

UNDER CONSTRUCTION

Aim Of This Page?



To make your life, and those you share drawings with easier.

To pass on the skills, knowledge and experience gained by formal Technical Drawing Training at school & college and over 25 years of CAD use.

My background is varied, but mainly within the construction industry.

Although now a Structural Engineer I've drawn for many disciplines, Architectural, Temporary Works Designer, Structural, Civil, Manufacturing.

Many of the common sense suggestions below would equally apply to non- construction industry CAD users.

Why Am I Qualified To Advise You On How To Draw?

I started my career in 1974 at the tender age of 16 (for those of you that are Engineers and can do that math you know how old I am). For the Architects amongst you, that makes the year of my birth 1958, and in the year 2000 I'm 42.

Note the love hate Engineer / Architect relationship surfacing (*The Author has a wicked smile on his face*)

Some of my best friends and worst nightmares are Architects, or are my worst nightmares just people that can't communicate using drawings?

I've been drawing for around 28 years (*Gulp has that much of my life really passed away?*).

I have been using computers and CAD Drafting packages of one kind or another since 1975. I have not drawn on a drawing board at all for at least the last six years.

In the 70's schools in the UK taught Woodwork, Metalwork and TD (That's Technical Drawing to those younger Technicians).

Today school children in the UK are not taught Technical Drawing. Graduates come from three / four years of University with minimal CAD and Drawing skills if any!

My hope is that this page will pass knowledge on that is no longer taught in the UK.

Try Drawing Using A Drawing Board

If you intend to take an examination to become a Member or Associate of a professional institute, you will probably find that they will expect you (even Structural Engineers) to produce some A3 drawings using Tee Square, Adjustable Set Square, Compass, Protractor, Pencils, Ink Pens, etc

It pays to practice using a scale rule and other manual drawing instruments, to use the correct types of lead in the pencil (HB for text 2H & 3H for line drawing), so as to not end up with a dirty looking smudged piece of tatty work.

Learn how to plan the drawing arrangement, because with paper you can't just pick it up and move the detail so that it looks right on the paper like you can with CAD.

A2 & A3 drawing boards can be purchased from Art shops, WH Smith, Argos and Index.

For around £38 you can purchase an A2 board with parallel motion (that's the horizontal bar that goes up and down the board to give you horizontal lines and enables you to place an adjustable set square on the bar to produce sloping or vertical lines.

For around £20 you can purchase an A3 board with carrying case with straightedge guide slots on all 4 sides.

If you are a Graduate Engineer it pays to have an understanding of the workings of CAD and some basic CAD / drawing skills. If you are instructing CAD Technicians, they must be able to understand your requirements and sketches, plus you must have the ability to read and understand drawings.

What better way of gaining that skill than by producing a few drawings.

The Importance of 2D Drawings

One of the skills that Technical Drawing lessons & manual drawing teaches is the ability to visualise an item in 3D. I now hear the cry "we can draw in 3D these days". True but most construction issue drawings are produced in 2D and issued to site in paper format.

One needs to develop the ability to build the project in the mind from the 2D details.

The Site Agent, Groundworks Ganger, Brick Layers, Electricians, Carpenters etc. all need to understand what they are looking at. A picture saves a1000 words, but one line in the wrong place, is a disastrous as a badly written specification.

Remember site operatives have to carry 2D paper copies around the site to the location of the work.

Until this process changes, Architects and Designers will always require the aid of 2D Cad software.

The 3D Model

3D is great for visualisations and creating models where the fee and the project demand that the time and money be spent in creating them. A time may come in the distant future when technology takes over and 3D becomes a financial and practical reality. But until then, 2D Plays an essential role in the construction world.

Types Of Drawing And Their Contents

The number and type of drawings you produce will depend upon the nature and size of the scheme you are producing details for. Within the Construction Industry I would suggest the following are more or less standard:-

Location Plan 1:1250

Planning Drawings

- General Arrangements – 1:100 & or 1:50
- Elevations – 1:100 & or 1:50
- Sections – 1:100 & or 1:50

Building Control / Construction Drawings.

