

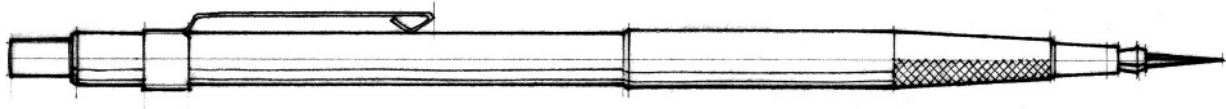
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Drawing Tools and Materials

This chapter introduces the pencils and pens necessary for inscribing lines, the instruments available for guiding the eye and hand while drawing, and the surfaces suitable for receiving the drawn lines. While digital technology continues to further augment and enhance this traditional drawing toolkit, the kinesthetic act of drawing with a hand-held pencil or pen remains the most direct and versatile means of learning the language of architectural graphics.

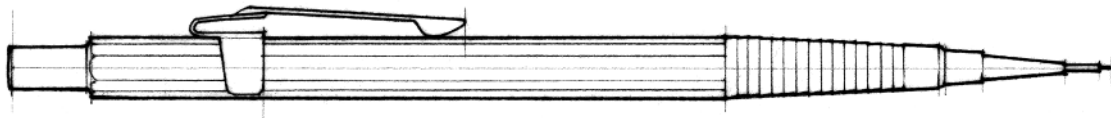
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Pencils are relatively inexpensive, quite versatile, and uniquely responsive to pressure while drawing.



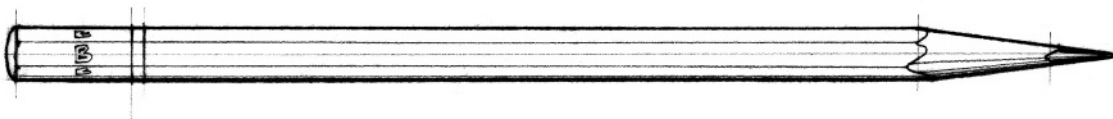
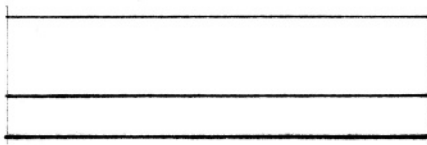
Lead Holders

- Lead holders employ standard 2 mm leads.
- The push-button action of a clutch mechanism allows the exposed length of the lead shaft to be adjusted or withdrawn when the pencil is not in use.
- The lead point, which is capable of a variety of line weights, must be well sharpened with a lead pointer.



Mechanical Pencils

- Mechanical pencils use 0.3 mm, 0.5 mm, 0.7 mm, and 0.9 mm leads.
- A push-button mechanism advances the lead automatically through a metal sleeve. This sleeve should be long enough to clear the edges of drafting triangles and straightedges.
- The relatively thin leads of mechanical pencils do not require sharpening.
- 0.3 mm pencils yield very fine lines, but the thin leads are susceptible to breaking if applied with too much pressure.
- 0.5 mm pencils are the most practical for general drawing purposes.
- 0.7 mm and 0.9 mm pencils are useful for sketching and writing; avoid using these pencils to produce heavy line weights.



Wood-Encased Pencils

- Wooden drawing pencils are typically used for freehand drawing and sketching. If used for drafting, the wood must be shaved back to expose $\frac{3}{4}$ " of the lead shaft so that it can be sharpened with sandpaper or a lead pointer.

All three styles of pencils are capable of producing quality line drawings. As you try each type out, you will gradually develop a preference for the characteristic feel, weight, and balance of a particular instrument.

Graphite Leads

Grades of graphite lead for drawing on paper surfaces range from 9H (extremely hard) to 6B (extremely soft). Given equal hand pressure, harder leads produce lighter and thinner lines, whereas softer leads produce denser, wider lines.

Nonphoto Blue Leads

Nonphoto blue leads are used for construction lines because their shade of blue tends not to be detected by photocopiers. However, digital scanners can detect the light blue lines, which can be removed by image editing software.

Plastic Leads

Specially formulated plastic polymer leads are available for drawing on drafting film. Grades of plastic lead range from E0, N0, or P0 (soft) to E5, N5, or P5 (hard). The letters E, N, and P are manufacturers' designations; the numbers 0 through 5 refer to degrees of hardness.

