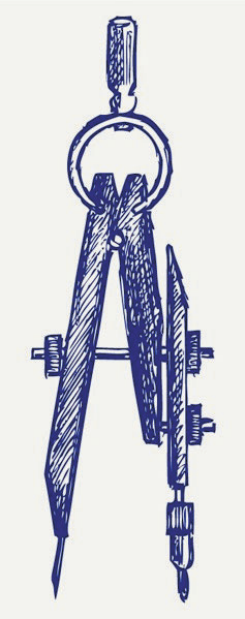
Manual Drafting Tools and Equipment

WHAT DO YOU NEED to make a technical drawing? When you are drawing by hand, how do you get perfectly straight and squared lines? How do you make perfect circles and curves? The answer is drafting tools. Without them, it is impossible to manually draft a precise technical drawing.



Objective:

Name common manual drafting tools and describe how they are used.

Key Terms:

adjustable curve (flexible curve)
drafting
drafting board
drafting compass
drafting table
drafting triangle
drafting vellum
dusting brush
erasing shield
French curve
irregular curve
lead holder
manual drafting
mechanical pencil
parallel ruler
parallel straightedge
protractor
scale ruler
straightedge
T-square
technical drawing
technical pen
technical pencil
template

The Use of Manual Drafting Tools

Drafting is the creation of technical plans that are used to determine how architectural and mechanical structures should be built. **Manual drafting** is the practice of creating drawings by hand, with pencil or ink on various mediums, including paper and film. CAD (computer-aided drafting) evolved from advanced manual drafting techniques. A **technical drawing** is a sketch, illustration, or diagram that visually communicates how something works or is constructed. The term "technical drawing" may be used in place of the word, "drafting." Drafters use manual means and CAD software to convert the designs of engineers and architects into technical drawings.

DRAFTING EQUIPMENT

Every drafter needs a drawing surface, pens and pencils, paper on which to draw, and a way to ensure precise line and curves in the technical drawing.

Pencils

A drawing pencil is used to sketch and each type is classified by lead softness or hardness. For the purpose of sketching, many drafters use a common pencil in a range from 2H to 2B. Technical pencils are used to finalize a sketch.

Grades of Lead

Lead grades may be hard (9H, 8H, 7H, 6H, 5H, 4H), medium (3H, 2H, H, F, HB, B), or soft (2B, 3B, 4B, 5B, 6B, 7B). A hard lead is used to draw light, thin lines, such as lettering guidelines and light construction lines. A medium lead is commonly used to draw thick lines on mechanical and architectural drawings. Soft leads are too soft to be effective in mechanical drafting. They are typically used for artwork.

Mechanical Pencil

A **mechanical pencil (lead holder, technical pencil)** is a hand tool, constructed from plastic or metal materials, that holds fine, replaceable lead. By twisting the outer casing of the lead holder, the pencil lead may be extended as the point is worn away. A lead holder is the more traditional version of mechanical pencils. You can change out the graphite or lead to achieve different line weights and thicknesses. All the leads come in one standard thickness but have a range of graphite softness or hardness that is utilized for different line weights. Many drafters use the modern mechanical pencil or automatic pencil that can be purchased at any office supply store. Leads are available in different thicknesses and specific sizes so that they do not need to be sharpened. The thickness designation is the same as is used for technical ink pen tip sizes, but mechanical pencils do not have the same full range of sizes.

FIGURE 1. Drafters often use a modern mechanical pencil or automatic pencil.

Pens

A **technical pen** is a specialized inking tool, used to make lines of constant width on technical drawings. They have fine grading diameters to control line width. They are available in a range of tips from very thin to very thick. Pen tips are connected to a reservoir of ink and are extremely precise and often expensive. Precision pens have replaced technical pens and can be purchased at most office supply stores. Precision pens, with built-in "precision" tips, can be used for sketching or drafting on any drafting media. They are inexpensive, come in a range of sizes, and require little maintenance. Precision pens are less precise than technical pens and the ink quality is inferior. Precision pens may not be reused.

Erasers

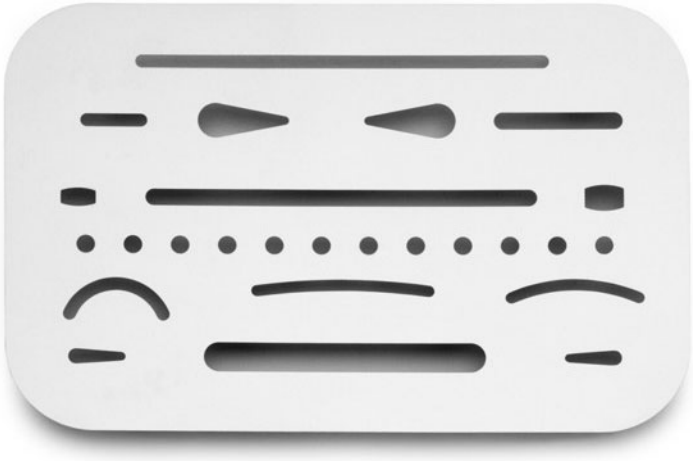


FIGURE 2. The use of an erasing shield helps ensure that only an exact portion of a line is removed.