- General Arrangement Plans – 1:50
- Elevations – 1:100 & or 1:50
- Sections – 1:50
- Assembly Sections and Plans – 1:20
- Details – 1:20, 1:10, 1:5
- Components – 1:20, 1:10, 1:5

General Arrangements – Plans, Sections and Elevations

General Arrangement drawings should allow the reader to:

- Comprehend the overall layout and shape of the site or the building(s).
- Obtain setting out dimensions for the site, the buildings, the structural grids and also primary elements such as brickwork / blockwork, stairs, floor slabs, finished floor levels etc.
 - ◇ Architects please note that wherever possible overall dimensions of new buildings should be brick dimensions. You can source Brickwork Dimension Tables from the BDA Brick Development Association in the UK.
- Reference and identify the primary components in the building(s) such as rooms, windows, doors etc.
 - ◇ Please add your window and door references early on, even better if it can be the first or second issue within the Detail Design stage. One of the first things that the Quantity Surveyor (QS) will want from the Structural Engineer is a Lintel Schedule.
 - ◇ Please don't alter your window and door references once you have issued your drawings. I once worked with an Architect who decided to re-number all the doors and windows a week before Tender Issue without informing the Structural Engineer or the QS.

- ◇ Don't re use a door or window reference once you have issued it. Especially if the opening has been moved from a non-load bearing to a load bearing position. If you do really have to do this drop the Structural Engineer a note to inform him you have done this.
- Identify which drawing will give them a larger detail to look at i.e. Assembly, Details and Components
 - ◇ Please ensure that you show Section and Elevation Arrows on your Plan
 - ◇ Remember that the normal convention for Sections is viewing up the Page and to the Left.
 - ◇ Please ensure that you provide at least two section on building plans, one vertically and one horizontally when viewing the plan. I once worked with an Architect who only provided a section in one direction through the building because a section in the other direction would generate too many Details to produce!. I never did understand how he expected the Contractor to finish the scheme on time and within budget with this level of detail.

Element Specific General Arrangements

Element specific General Arrangement Drawings i.e. (ceiling layouts) should allow the reader to:-

- Comprehend the overall shape and layout of the particular element with comparison to the overall building layout and shape at the specific level (see below) of the building.
 - ◇ Specific level - positions of doorways may not be useful on a suspended ceiling layout but the positions of builders work apertures into the ceiling void might be extremely pertinent;
- Obtain setting out dimensions for the detailed element relative to the construction grid or primary construction features i.e. walls
 - ◇ Examples are access hatches; roof Lights, mechanical plant grills within a suspended ceiling layout.
- Obtain identify spaces and adjacent primary components in the building(s)
- Locate references leading to Assembly Drawings, Components Drawings and Details.

Assembly Sections and Plans and Details

Assembly drawings should allow the reader to:

- See how one part of the construction interfaces with another.
- Understand the relationship between separate parts of the construction including critical dimensions.
- Obtain references to further detailed information.

Components

Component drawings e.g. windows, provided by the designer are usually restricted to non-standard items that will be prefabricated or assembled away from the site, they should allow the reader to:

- Use the drawings to order non-standard components from specialist suppliers / manufactures.
- Obtain details of relationship between separate parts including critical dimensions.

Schedules

Schedules should provide the reader with:

- Collections of similar building components, with quantities, types, sizes and locations etc.
- References to other information e.g. Assembly Drawings, Details, and Specifications etc.
 - ◇ In days long gone, schedules were always drawn, now days they are produced in Word or Excel (Word Processors and Spreadsheets).
 - ◇ It is not always possible or practical, but on small scheme try to include the schedule on the drawing. i.e. Piling Schedule, Bar Bending Schedule where details and schedule can comfortably fit on the drawing.

Summary

When drawing by hand you scale what you are drawing, as you are drawing it. With computers you can zoom in and out past the actual scale size that the detail will ultimately be plotted out at. This can lead to over or under detailing by the CAD Technician.

Always put yourself in the position of those on site that are going to have to build (or try to build) what you have detailed.

Plan your drawings; In the old days we would draw small cartoons strip of drawings to plan how many of what type we would need for the project. These cartoons strips were somewhat like a storyboard that animators use to map out a full-animated feature.

Look at the drawings; forget what you have in your head, just look at what is on the paper, and ask yourself **“could I build this from the information supplied?”**.

Always get a check print to check dimension tally throughout the scheme. It is a long tradition with Architects that the string dimensions rarely add up to the overall dimensions. I asked an Architect friend why this was?, even with CAD, his answer was “tradition” (I took that as being a bad habit).

There are a number of publications that give guidance of what level of detail should appear on different types of drawing, here are a few.