Recommendations for Grades of Graphite Lead

4H

- This dense grade of lead is best suited for accurately marking and laying out light construction lines.
- The thin, light lines are difficult to read and reproduce and should therefore not be used for finishing drawings.
- When applied with too much pressure, the dense lead can engrave paper and board surfaces, leaving grooves that are difficult to remove.

2H

- This medium-hard lead is also used for laying out drawings and is the densest grade of lead suitable for finishing drawings.
- 2H lines do not erase easily if drawn with a heavy hand.

F and H

- These are general-purpose grades of lead suitable for layouts, finishing drawings, and handlettering.

HB

- This relatively soft grade of lead is capable of dense linework and handlettering.
- HB lines erase and print well but tend to smear easily.
- Experience and good technique are required to control the quality of HB linework.

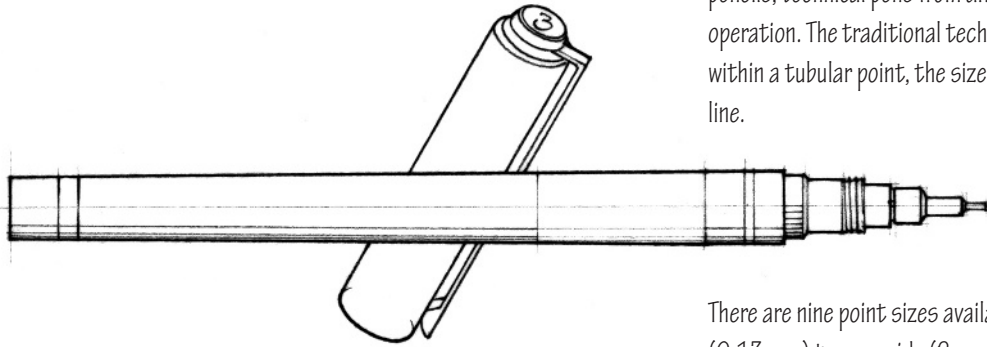
B

- This soft grade of lead is used for very dense linework and handlettering.

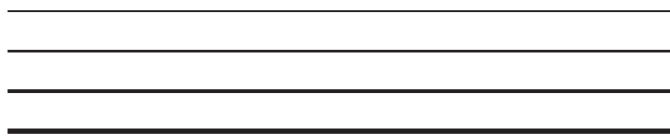
The texture and density of a drawing surface affect how hard or soft a pencil lead feels. The more tooth or roughness a surface has, the harder the lead you should use; the more denser a surface is, the softer a lead feels.

Technical Pens

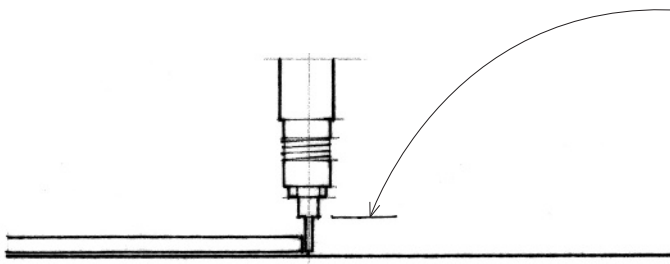
Technical pens are capable of producing precise, consistent ink lines without the application of pressure. As with lead holders and mechanical pencils, technical pens from different manufacturers vary in form and operation. The traditional technical pen uses an ink-flow-regulating wire within a tubular point, the size of which determines the width of the ink line.



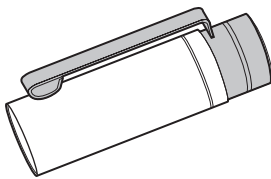
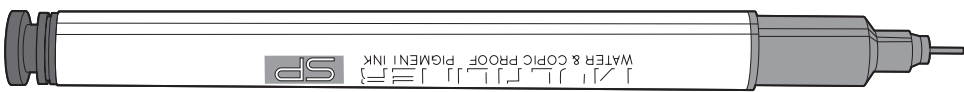
There are nine point sizes available, from extremely fine (0.13 mm) to very wide (2 mm). A starting pen set should include the four standard line widths—0.25 mm, 0.35 mm, 0.5 mm, and 0.70 mm—specified by the International Organization for Standardization (ISO).