Special erasers for manual drafting are available at art stores and online. Drafters, creating a final technical drawing, use specially designed erasers. Some erasers are called kneaded, plastic, or stick. Depending on the intended use, erasers may be soft or hard. Erasers are designed to remove ink, graphite, and plastic leads. An **erasing shield** is a thin metal or celluloid plate, with openings of several sizes and shapes, that confines an erasure to a limited area. It ensures that only an exact portion of a line is removed. A **dusting brush** is a hand tool, made from very soft fibers, used to remove any erasure debris. It also reduces the chance of your hand smudging or smearing the drawing.

Drafting Tables and Boards

A **drafting table** is a work surface that is adjustable for height and angle of incline. These tables have a variable pitch top placed atop a rigid leg-support structure. A **drafting board** is a pitched tabletop with perfectly squared corners and a flat surface. Most manual technical drawings are created on drafting vellum. **Drafting vellum** is smooth, translucent paper, made from plasticized cotton, that remains unaffected by changes in temperature or humidity. Drafting vellum is available in rolls, pads, and sheets.

Straightedges

A **straightedge** is a drafting tool, made of metal, plastic or wood, that is used to draw a straight line. T-squares, scale rulers, parallel straightedges, and drafting triangles are types of straightedges.

T-square

A **T-square** is a ruler with a short crosspiece that slides along the edge of the drawing board as a guide for making straight, parallel lines.

Scale Ruler

A **scale ruler** is a three-sided ruler, used to convert between scaled drawings and the actual dimensions without making mathe-

FIGURE 3. A scale ruler is used to reduce or enlarge a technical drawing.

FURTHER EXPLORATION...

ONLINE CONNECTION: Drafting Table and Parallel Straightedge Set Up

It is very important that a parallel straightedge is properly installed. Every line you make depends on it. Watch the YouTube "Drawing Board Set Up" video to learn how to set up and install a parallel straightedge at https://www.youtube.com/watch?v=RbtzYP0zPOM.

A parallel straightedge is used to ensure that all vertical and horizontal lines are parallel to one another.

matical calculations. It is used by architects and readers of blueprints to reduce or enlarge a drawing.

Parallel Straightedge

A **parallel straightedge** (**parallel ruler**) is a tool consisting of two straightedges, connected by pivoted crosspieces of equal length that ensure that both straightedges are parallel to each other at all times, although the distance between the straightedges may vary. A parallel straightedge is used primarily as a guide on a drafting table. It helps you to draw straight and precise lines that are parallel to each other. It can be an expensive instrument and is fastened to both sides of the drafting board with thin wire. The wire holds the straightedge perfectly parallel to the bottom of the board allowing you to move it straight up and straight down. A parallel straightedge is often considered the most important instrument in manual drafting.

Drafting Triangle

A **drafting triangle** is a precision tool for drawing lines at specific angles, usually constructed of transparent plastic that allows you to see the drawing underneath the tool. A drafting triangle always has one right angle at 90°. They are used in combination with a T-square or straightedge to draw vertical and angled lines. A standard 30°-60°-90° triangle has angles of 30°, 60°, and 90°. A standard 45° triangle has angles of 45° and 90°.

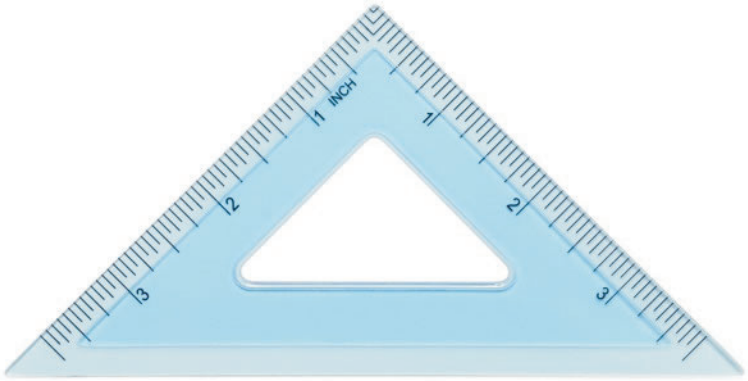


FIGURE 4. Drafting triangles are used in combination with a T-square or straightedge to draw vertical and angled lines. The image here is a 45° triangle.

