSUNITS=0 (unspecified) in either file, AutoCAD disables auto-scaling and inserts at 1:1. Always verify INSUNITS before exchanging files.

Method 2 — Manual SCALE Command

Use this when INSUNITS is not set or when you need to convert existing geometry that is already in the drawing at the wrong scale.

- Open the metric DWG. Note the INSUNITS value.
- Copy and paste the geometry into your imperial drawing (it arrives at 1:1).

- Type SCALE. Select all pasted geometry.
- Specify base point (typically origin 0,0 or a key corner).
- Enter scale factor: 0.03937 (to convert mm → inches).
- Verify: select a known dimension and confirm it reads correctly in inches.

Method 3 — XREF Scaling

When attaching a metric drawing as an XREF into an imperial host drawing, AutoCAD uses the INSUNITSDEFSOURCE and INSUNITSDEFTARGET variables if the INSUNITS settings are not embedded in the files.

Variable	Value	Meaning
INSUNITSDEFSOURCE	4	Treat incoming XREF as millimeters
INSUNITSDEFTARGET	1	Current drawing is in inches
XREFSCALE (result)	0.039370	Auto-applied scale on attach

Common Conversion Scale Factors

From	To	Scale Factor	Use in AutoCAD
Millimeters	Inches	0.039370	Scale metric block → imperial drawing
Inches	Millimeters	25.4	Scale imperial block → metric drawing
Meters	Inches	39.3701	Scale metric civil → imperial site plan
Inches	Meters	0.0254	Scale imperial → metric civil
Meters	Feet	3.28084	Scale metric site → engineering feet
Feet	Meters	0.3048	Scale engineering feet → metric
Millimeters	Feet	0.003281	Scale metric building → engineering drawing
Feet	Millimeters	304.8	Scale engineering → metric building

CHAPTER 7

INTERMEDIATE

Drawing Sizes and Best Unit Choices

The physical sheet size you plot on directly affects what scales are practical and therefore which unit system works best. Here are the standard sheet sizes and the unit/scale combinations that work in each.

ANSI Standard Drawing Sizes (Imperial)

ANSI sizes are the US standard used by most engineering and architectural firms. Dimensions are in inches. D and E sizes are the large-format sheets used for site plans, plot plans, and multi-story building plans.

Size	Dimensions	Typical Use	Best Units	Common Scales
A (Letter)	8.5" x 11"	Details, sketches, reports	Arch / Decimal	1"=1', 3"=1'
B (Ledger)	11" x 17"	Small plans, details	Arch / Eng	1/4"=1', 1"=10'
C	17" x 22"	Residential plans	Architectural	1/4"=1', 1/8"=1'
D	22" x 34"	Commercial, site plans	Arch / Engineering	1/8"=1', 1"=20'
E	34" x 44"	Large site/civil plans	Engineering	1"=20', 1"=40'
E1	30" x 42"	Structural, large arch	Architectural	1/8"=1', 3/32"=1'

Architectural Sheet Sizes

Arch sizes are slightly larger than ANSI and are preferred by US architecture firms. They provide more drawing area and align with standard detail ratios.

Size	Dimensions	Typical Use	Typical Scales
Arch A	9" x 12"	Details, sketches	3"=1', 1-1/2"=1'
Arch B	12" x 18"	Small floor plans	1/4"=1', 1/2"=1'
Arch C	18" x 24"	Residential plans	1/4"=1', 1/8"=1'
Arch D	24" x 36"	Commercial, multi-family	1/8"=1', 1/16"=1'
Arch E	36" x 48"	Large commercial, hospital	1/8"=1', 3/32"=1'
Arch E1	30" x 42"	Common large-format arch	1/8"=1', 3/32"=1'

ISO Metric Sheet Sizes

ISO 216 is the international paper standard. A0 is the largest; each subsequent size is half the area of the previous. Metric drawings typically use 1:X ratios.