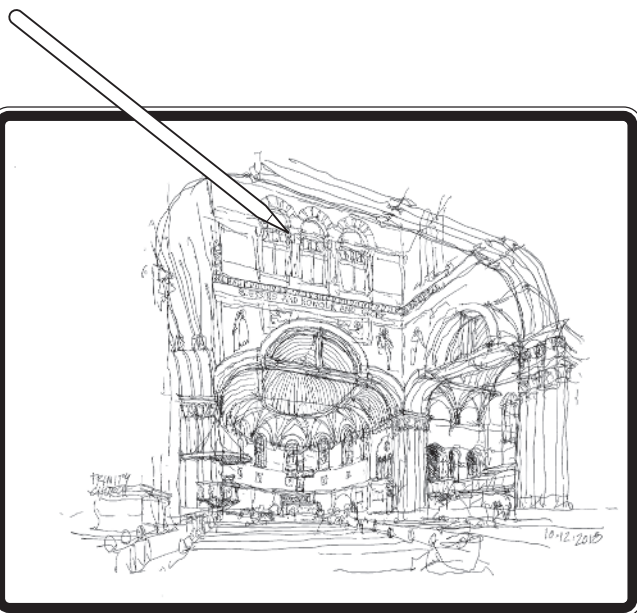
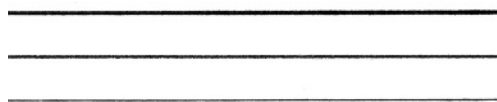
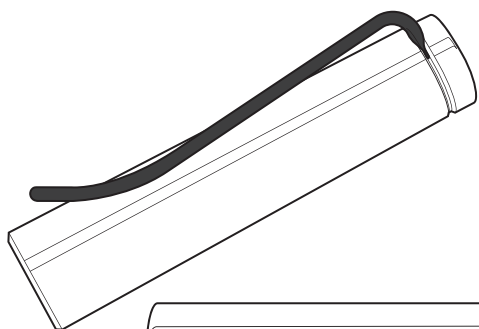
- 0.25 mm line width
- 0.35 mm line width
- 0.50 mm line width
- 0.70 mm line width



- The tubular point should be long enough to clear the thickness of drafting triangles and straightedges.
- Use waterproof, nonclogging, fast-drying black drawing ink.
- Keep points screwed in securely to prevent ink from leaking.
- After each use, replace the pen cap firmly to prevent the ink from drying.
- When pens are not in use, store them horizontally.



Since digital tools have reduced the need for manual drafting, a variety of less expensive, low-maintenance technical pens have been developed. Equipped with tubular tips and waterproof, pigment-based ink, these pens are suitable for writing, freehand drawing, as well as drafting with straightedges. They are available in point sizes that range from 0.03 mm to 1.0 mm. Some are refillable and have replaceable nibs.



Fountain Pens

Fountain pens typically consist of a reservoir—either a disposable cartridge or an internal piston—containing a water-based ink that is fed to a metal nib by capillary action. While not suitable for drafting, fountain pens are ideal for writing and freehand sketching because they offer ease in drawing incisive, fluid, often expressive lines with little or no pressure.

Fountain pen nibs come in extra-fine, fine, medium, and broad sizes; flat-tipped nibs are also available for italic and oblique strokes. Some nibs are flexible enough that they respond to individual stroke directions and pressure.

Other Drawing Pens

Gel pens use a thick, opaque ink consisting of pigment suspended in a water-based gel while rollerball pens use a water-based liquid ink. Both offer similar qualities to fountain pens—they are capable of a consistent ink flow and laying down lines with less pressure than that required by regular ballpoint pens.

Digital Stylus

The digital equivalent of the pen and pencil is the stylus. Used with a digitizing or computer tablet with a touch screen and appropriate software, it replaces the mouse and enables the user to draw in a freehand manner. Some models and software are able to detect and respond to the amount of hand pressure to mimic more realistically the effects of traditional media.

DRAWING GUIDES

T-Squares

T-squares are straightedges that have a short crosspiece at one end. This head slides along the edge of a drawing board as a guide in establishing and drawing straight parallel lines. T-squares are relatively low in cost and portable but require a straight and true edge against which their heads can slide.