Drafting Compass

A **drafting compass** is a metal device consisting of a horizontal beam and two vertical legs, used for drawing and measuring circles and arcs. One leg is sharp and one leg holds the pencil, lead, or inking pen. Drafting compasses have a range of adjustments and attachments that allow them to create very small to very large circles.

FIGURE 5. This complex drafting compass has a range of adjustments and attachments that allow creation of very small to very large circles.

Flexible Curve

A **flexible curve (adjustable curve)** is a long, bendable ruler, that may be fixed in position to form and hold a smooth curve. Its form can be adjusted to produce any curved line.

French Curve

A **French curve** (an **irregular curve**) is a template, with various edges and swirls, that allows you to draw and connect curves together so that they are perfectly fitted together.

Protractor

A **protractor** is a tool for laying down and measuring angles; typically a flat semicircle, marked with degrees along the curved edge. It is usually made of clear plastic to ensure marks are exact. Protractors create accurate and precisely angled lines with a straightedge that can be pressed along a T-square or parallel rule.

FIGURE 6. Use of a protractor is necessary to create lines at specific angles. Protractors are used in combination with a straightedge, T-square, or triangle to draw lines at any direction.

Template

A **template** is a flat piece of plastic with standard symbols cut in it, used when symbols (denoting such things as electrical elements, plumbing elements, fixtures, etc.) are to be drawn repeatedly. Templates are available in a range of sizes or scaled shapes, usually at specific increments. Shapes include circles, ellipses, squares, and triangles.

DRAFTING EQUIPMENT GUIDELINES

Manual drafting equipment guidelines help ensure clean and accurate drawings that are created efficiently. Manual drafting equipment should be used properly and be properly maintained to ensure accurate, sharp and clean drawings.

Pencils

Whether a drafter is using a traditional lead holder or a modern mechanical pencil, it is important to ensure that the pencil draws a consistently thick line. The grading system for lead applies to both lead holders and modern pencils.

Mechanical Pencils

Lead holders (traditional mechanical pencils) have tips that must be constantly sharpened to maintain the proper thickness. However, constant sharpening can result in excess graphite powder that may smear onto the drawing. To ensure that a lead tip is a constant thickness, it is twisted in the fingers as a line is drawn. If not twisted while drawing, the lead quickly flattens out along a single line. To produce the required effect, leads need to be changed out for each different line weight. Lead holders are still commonly used but they can be time consuming and messy. Modern mechanical or automatic pencils are used like any other pencil. They contain more than one lead at a time. They do not need to be sharpened and are much quicker and cleaner to use than lead holders. The lead for modern mechanical pencils comes in the exact thickness desired.

Grades of Lead

FIGURE 7. Replacement pencil leads for mechanical pencils are available in a wide range of grades.

Pencil leads come in grades that range from hard to soft. The softer the lead, the darker the line it produces. The harder the lead, the lighter line it produces. Each grade has a number and letter designation similar to common pencils. Hard grades have a letter H plus a number. Higher numbers equal a harder grade: 9H is the hardest, to 2H the softest. Soft grades have a letter B plus a number. Higher numbers are the softer grades: from 2B up to 7B+ (the softest). Medium grades are given a letter only: F, HB, and B. However, the standard medium range usually includes several numbers in addition to the letters H or B. The common yellow school pencil is a 2B.

Technical Pens

A technical pen is held at a 90° angle (perpendicular) when drawing onto paper or film. Holding at any other angle may cause ink to leak and/or for the surface to be scratched by the tip. Ink requires time to dry and the drafter must wait before drawing over or around recently

FURTHER EXPLORATION...

ONLINE CONNECTION:
How to Use Manual Drafting Tools and Equipment

Manual drafting equipment requires practice to use it properly. If not used correctly, it becomes exceptionally difficult to create clean, straight, and square lines. Take some time to practice using manual drafting tools. You can begin by watching the YouTube video, "Tools For Drafting By Hand," at https://www.youtube.com/watch?v=FFDHScQFscw.

drawn lines. Technical pens are rarely used for manual drafting of technical drawings. They are commonly used for artistic drawings that take a lot of time. Technical pens must be cleaned each time they are used. Tips that are not regularly cleaned will clog, will not create accurate line weights, and may "bleed" onto the drawing. Precision pens require no cleaning and do not need to be held at a 90° angle to the drafting media surface. The tips of precision pen tips are delicate. To avoid breaking the tip, care should be taken when pressing the tip to the paper.

Erasers

Hard erasers may be used to remove graphite or inked lines. They tend to erase more thoroughly than soft erasers, especially for ink. However, they can scratch the drawing surface if not used carefully and will leave residue on the drawing. Eventually they need to be replaced. Soft erasers leave as much residue as a hard eraser. They can last a very long time and do not scratch the drawing surface. A soft eraser can be used to "pick up" small particles of graphite. An erasing shield allows the user to remove a very specific portion of a line by locating it in the cutouts. Erasures can leave particles and smears on a technical drawing. When drawing by hand, the use of a dusting brush helps ensure a clean and clear surface. The brush's soft fibers brush away any leftover particles without smearing.