Size	Dimensions (mm)	Dimensions (approx in)	Common Scales (metric)
A0	841 × 1189 mm	33.1" × 46.8"	1:50, 1:100, 1:200
A1	594 × 841 mm	23.4" × 33.1"	1:50, 1:100
A2	420 × 594 mm	16.5" × 23.4"	1:20, 1:50
A3	297 × 420 mm	11.7" × 16.5"	1:20, 1:50
A4	210 × 297 mm	8.3" × 11.7"	1:5, 1:10, 1:20

Units by Discipline — Comprehensive Table

Discipline	Unit System	INSUNITS	Typical Sheet	Working Scale
Residential Architecture	Architectural (in)	1	Arch D / E	1/4"=1'
Commercial Architecture	Architectural (in)	1	Arch D / E	1/8"=1'
High-Rise Architecture	Architectural (in)	1	Arch E	1/16"=1'
Structural Engineering	Architectural (in)	1	ANSI D / E	1/4"=1' or 1/8"
Civil / Roads	Engineering (ft)	2	ANSI D / E	1"=20' to 1"=100'
Land Survey	Engineering (ft)	2	ANSI D / E	1"=50' to 1"=200'
Utility (Electric)	Architectural (in)	1	ANSI D / E	1"=20' to 1"=40'
Mechanical (US)	Decimal (in)	1	ANSI B / D	Full size or 1:2
Mechanical (Metric)	Decimal (mm)	4	A3 / A1	1:1, 1:2, 1:5
Plumbing / MEP	Architectural (in)	1	Arch D / E	1/8"=1' or 1/4"=1'
Landscape	Engineering (ft)	2	ANSI D / E	1"=10' to 1"=30'
Interior Design	Architectural (in)	1	Arch C / D	1/4"=1' or 1/2"=1'
International Arch	Metric (mm)	4	A1 / A0	1:50, 1:100
GIS / Mapping	Meters	6	ANSI E	1:1000 to 1:10000

CHAPTER 8

INTERMEDIATE

Architectural Units — Deep Dive

Architectural units are the backbone of US building design. Here is every detail you need to configure them correctly and avoid the most common mistakes.

Input Rules — Complete Reference

How to type architectural distances at the command line:

You Type	AutoCAD Reads	Notes
6	6"	Default is inches when no foot mark present
6'	6'-0"	Foot mark — exactly 6 feet
6'6	6'-6"	6 feet 6 inches — quote optional
6'6"	6'-6"	Explicit — feet and inches
6'6-1/2	6'-6 1/2"	Feet, inches, fraction with hyphen
6'6-1/2"	6'-6 1/2"	Same with explicit quote
18-3/4	18 3/4"	Fractional inches, no feet
1'3-1/4"	1'-3 1/4"	All components
0-3/4	3/4"	Less than one inch

Fraction Precision — When to Use Each Setting

Precision	Denominator	Display Example	Use This For
0	Whole inches only	6'-8"	Rough blocking, site concepts
1/2	Half inches	6'-8 1/2"	Framing layouts, general arch
1/4	Quarter inches	6'-8 1/4"	Most architectural work
1/8	Eighth inches	6'-8 1/8"	Standard for construction drawings
1/16	Sixteenth inches	6'-8 1/16"	Finish work, millwork, tile
1/32	Thirty-second	6'-8 1/32"	Precision cabinetry, joinery
1/64	Sixty-fourth	6'-8 1/64"	Ultra-precision — rarely needed

TIP

Standard of practice: Use 1/8" precision for most construction documents. Switch to 1/16" for enlarged details (millwork, cabinet shop drawings, tile and stone layouts).

Angle Settings for Architectural Work

Most architectural work uses decimal degrees with counterclockwise positive:

Setting	Recommended Value	Notes
Angle Type	Decimal Degrees	Standard for architecture
Precision	0 or 0.00	Whole degrees for most work
Base Angle	East (0°)	AutoCAD default — measure CCW from east
Clockwise	No	Counterclockwise positive — standard math convention

Common Architectural Unit Mistakes

- **Forgetting the foot mark:** Typing 10 when you mean 10' gives you 10 inches. Always use the apostrophe for feet.
- **Spaces in command input:** 6' 6" with a space may be misread. Use 6'6" with no space between feet and inches.
- **Wrong INSUNITS on received file:** A file with INSUNITS=0 inserts blocks at 1:1 regardless of unit settings. Always check.
- **Display precision vs. actual precision:** Showing 1/4" precision doesn't mean geometry snaps to 1/4". Use SNAP for that.
- **DIMSCALE not updated after scale change:** If you change your drawing scale, update DIMSCALE or use annotative dimensions.