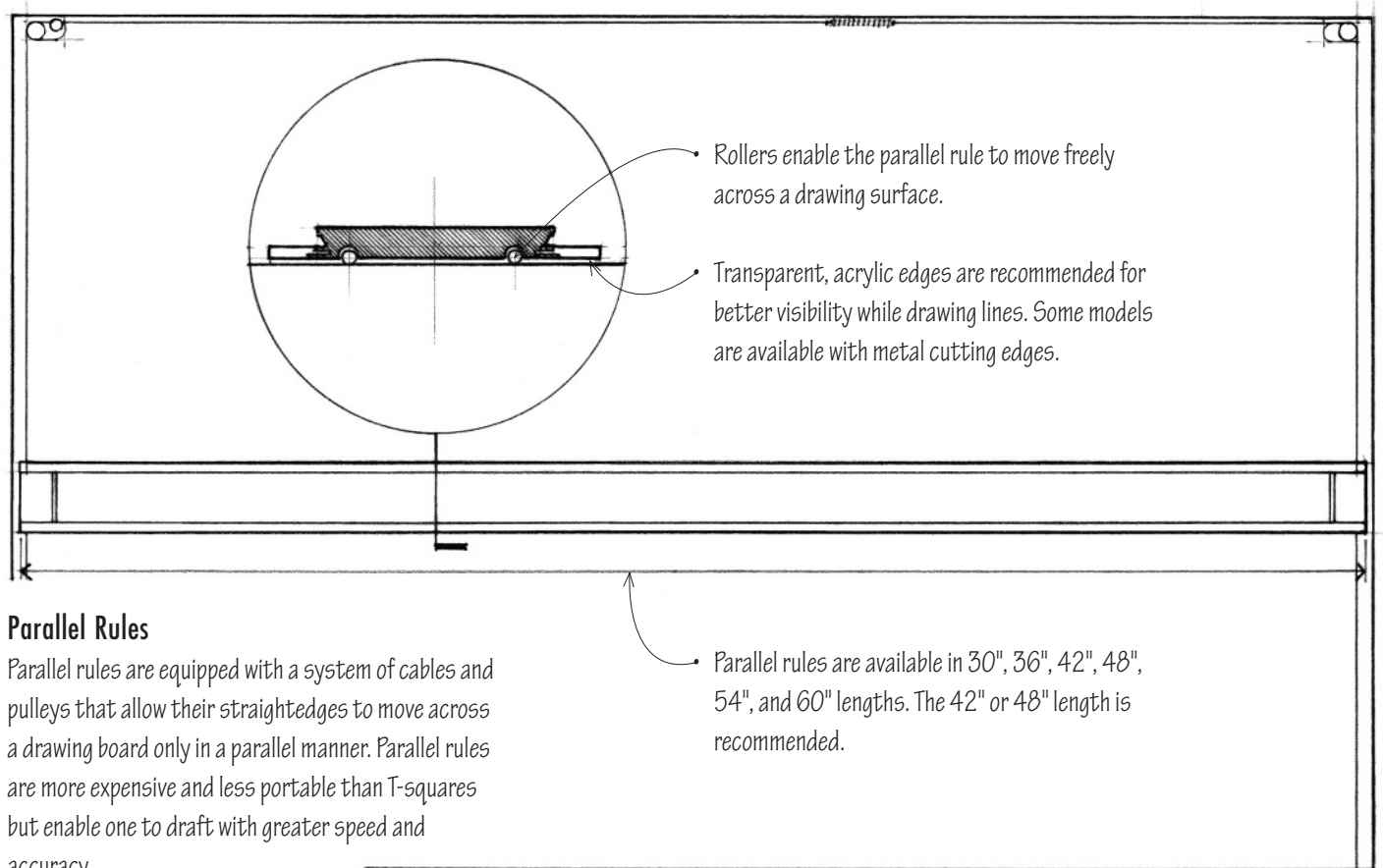
- T-squares are available in 18", 24", 30", 36", 42", and 48" lengths. 42" or 48" lengths are recommended.

- A metal angle secured to the drawing board can provide a true edge.

This end of a T-square is subject to wobbling.