Further Reading

Title	Author	Publisher	ISBN
A Guide to Drawn Information	Mervyn Hill	RIBA Publications	1 85946 051 8

Drawing Title Block

Most established companies have drawing sheets or templates created to their own specifications. The minimum contents on a tile block should include most of the following:-

- Name, Address, Telephone Number, Fax Number, Email Address of Company producing drawing.
- Job Title.
- Drawing Title.
- Drawn by.
- Checked by.
- Date.
- Scale (at a sheet size is a good idea when it comes to computers i.e. 1:50@A1)
- Project Number.
- Drawing Number.
- Revision Reference.
- CAD File name and path to the file folder.
- Issue status (i.e. For QS Purposes Only, For Tender Purposes Only, Issued for Construction etc.)
- Drawing Issue / Revision Box.
 - ◇ Why is it then that many draughtsmen find it impossible to fill in all the little boxes in the Tile Block ?
 - ◇ Always check that your Title Block is completed before you issue a drawing.
 - ◇ It always truly amazes me that Architects will issue drawings without a drawing number!
 - ◇ Even worse if the Drawing Title is not completed as well. On a number of occasions I have dealt with Architectural practices that work in this way, to start with
- Always Issue drawings with a drawing issue sheet.
 - ◇ Even more amazing is the amount of drawing offices that allow drawings on a scheme not to have a drawing register. Hey Umm perhaps that's it. No drawing register no drawing issue sheet.
 - ◇ If you ever want to get ISO 9001 or 2 - QA (Quality Assurance) and keep it, ensure you have these systems in place and you use them.
 - ◇ It's one of the things the British Standards Inspectors love to catch you out on. On our last audit the Architect who had sent drawings into us got their knuckles rapped for not having the checked box signed on their drawings, and not issuing drawings with an issue sheet. Our paperwork and procedures passed whilst the Architectural practice were issued with a no-conformity even though they were not being audited.

- Always ensure that Superseded drawings are marked as such.
- Keep drawing in alpha- numerical order in the draw so that you can lay your hands on them quickly.
 - ◇ Don't come up with a drawing numbering system that the British could not have deciphered in World War II. Remember KISS (Keep It Simple Stupid) On one job the contractor renumbered the Architects drawings by type of detail because the filing order of the drawings did not make any sense.

Thickness Of Lines

Another trait of the young Graduate or CAD Operator/ Technician is that they tend to draw everything in one pen thickness. This makes the drawing very bland and hard to read.

In the manual drawing days, you drew using Rotring drafting pens (Late 70's onwards), depending on which system you purchased the pen sizes and colour band at the tip and on the cap, which matched that of the appropriate stencil. The colours went something like this:-

Rotring *variant*

Pen Thickness	Colour
0.1	Red
0.2	Yellow
0.3	Grey
0.4	Brown
0.5	

Rotring *isograph*

Pen Thickness	Colour
0.18	Red
0.25	White
0.35	Yellow
0.4	
0.5	Brown

STADTLER *marsmatic*

Pen Thickness	Colour
ISO 0.18	Red
ISO 0.25	White
ISO 0.35	Yellow
ISO 0.40	
ISO 0.50	Brown

Colour to Line thickness

There is no hard a fast rule as to what this should be, but historically when we use to have pen plotters, we kind of followed the colour scheme of the manual pens that we had always used.

Colour No.	Colour	Line Thickness
1	red	0.25
2	yellow	0.35
3	green	0.50
4	cyan	0.18
5	blue	0.50
6	magenta	0.70
7	white	0.25
8	(grey)	0.25
9		0.10

Guidance on Line thickness

When drawing by hand you tend to use four pens, here are some guidelines

- Use 0.18 or 0.20 for dimensions, wall cavities, centre lines
- Use 0.25 or 0.30 for the outer and inner lines of walls
- Use 0.25 or 0.30 for Notes
- Use 0.35
- Use 0.50 for Titles
- Use 0.50 for depicting Reinforcement in RC details.

A Bit of Drawing Office History

Pre Late 70's drafting tended to be with a Pelikan or Rotring Graphos pen where you attached a nib to the pen if you did not use the cartridge then a drop of ink was placed on the nib and you drew until the ink ran dry. Wiping the nib with a piece of tissue paper from a toilet roll or an orange duster with black spots.

Those were the days!

Text – Style & Size

Most CAD Packages now days allow you to use CAD Fonts or True Type Fonts.

CAD Fonts (aka Vector Fonts) are drawn characters, TT Fonts are graphics, because of this TT Fonts can dramatically increase the size of your drawing, slow down the regeneration of zooms, pans etc. and crash your system on a semi regular basis.

I strongly recommend that you avoid TT Text like the plague, and use CAD Fonts. If you really don't feel that you have any other choice then don't use Arial, which is one of the worst for crashing AutoCAD.