CHAPTER 9

INTERMEDIATE

Engineering Units — Deep Dive

Engineering units are the standard for civil work in the United States. They express all measurements in feet with decimal fractions — never fractional inches. Understanding how they differ from architectural units prevents costly errors when files are exchanged between disciplines.

Format and Input Rules

Engineering units always display in decimal feet:

You Type	AutoCAD Displays	Equivalent Imperial
100	100.0000'	100 feet 0 inches
100.5	100.5000'	100 feet 6 inches
50.25	50.2500'	50 feet 3 inches
8.333333	8.3333'	8 feet 4 inches
0.0833	0.0833'	1 inch (1/12 of a foot)
1000	1000.0000'	1000 feet = 0.189 miles

Engineering vs Architectural — Side by Side

Attribute	Architectural	Engineering
Primary unit	Inch	Foot
Sub-unit	Fractional inches	Decimal fraction of foot
Example: 1 foot 6 inches	1'-6"	1.5000'
Example: 18 and 3/4 inches	1'-6 3/4"	1.5625'
INSUNITS setting	1 (Inches)	2 (Feet)
Typical discipline	Architecture, MEP, Structural	Civil, Survey, Roads
Text height (1/8" paper at 1"=20')	30" in model	2.5' in model
DIMSACLE at 1"=20'	240	240
Coordinate display	0'-0", 0'-0"	0.0000', 0.0000'
Works well for	Floor plans, elevations, details	Site plans, grading, alignments

Precision in Engineering Units

Engineering drawings typically use 4 decimal places of precision for coordinates and 2–3 decimal places for dimensions. Survey work sometimes uses 5 decimal places.

Precision	Smallest Increment	Use
0.0000 (4 places)	0.0001' = 0.0012"	Standard engineering / civil
0.00000 (5 places)	0.00001' = 0.00012"	Precision survey
0.000 (3 places)	0.001' = 0.012"	General site plans
0.00 (2 places)	0.01' = 0.12"	Rough grading, concepts

Civil and Survey Units

Civil and survey work involves the largest scales in typical drafting — from individual parcels at 1"=100' to county maps at 1"=2000'. The unit choices and coordinate systems used in this discipline have implications that reach far beyond the drawing itself.

Decimal Feet in Land Surveying

The US survey foot is the standard unit for all land survey work. Coordinates are expressed in decimal feet to four or five decimal places. The difference between US Survey Feet and International Feet is small but matters for precision GIS work:

$$1 \text{ US Survey Foot} = 1200/3937 \text{ meters} = 0.30480060960\dots \text{ m}$$

$$1 \text{ International Foot} = 0.3048 \text{ meters (exact)}$$

The difference is 0.0000020 meters per foot — about 2mm per kilometer. For parcels under a mile, this is negligible. For statewide GIS, it matters.

State Plane Coordinate System (SPCS)

State Plane coordinates give every point in the US an X,Y coordinate in a flat grid based on projection zones. Each state has one or more zones. Coordinates are in feet (US Survey) or meters depending on the zone and jurisdiction.

State/Region	Units	Typical Easting (X)	Typical Northing (Y)
California (Zone 2)	US Survey Feet	6,000,000 – 7,500,000	500,000 – 2,000,000
Texas (South Central)	US Survey Feet	700,000 – 1,000,000	13,000,000 – 14,000,000
New York (Central)	US Survey Feet	800,000 – 1,200,000	900,000 – 1,500,000
Illinois (East)	Meters	300,000 – 900,000	0 – 1,000,000

WARNING

AutoCAD CAUTION: State plane coordinates have very large values (millions of feet). If you set your drawing limits to include state plane coordinates, AutoCAD may struggle with display precision. Use the BASE point command or a coordinate shift to work near the origin.

Large-Scale Drawing Setup

For civil drawings at large scale, follow this setup sequence:

- Step 1: Set UNITS to Engineering, Decimal Feet, 4 decimal places.
- Step 2: Set INSUNITS = 2 (Feet).
- Step 3: Set LIMITS to cover your project area plus margins.
- Step 4: Set LTSCALE to match your plotting scale (e.g., LTSCALE=120 for 1"=10').
- Step 5: Set DIMSCALE to match your plotting scale factor.
- Step 6: Set text style height to 0 (annotative) or to scale-factor × paper height.
- Step 7: Consider using Annotative objects to manage multi-scale viewports.