Use this length of the straightedge.

- T-squares with clear, acrylic straightedges should not be used for cutting. Metal T-squares are available for this purpose.

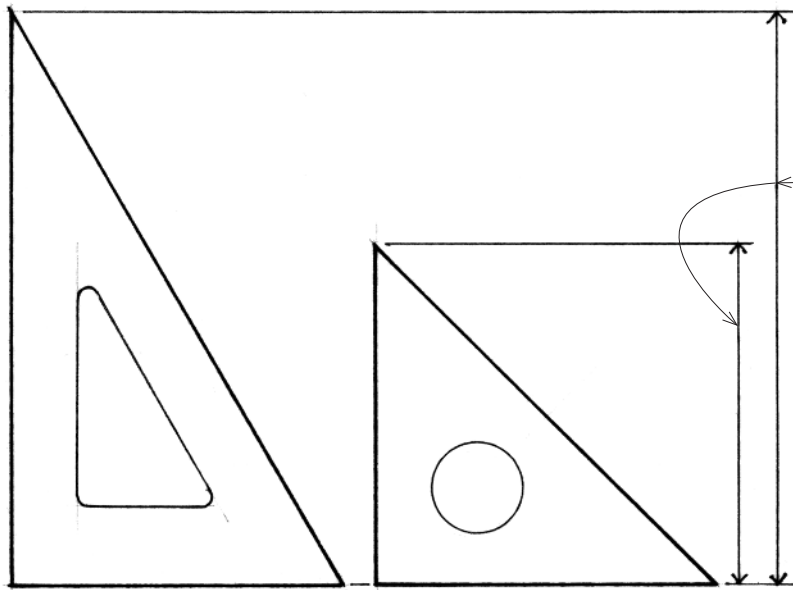


Parallel Rules

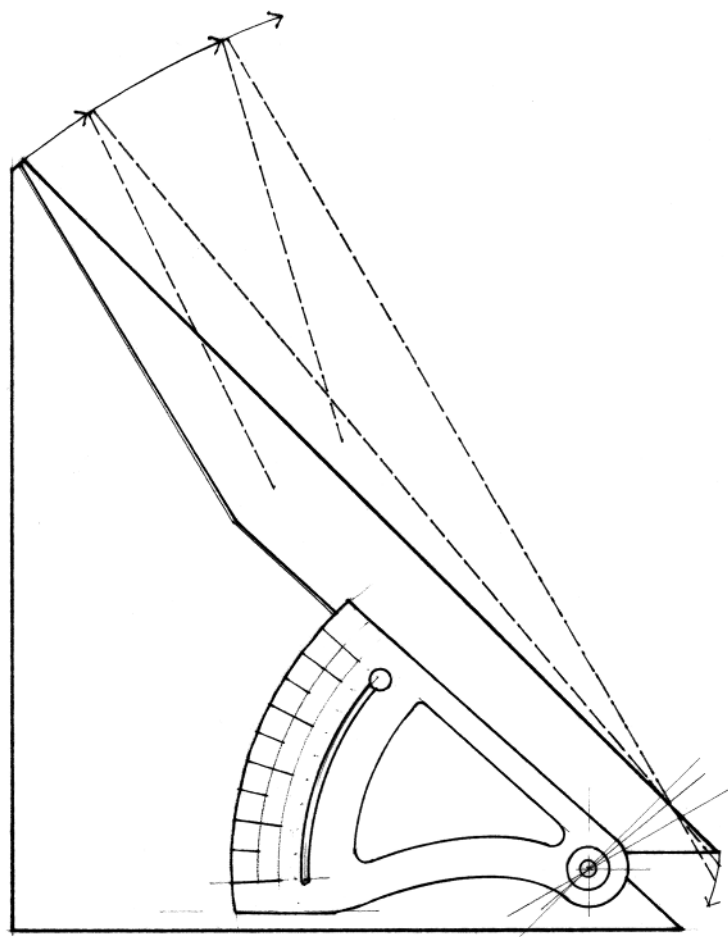
Parallel rules are equipped with a system of cables and pulleys that allow their straightedges to move across a drawing board only in a parallel manner. Parallel rules are more expensive and less portable than T-squares but enable one to draft with greater speed and accuracy.