HP solved the problem with rotating TT Fonts in CAD packages around 6 months after the launch of HP DesignJets.

Another problem with TT Fonts is that not all CAD Software will allow you to place these to a specific height only a pitch. You are then into scaling factors etc.

Always think about the ultimate scale the final drawing is going to be plotted at. A very simple rule I follow is Titles 5mm high, Notes 2.5mm high.

There are people out there (you know who you are) who can't multiply 2.5mm by the scale of the drawing i.e. 2.5mm x scale of 100 = a text height of 250mm

The chart below lists drawing scale factors and AutoCAD text heights for common architectural drafting scales. You can use the following charts to help you set up new drawings or to investigate the drawing scales of existing drawings

Scale charts

Table 1: Drawing scale and text height chart (millimetres)

Drawing Scale	Drawing Scale Factor	Text for Notes 2.5mm High	Text for Titles 5.0mm High
1:1	1	2.5	5.0
1:5	5	12.5	25
1:10	10	25	50
1:20	20	50	100
1:50	50	125	250
1:100	100	250	500
1:200	200	500	1000
1:500	500	1250	2500
1:1250	1250	3125	6250
1:2500	2500	6250	12500

The chart below lists AutoCAD model space limits sheets for common architectural drafting scales and architectural sheet sizes

Note that these sizes are based on the whole sheet size and not the sheets with margins

Table 2: Drawing scale and sheet size (metric)

Drawing Scale	210 x 297 mm (A4)	297 x 420 mm (A3)	420 x 594 mm (A2)	594 x 841 mm (A1)	841x 1189 mm (A0)
1:200	42 x 59.4 m	59.4 x 84 m	84 x 118.8 m	118.8 x 168.2 m	168.2 x 237.8 m
1:100	21 x 29.7 m	29.7 x 42 m	42 x 59.4 m	59.4 x 84.1 m	84.1 x 118.9 m
1:50	10.5 x 14.85 m	14.85 x 21 m	21 x 29.7 m	29.7 x 42.05 m	42.05 x 59.45 m
1:20	4.2 x 5.94 m	5.94 x 8.4 m	8.4 x 11.88 m	11.88 x 16.82 m	16.82 x 23.78 m
1:10	2.1 x 2.97 m	2.97 x 4.2 m	4.2 x 5.94 m	5.94 x 8.41 m	8.41 x 11.89 m
1: 5	1.05 x 1.485 m	1.485 x 2.1m	2.1 x 2.97 m	2.97 x 4.2 m	4.20 x 5.94 m

How To Draw

Here are the very CAD basic that every CAD user should learn

- Draw Accurately
- Learn how to use snaps
- Learn how to start a line relative to another point
 - ◇ By Learning how to draw using coordinates and snaps there is no reason for line not to meet a common point and for the length of lines to be accurately drawn. If you learn the three bulleted point above your lines depicting the walls of your building will always be parallel and the corners will always meet at 90 degrees with the lines meeting at a common node or vertex.
- Ensure that you understand tolerance in drawing.
 - ◇ In the construction industry be build with modular units called bricks. It is truly amazing the number of younger Architects and graduates that don't know what a brick module is. Older Architects and Architectural Technicians lay out the building using brick dimensions and consider the type of bond being used.
 - ◇ Many more experience draughtsmen actually indicate the number of bricks and joints under the dimension on the drawing.
 - ◇ Architects, please talk to your Structural Engineers about where you would like the Movement Joints in walls to occur.
- Learn the difference between First and Third Angle Projection

Example drawing to be added here.....
- Always try and take sections looking up the page and to the left.
- Text in a drawing should always be between the horizontal and vertical looking left.
 - ◇ Never, ever dimension or detail a drawing that has to be rotated by 360 degrees to read all the dimension and or notes.
- Try and make the North Elevation of the building occur at the top of sheet. Just like maps one tend to think that the top of the drawing is north. Yes you can put a north point looking down to the bottom of the page, but why not rotate the drawing by 180 degrees and have it pointing up.

- Learn how much or little Hidden Detail to show?
 - ◇ Too much or too little hidden detail can confuse the reader of the drawing as to what is actually happening. Below is a drawing that can be ... **to be continued**

Example drawing to be added here.....

- Create a layer convention then use it?
 - ◇ I have worked on a shared CAD drawing with the Architect where I have turned off a layer called “new_paths” only to have all the windows disappear!. The moral here is once you have a layer convention use it.