Scale Factors for Civil Drawings

Plot Scale	Scale Factor	LTSCALE	Text Ht (0.1" on paper)	DIMSCALE
1" = 1'	12	12	1.2"	12
1" = 5'	60	60	6"	60
1" = 10'	120	120	12"	120
1" = 20'	240	240	24"	240
1" = 30'	360	360	36"	360
1" = 40'	480	480	48"	480
1" = 50'	600	600	60"	600
1" = 60'	720	720	72"	720
1" = 100'	1200	1200	10'-0"	1200
1" = 200'	2400	2400	20'-0"	2400
1" = 500'	6000	6000	50'-0"	6000

Advanced Metric-Imperial Workflows

This chapter covers complete, real-world workflows for handling mixed unit projects — the kind that show up when you collaborate with international firms, use metric vendor content in US drawings, or need to deliver the same design in both unit systems.

Workflow 1 — Receiving a Metric DWG File

Complete step-by-step process for incorporating a metric file:

Step 1: Open the metric file alone first

Type INSUNITS. Note the value. Type UNITS and record the length type and precision. Measure a known dimension to verify the file is at expected scale.

Step 2: Check for conflicting variables

Type MEASUREMENT (0=imperial, 1=metric). This controls hatch pattern and linetype scale. If mixing files, note this value — it affects LTSCALE behavior.

Step 3: Decide: import geometry or use as XREF?

XREF keeps files separate and auto-scales if INSUNITS is set. Copy-paste imports geometry at 1:1 and requires manual SCALE.

Step 4: If using XREF — attach with correct settings

XREF Attach → select file → set Path Type → check that scale shows 0.03937 (mm→in). If INSUNITS is correct, this auto-populates. If not, type 0.03937 manually.

Step 5: If pasting geometry — apply SCALE command

Select all imported geometry. SCALE → base point at 0,0 → enter 0.03937. Verify a known dimension reads correctly in inches.

Step 6: Update dimension and annotation styles

The imported geometry is now scaled to inches but may carry metric dimension styles. Use DIMSTYLE to apply your imperial standard to new dimensions in the file.

Workflow 2 — Dual-Unit Drawing Delivery

Sometimes you need to deliver the same drawing in both metric and imperial. The cleanest approach is to maintain a single metric master and generate the imperial version programmatically.

- Maintain the master drawing in millimeters (INSUNITS=4).
- Create a separate imperial output DWG.
- XREF the metric master into the imperial file — auto-scales at 0.03937.
- Add all annotation (dimensions, text, title block) in the imperial file using inch units.
- Plot the imperial file. Your geometry is correct; only the annotation layer is new.
- Update the metric master → the imperial file updates automatically on reload.

Workflow 3 — Block Library Strategy

Maintaining two versions of every block (metric and imperial) is error-prone. The better approach is a single metric master library with insertion scaling.

TIP

BEST PRACTICE: Create all library blocks in millimeters with INSUNITS=4. When inserting into an imperial drawing (INSUNITS=1), AutoCAD scales them at 1/25.4 automatically. You maintain one library for both worlds.

Workflow 4 — Annotative Scaling Across Systems

Annotative objects scale automatically for the current viewport scale. The annotation scale must be set correctly regardless of unit system.

Viewport Plot Scale	Imperial Annotation Scale	Metric Equivalent
1/4" = 1'-0"	1/4" = 1'-0"	1:48
1/8" = 1'-0"	1/8" = 1'-0"	1:96
1" = 20'	1" = 20'	1:240
1" = 50'	1" = 50'	1:600
1:100 (metric)	1" = 8.333'	1:100
1:50 (metric)	1" = 4.167'	1:50

CHAPTER 12

BEGINNER

Quick Reference Tables

Pull-out reference tables for daily use. Print this chapter and pin it at your workstation.