Triangles

Triangles are drafting aids used to guide the drawing of vertical lines and lines at specified angles. They have a right angle and either two 45° angles or one 30° and one 60° angle.



- 4"–24" lengths are available.
- 8"–10" lengths are recommended.
- Small triangles are useful for crosshatching small areas and as a guide in lettering. See page 225.
- Larger triangles are useful in constructing perspectives.
- The 45°–45° and 30°–60° triangles can be used in combination to produce angular increments of 15°. See page 32.



- Triangles are made of clear, scratch-resistant, non-yellowing acrylic to allow a transparent, undistorted view through to the work below. Fluorescent orange acrylic triangles are also available for greater visibility on the drafting surface.
- Machined edges should be polished for precision and to facilitate drawing. Some triangles have raised edges for inking with technical pens.
- Inner edges may be beveled to serve as finger lifts.
- Keep triangles clean by washing with a mild soap and water.
- Triangles should not be used as a straightedge for cutting materials.

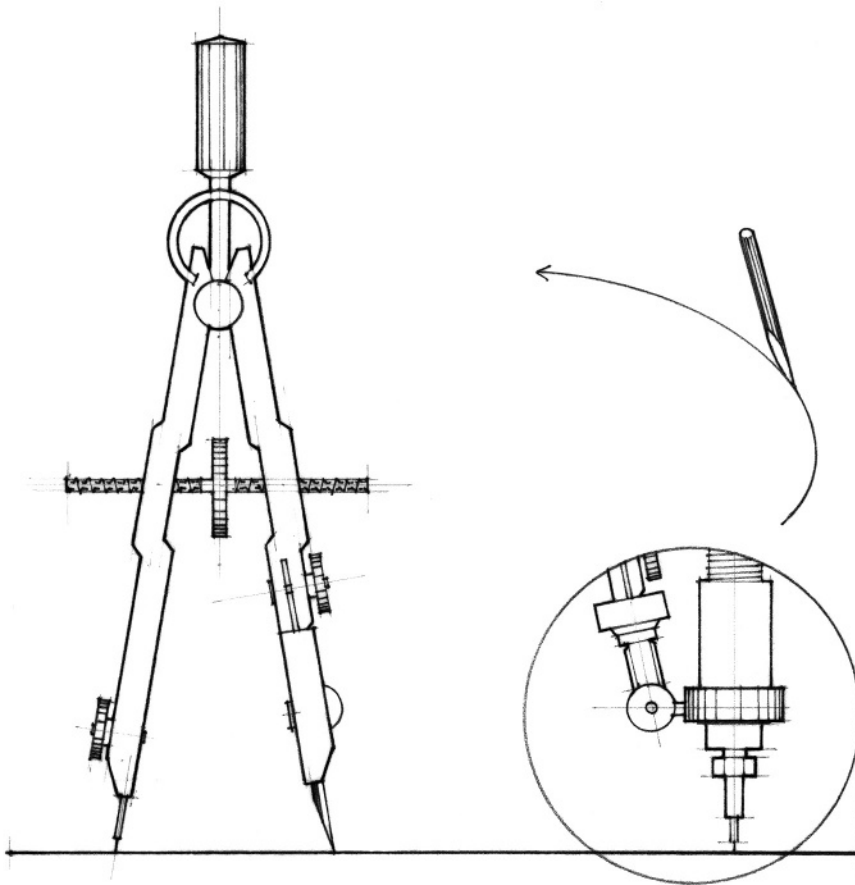
Adjustable Triangles

Adjustable triangles have a movable leg that is held in place with a thumbscrew and a scale for measuring angles. These instruments are useful for drawing such inclined lines as the slope of a stair or the pitch of a roof.

Compasses

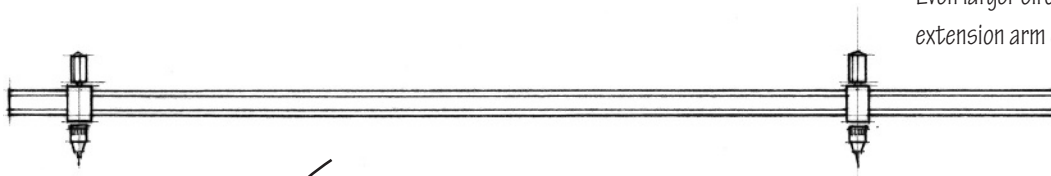
The compass is essential for drawing large circles as well as circles of indeterminate radii.