Drawing Boards

A drawing board must be perfectly square to create accurate and parallel lines. The drawing surface must be composed of a completely smooth material to ensure that a pen or pencil does not "dip or slide" into a surface depression. Historically, drawing boards were composed of a thin, hard, smooth rubber mat. Drafting tape is used to adhere and secure a drawing to the board. Today, most drafting, design, and engineering offices keep a few simple boards for sketching.

Straightedges

Parallel straightedges and T-squares with a thin lip along the sides are recommended rather than those with an edge of a constant thickness. An edge of constant thickness may cause ink to bleed or cause graphite to smear. In practice, an edge with a thin lip does not actually touch the drawing and that keeps the drawing clean. Clean straightedges and T-squares prevent smudges on the drawing. A parallel straightedge should be routinely checked for accuracy. A drafter

should draw several horizontal lines at different increments and the measure their distance to each other. The distance should be the same across entire line. A T-square is routinely checked in the same manner. When using a T-square the top of the "T" should always be pressed firm to the drawing board to ensure that lines are properly perpendicular or parallel to each other.

Triangles

Triangles can be used in combination with other triangles to create less common angles. One edge of the triangle is always pressed firmly to a straightedge or T-square. When using an adjustable triangle, it is important that the lock or knob is tight and set at the correct angle. Then, the adjustable arm moves easily when a pen or pencil is pressed against it and, just like a straightedge or a T-square, triangles with a thin lip edge are recommended. If a triangle does not have a thin edge, it can be raised by several levels of tape to keep the drawing clean. Triangles should be cleaned regularly.

Drafting Compasses

A drafting compass can be used to create arcs, curved lines, and combinations of both. A compass is held at about 70° to the board when drawing. It takes some practice to be able to spin it accurately and develop a good technique. Some compasses can be cumbersome to properly twist in a full circle. Complex compasses have many arm adjustments and screws that can accidently be turned or pushed. Before drawing, a drafter must patiently read through any instructions to ensure that all adjustments are correct.

Curves

An adjustable curve is easy to adjust and bend and holds its position well once the correct shape is formed. They are used to create random lines or even wavy lines and should be cleaned after each use to keep graphite from smearing a drawing. While useful for drawing clean curved lines that change their direction or size, A French curve can be time consuming to use. A drafter must make points on the drawing and use the curve in several different positions to create a desired curved line. It does not have exact arcs or any specific radius along its curves. A drafter must make several sketches along different paths to create a desired curve. A French curve should be cleaned regularly to prevent smudges and smears on technical drawings.

FURTHER EXPLORATION...

ONLINE CONNECTION: How to Use an Adjustable Curve

An adjustable curve is a very unique and useful drafting tool. It can be bent into almost any curved shape. You can place it directly on an object to create the curve line and then transfer it onto your drawing. It can also be used to draw meandering wavy lines in any direction or form. Watch the YouTube video, "The Quilters Flexible Curve," at https://www.youtube.com/watch?v=fEPyWSHoGjc.

Templates

Templates are used for common symbols that must be drawn multiple times. They are available for all drafting professions and are prepared in the drawing scales typically used by the profession. Some templates have small spacers that allow it to be raised slightly above the drawing to keep the surface clean and to avoid ink from bleeding under the template. Templates are cleaned regularly to avoid smudges and smears on a technical drawing.

Summary:

Manual drafting is an art form that requires skill and precision to create perfectly straight and squared lines, line weights, and details by hand. Drafting tools are designed to help you draw precise lines to create technical drawings and illustrations. Pens and pencils, used with straightedges, triangles, compasses, and curves enable the creation of precise, detailed drawings. By learning how to use these tools, you get a glimpse into the artistic side of drafting and design.

Checking Your Knowledge:

1. What makes a straightedge important to a manual-drafting project?
2. Describe uses for a template.
3. What are three tips for using triangles properly?
4. How are adjustable curves used for technical drawings?
5. Describe how a drafting compass is used.

Expanding Your Knowledge:

Drafters, artists, and illustrators use manual drafting equipment to create precise technical drawings. Use some of the Web Links below to learn more about how manual drafting tools and techniques are used today.

Web Links:

Engineering Drawing
https://www.youtube.com/watch?v=z4xZmBpXIzQ

Technical Drawing
https://www.youtube.com/watch?v=YE0oZZO7vbk

Manual Drafting Techniques
https://www.designingbuildings.co.uk/wiki/Manual_drafting_techniques