Complete Scale Factor Cheat Sheet

Imperial architectural and engineering scales:

Scale	Scale Factor	Viewport zoom	DIMSCALE	Text Ht (1/8" paper)
3"=1'	4	1/4xp	4	0.5"
1-1/2"=1'	8	1/8xp	8	1"
1"=1'	12	1/12xp	12	1-1/2"
3/4"=1'	16	1/16xp	16	2"
1/2"=1'	24	1/24xp	24	3"
3/8"=1'	32	1/32xp	32	4"
1/4"=1'	48	1/48xp	48	6"
3/16"=1'	64	1/64xp	64	8"
1/8"=1'	96	1/96xp	96	12"
3/32"=1'	128	1/128xp	128	1'-4"
1/16"=1'	192	1/192xp	192	2'-0"
1"=10'	120	1/120xp	120	15"
1"=20'	240	1/240xp	240	2'-6"
1"=30'	360	1/360xp	360	3'-9"
1"=40'	480	1/480xp	480	5'-0"
1"=50'	600	1/600xp	600	6'-3"
1"=60'	720	1/720xp	720	7'-6"
1"=100'	1200	1/1200xp	1200	12'-6"
1"=200'	2400	1/2400xp	2400	25'-0"

Metric Scale Factors

ISO metric drawing scales and their factors:

Metric Scale	Scale Factor	Text Ht (2.5mm paper)	DIMSCALE
1:1	1	2.5 mm	1
1:2	2	5 mm	2
1:5	5	12.5 mm	5
1:10	10	25 mm	10
1:20	20	50 mm	20
1:25	25	62.5 mm	25
1:50	50	125 mm	50
1:100	100	250 mm	100
1:200	200	500 mm	200
1:500	500	1250 mm	500
1:1000	1000	2500 mm	1000

INSUNITS Code Reference

Code	Unit	Code	Unit	Code	Unit
0	Unitless	6	Meters	12	Light years
1	Inches	7	Kilometers	13	Yards
2	Feet	8	Microinches	14	Parsecs
3	Miles	9	Mils	15	US Survey Feet
4	Millimeters	10	Angstroms		
5	Centimeters	11	Nanometers		

Key Conversion Quick-Reference

To Convert	Multiply by	Result
Inches → mm	25.4	mm
mm → Inches	0.039370	Inches
Feet → mm	304.8	mm
mm → Feet	0.003281	Feet
Feet → Meters	0.3048	Meters

Meters → Feet	3.28084	Feet
Inches → Feet	0.08333	Feet
Feet → Inches	12	Inches
Miles → Feet	5280	Feet
Feet → Miles	0.000189	Miles
Yards → Feet	3	Feet
Acres → sq ft	43,560	Square Feet

Common Fractional Inch Quick Reference

Fraction	Decimal"	mm	Fraction	Decimal"	mm
Fraction	Decimal in.	mm	1/2	0.5	12.700
1/64	0.015625	0.397	9/16	0.5625	14.288
1/32	0.03125	0.794	5/8	0.625	15.875
1/16	0.0625	1.588	11/16	0.6875	17.463
1/8	0.125	3.175	3/4	0.75	19.050
3/16	0.1875	4.763	13/16	0.8125	20.638
1/4	0.25	6.350	7/8	0.875	22.225
5/16	0.3125	7.938	15/16	0.9375	23.813
3/8	0.375	9.525	1	1.0	25.400
7/16	0.4375	11.113			

VERSION HISTORY

Version	Date	Changes
v1.0	Jan 2024	Initial release — 12 chapters, scaling/units core content, Quick Reference Card
v2.0	Apr 2024	Added Scale Calculator, Unit Converter, Fraction Conversion, Annotative Text tools
v3.0	Aug 2024	Added Title Block Setup, Hatch Calculator, Command Aliases, Drawing Setup Wizard
v4.0	Jan 2025	Added Utility Reference, Conductor Sag, Pole Loading; electrical utility industry section added; 24 tools total
v5.0	May 2026	MAJOR UPDATE — SDG&E Manual Library (OHCS 842pp, EDD 486pp, UGCS 1,044pp); Scientific Calculator

ABOUT THIS MANUAL

This manual accompanies the AutoCAD 2024 Scaling & Units Reference web application hosted at **anthonyws.com**. The web app is a Progressive Web App (PWA) that works fully offline once cached — install it to your home screen on any phone, tablet, or desktop for instant access to all 36 tools without an internet connection.