Classic Examples Of How Not To Draw Using CAD

Example drawing to be added here.....

Setting Up A Layer Convention

Layering Standards provide consistent naming schemes for drawing layers that will help you manage objects in all your drawings. The use of a consistent layering scheme for simple and complex drawings is important whether you work alone or in a large organisation.

Layering standards facilitate your control of objects in the AutoCAD environment for yourself and anyone else who works with your drawings and facilitates control of the following:-

- Consistency in drawing practices and locating objects
- Consistent application of linetypes to objects
- Drawing organisation
- Streamlined display and overlay of objects
- Easier creation of selection sets for editing operations
- Protection of objects when you freeze or lock layers
- Control of object screen colours for clarity
- Control of pen widths for plotting
- Layer management of external references
- Compatibility with custom automation (.lsp files scripts and Active X)
- Assigning rendering materials

Special Layers (Blocks and Dimensions)

There are two special layers, they in an AutoCAD drawing file. The first is layer 0. Every drawing must have a layer 0. It can not be deleted, purged or renamed. Its special characteristic is that blocks created on it can be inserted on any other layer and take on the properties of the layer on which they are inserted.

The second special layer is called DEFPOINTS. This layer is created the first time you add a dimension to your drawing. The DEFPOINTS layer is where the definition points for dimensions are created, and its special feature is that objects created on it are never plotted, although you can see them on screen.

Layers Summary

- Layers are probably the most important concept in AutoCAD
- Layers allow objects to be created with different colours and linetypes
- Layers are created using the Layer and Linetype Properties dialogue box
- There are 255 colours available, but seven standards colours should be sufficient for normal use
- Lintypes are loaded as required for named layers
- Layers saved to a standard sheet or Template need only be created once
- New Layers can easily be added
- Layer states are
 - ◇ ON: all objects are displayed and can be modified
 - ◇ OFF: objects are not displayed
 - ◇ FREEZE similar to OFF but allows faster regeneration of screen
 - ◇ THAW: undoes a frozen layer
 - ◇ LOCK: Objects are locked but cannot be modified
 - ◇ UNLOCK: undoes locked layer
- Layer states are displayed and activated in icon form the Layer Control dialogue box of using layer control from the object Properties toolbar
- Care must be taken when modifying a drawing with layers which are turned off or frozen

Further Reading

(Further reading on this subject matter see 5-2 of Autodesk Official Training Courseware, AutoCAD Help, AutoCAD Learning Assistant and Beginning AutoCAD Page 55)

Recycle Your Details

There is a real pressure from clients for you to produce your work. They want it and they want it yesterday. In such a fiercely competitive market the key to success is fast response. If you are a professional you will want to protect your PI (Professional Indemnity Insurance) and more importantly your reputation.

Recycling standard details enables you to provide a wealth of good information that can help a scheme run smoothly. Standard details can be tailored so that it looks scheme specific. The tailoring can be as little as filling in the title block and giving the drawing a scheme specific drawing number. It also makes your client feel like they are getting real value for money.

What is a Standard Drawing?

Any detail or group of details that you are likely to repeat from scheme to scheme.

Examples of standard Architectural Details are:-

- Loft Conversions Details
- Threshold Details
- Window Cill and Jamb details
- Door Schedules
- Window Schedules

Examples of standard Structural Details are:-

- Movement Joints
- Loft Conversions
- Steel Connections
- Truss Roof Details

What are Symbols or Blocks

In CAD packages generally the term symbol means a pre-drawn standard parts or items that can be used on electronic drawings in the same way as stencils, or letraset transfers are used on manual drawings

In Generic CADD 6.0 these are saved as COMPONENTS *.cmp

In Visual CADD these are saved as SYMBOLS *.vcs

In AutoCAD these are saved as WBLOCKS *.dwg

In Cadvance these are saved as SYMBOLS *.sym

As with drawings, each CAD package has it's own file extension.

In AutoCAD – BLOCKS live within a drawing..

- WBLOCKS are saved outside the drawing and can be imported into drawings
- The term BLOCKS is Generically applied to WBLOCKS just to confuse things!
- Plus a whole drawing may be loaded as a BLOCK

Note

Drawn objects may be combined into a single entity as a symbol. Using symbols saves you from drawing common items repeatedly and reduces the drawing size.

X Refs

X Ref stands for eXternal REFerence.

More to add here.....from the Xref Document.

Issuing Your Drawings To Others

Check you work before you issue

Drawing Issue Sheet

To be continued.....