The manual covers the core technical content: unit systems, conversion mathematics, scale factors, and drafting workflows. For interactive calculators and real-time computation, use the companion web app. For SDG&E; construction standard manuals, use the built-in document readers described in Chapter 13.

PWA TIP

On iOS: open the app in Safari, tap the Share icon, then "Add to Home Screen." On Android: open in Chrome, tap the three-dot menu, then "Install App." All 36 pages are cached locally — no connectivity required after first visit.

ALL LEVELS

CHAPTER 13

Companion Web App — Tool Reference

The AutoCAD Scaling & Units Reference web app provides 36 interactive tools organized into five categories: AutoCAD Core, Utility Industry, SDG&E; Manual Library, Calculators & Science, and Reference. All tools are available offline via the Progressive Web App (PWA). The current release is v5.0 with Service Worker cache version 21.

36 Tools	3 Readers	2,372 Manual Pages	11 Calculators	SW v21
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A — AutoCAD Core Tools

These tools address everyday AutoCAD drafting workflows — unit setup, scale calculation, annotative scaling, and drawing organization.

Tool	Category	Description
■ Home / Dashboard	Navigation	App landing page with quick-access links to all tools, recent updates, and PWA install prompt.
■ Scale Calculator	Scale	Interactive calculator — enter drawing scale and get scale factor, viewport XP zoom, DIMSCALE, and paper text heights. Covers architectural, engineering, and metric scales.
■ Unit Converter	Units	Convert between inches, feet, mm, cm, m, and survey feet with live results. Handles fractional inch input.
½ Fraction Conversion	Units	Full fraction-to-decimal table with mm equivalents. Denominators from 1/2 to 1/64. Searchable and printable.
■ Annotative Text	Annotation	Annotative scale reference — paper heights, model heights, and DIMSCALE for all common drawing scales. Beginner to advanced.
■ Title Block Setup	Setup	Step-by-step title block configuration guide. Covers attributes, fields, sheet sets, and border sizing for ANSI and ISO sheets.
■■ Drawing Setup Wizard	Setup	Guided drawing template wizard — choose discipline, sheet size, units, and get a ready-to-use setup checklist.
■ Hatch Calculator	Annotation	Calculate HPSCALE for any drawing scale. Covers ANSI, ISO, and custom hatch patterns.

Tool	Category	Description
■ Command Aliases	Reference	Complete AutoCAD 2024 command alias table — 200+ commands with aliases, keyboard shortcuts, and ribbon locations.
■ LISP Scripts	Automation	Library of AutoLISP utility scripts for common drafting tasks. Copy-paste ready with usage notes.
■ Layer Standards	Standards	AIA and utility-industry layer naming conventions with color and linetype assignments.
■ Linetype Guide	Standards	Linetype reference — LTSCALE math, standard linetypes, and custom linetype definitions.
■ Search	Navigation	Full-text search across all 36 tools and reference pages.
■ Viewport / Paper Space	Plotting	Complete viewport setup guide — creating viewports, locking scale, layer overrides, and annotative scaling.
↔ Dimension Styles	Annotation	DIMSTYLE configuration reference — all DIMVARS explained with recommended values for each discipline.
■ XREF Guide	Reference	External reference workflow — attaching, clipping, binding, and overlay. Covers path types and XREF manager.
■ Sheet Set Manager	Organization	SSM setup guide — creating sheet sets, adding sheets, publishing, and using fields with SSM data.
■ Blocks & Attributes	Reference	Block creation and attribute reference — ATTDEF, ATTEDIT, dynamic blocks, and block table data links.
■ Plot / Print Setup	Plotting	Plot configuration guide — CTB vs STB, page setup manager, plot styles, and batch plotting with Sheet Sets.
■ Drawing Health Audit	Maintenance	Checklist and commands for cleaning up corrupt or bloated DWG files — PURGE, AUDIT, OVERKILL, -SCALELISTEDIT.
■ Template Builder	Setup	Step-by-step guide to creating a custom DWT template from scratch — layers, styles, title block, and saved settings.
■ Table & Data Links	Reference	DATA LINK and TABLE workflow — linking Excel spreadsheets to AutoCAD tables with live updates.

B — Utility Industry Tools

Electrical utility-specific engineering tools developed for SDG&E; and similar US utility companies. Covers distribution design calculations used in overhead and underground construction.

Tool	Category	Description
■ Utility Reference	Utility / Elec	Master reference for electrical utility drafting — conductor tables, voltage levels, equipment standards, NESC clearances, and drawing conventions.
■ Conductor Sag	Utility / Overhead	Catenary sag calculator — enter span length, conductor weight, and tension to get mid-span sag and clearance. Based on RUS and NESC methods.
■ Pole Loading	Utility / Overhead	Pole loading analysis reference — ANSI O5.1 strength classes, moment calculations, and guy wire sizing guidance.
■ Conduit Fill	Utility / UG	NEC conduit fill calculator — enter conduit type, size, and wire gauges to get fill percentage and determine compliance with Chapter 9 tables.
■ Wire Ampacity	Utility / Elec	Ampacity lookup table for copper and aluminum conductors — NEC 310.15 values at multiple temperatures and installation conditions.
■ Transformer Sizing	Utility / Elec	Distribution transformer sizing calculator — enter load kVA and power factor to get recommended transformer size, percent loading, and next standard size.

C — SDG&E; Manual Library

The SDG&E; Manual Library provides embedded PDF readers for three official SDG&E; construction standard documents. Each reader uses Mozilla PDF.js for high-fidelity rendering, chapter navigation, full-text search, and zoom/page controls. Manuals are not hosted by this app — users load their own PDF files from their device.

Manual	Full Title	Pages	Pages in App
■ OH Const Stds (OHCS)	Overhead Construction Standards	842 pages	ohcs-reference.html + ohcs-reader.html
■ EDD Manual (EDD)	Electric Distribution Design Manual	486 pages	edd-reference.html + edd-reader.html
■ UG Const Stds (UGCS)	Underground Construction Standards	1,044 pages	ugcs-reference.html + ugcs-reader.html

Each manual has two companion pages:

Reference Page	A searchable index of all sections, subsections, and standards numbers within the manual. Organized by chapter with
Reader Page	Full PDF.js reader that renders the actual manual pages to canvas. Supports chapter-jump navigation via the sidebar

**HOW TO
LOAD A
MANUAL**

Open the Reader page (e.g., ohcs-reader.html). Click the "Open PDF" button or drag your PDF onto the drop zone. The file stays local on your device — nothing is uploaded. Once loaded, use the chapter sidebar to jump to any section. Use Ctrl+F / Cmd+F to search within the rendered text.

OHCS — Overhead Construction Standards

The OHCS (842 pages) covers all SDG&E; overhead electrical distribution construction standards. Major sections include pole assembly standards (OH 1000 series), conductor installation (OH 2000), equipment standards — transformers, switches, capacitors (OH 3000), streetlight construction (OH 4000), and service standards (OH 5000). The Reference page indexes all OH XXXX standard numbers.

EDD — Electric Distribution Design Manual

The EDD Manual (486 pages) is the engineering design companion to the OHCS. It provides engineering criteria, design calculations, conductor selection methodology, equipment sizing, and planning standards for overhead distribution. Sections cover primary design (EDD 100), secondary design (EDD 200), underground design (EDD 300), equipment (EDD 400), and planning (EDD 500).

UGCS — Underground Construction Standards

The UGCS (1,044 pages) is the largest of the three manuals and covers all underground electrical distribution construction. Sections include general requirements (UG 3000), conduit and duct bank systems (UG 3100–3200), cable pulling and splicing (UG 3300), underground equipment — switchgear, transformers, junction boxes (UG 3400–3600), residential and commercial URD (UG 4000), and streetlight underground systems (UG 5000). The UGCS Reader renders all 1,044 pages with full chapter navigation.

D — Calculators & Science

Standalone engineering calculators and science reference tools that complement the drafting workflow.

Tool	Category	Description
■ Scientific Calculator	Calculator	Full-featured scientific calculator — trigonometry (sin, cos, tan, inverse), logarithms (ln, log), powers, roots, factorial, and constants (π , e). Keyboard-operable. History panel shows last 10 calculations.
■ Chemistry Reference	Science	Interactive periodic table with element detail panels — atomic number, weight, electron config, electronegativity, melting/boiling points, and common uses. Searchable by name, symbol, or atomic number. Useful for material specifications in engineering drawings.

E — Reference & System

Tool	Category	Description
■ What's New	Reference	Version history and release notes for all app updates v1.0 through v5.0. Always the last item in the navigation bar.
■ Help & Tool Guide	Reference	Complete tool-by-tool guide with descriptions, tips, and usage examples for all 36 tools.
■ Offline Page	System	Shown automatically when the device has no internet connection. Lists all 36 cached pages available offline.

Navigation Structure

The app uses a top navigation bar with dropdown menus. The navigation order is fixed:

Position	Nav Item	Type	Contents
1	■ Home	Direct link	Dashboard / landing page
2	■ Scale Tools	Dropdown	Scale Calculator, Unit Converter, Fraction Conversion, Hatch Calculator
3	■ Annotation	Dropdown	Annotative Text, Dimension Styles
4	■ Drawing Setup	Dropdown	Title Block, Drawing Wizard, Template Builder
5	■ Organization	Dropdown	Layer Standards, Linetype Guide, Sheet Set Manager
6	■ Advanced	Dropdown	XREF Guide, Blocks & Attributes, Table Data Links, LISP Scripts
7	■ Plotting	Dropdown	Viewport / Paper Space, Plot / Print Setup
8	■ Maintenance	Dropdown	Drawing Health Audit
9	■ Utility Industry	Dropdown	Utility Reference, Conductor Sag, Pole Loading, Conduit Fill, Wire Ampacity, Transform

Position	Nav Item	Type	Contents
10	■ Sci Calc	Direct link	Scientific Calculator
11	■ Chem Ref	Direct link	Chemistry Reference / Periodic Table
12	■ What's New	Direct link	Version history — always last

PWA & Offline Capability

The app is a Progressive Web App using a Service Worker (cache version: acad-ref-v21) to pre-cache all 36 pages and assets. Once any page has been visited, the entire app is available offline. The fetch strategy is Cache-First — cached resources are served instantly without a network round-trip. New versions force a cache update by incrementing the CACHE_NAME constant.

Pre-cached pages	36 HTML pages
Pre-cached assets	PDF reference card, scaling manual PDF, app icons (7 sizes), manifest.json
Cache strategy	Cache-First → Network fallback → Offline page
Service Worker version	acad-ref-v21
Install support	iOS (Safari Add to Home Screen), Android (Chrome Install App), Desktop Chrome/Edge
Auto-update trigger	CACHE_NAME constant increment forces old cache deletion on next visit

Deployment — Netlify

The app is deployed as a static site on Netlify. All files live in the `_netlify-deploy` directory of the project. No build step is required — files are deployed as-is.

Host	Netlify (static site)
Site ID	9fee886d-e95c-4c06-8d28-c781e037de08
Deploy command	<code>netlify deploy --prod --dir .</code>
Run from	<code>_netlify-deploy</code> directory (Windows 11 terminal)
Source PDF files	AutoCAD_Scaling_Units_Manual.pdf, AutoCAD_Quick_Reference_Card.pdf
SDG&E reader PDFs	Loaded client-side by user — not hosted on Netlify

DEPLOY NOTE After making changes to any HTML file, always bump the `CACHE_NAME` in `sw.js` (e.g., `acad-ref-v21` → `acad-ref-v22`) to force all users to receive the updated cached files on their next visit.

About the Author

Anthony Squires is a Senior Drafter with 20+ years of AutoCAD experience and extensive background in Autodesk Inventor and SolidWorks. He currently works in the electrical utility industry at SDG&E, applying 2D/3D CAD skills to overhead and underground distribution design. Previous roles include 3D mechanical design at Biwater (reverse osmosis water treatment plants) and Dennis Group (Starbucks manufacturing line in full 3D AutoCAD).

Anthony is currently expanding into AI-assisted development, mobile applications (Flutter), and 3D web experiences (Blender + 3DVista) — bridging decades of drafting expertise with modern digital platforms to put professional-grade CAD reference tools in every drafter's pocket.

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YouTube	youtube.com/@thedigitalshack

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