- It is difficult to apply pressure when using a compass. Using too hard a grade of lead can therefore result in too light of a line. A softer grade of lead, sharpened to a chisel point, will usually produce the sharpest line without undue pressure. A chisel point dulls easily, however, and must be sharpened often.



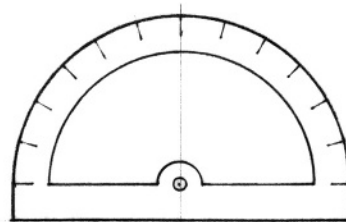
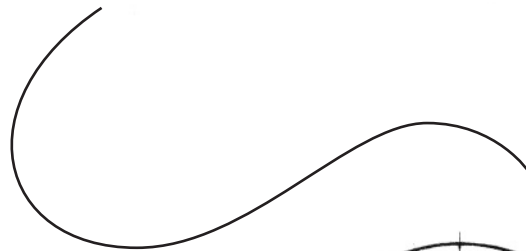
- An attachment allows technical pens to be used with a compass.

- Even larger circles can be drawn by appending an extension arm or using a beam compass.



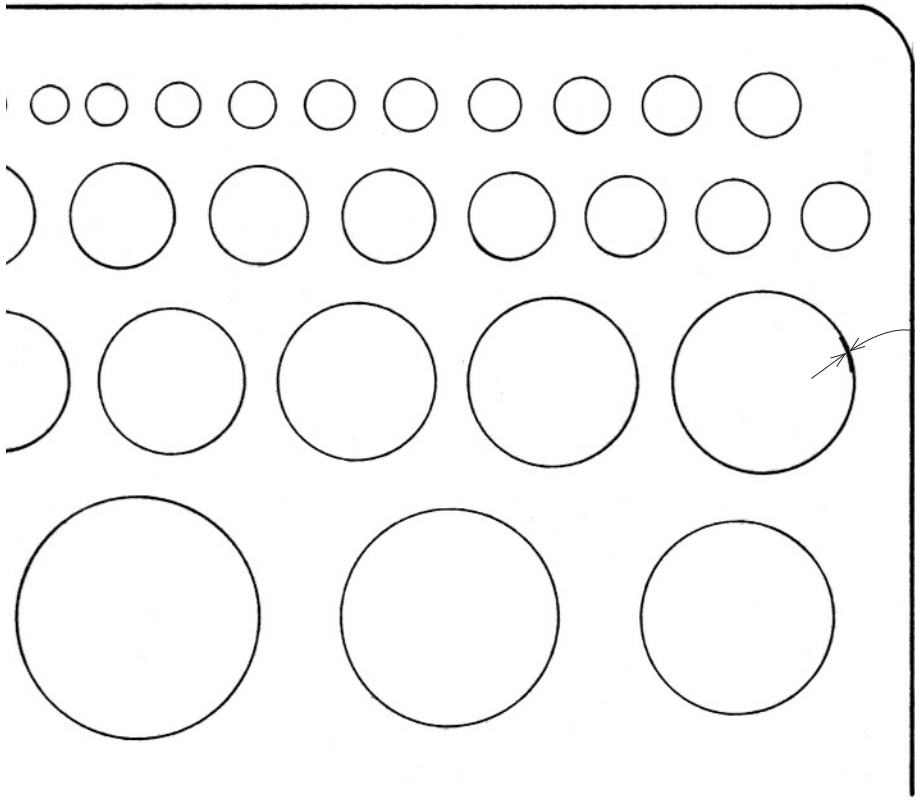
French Curves

- A variety of French curves are manufactured to guide the drawing of irregular curves.
- Adjustable curves are shaped by hand and held in position to draw a fair curve through a series of points.



Protractors

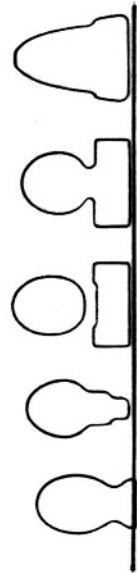
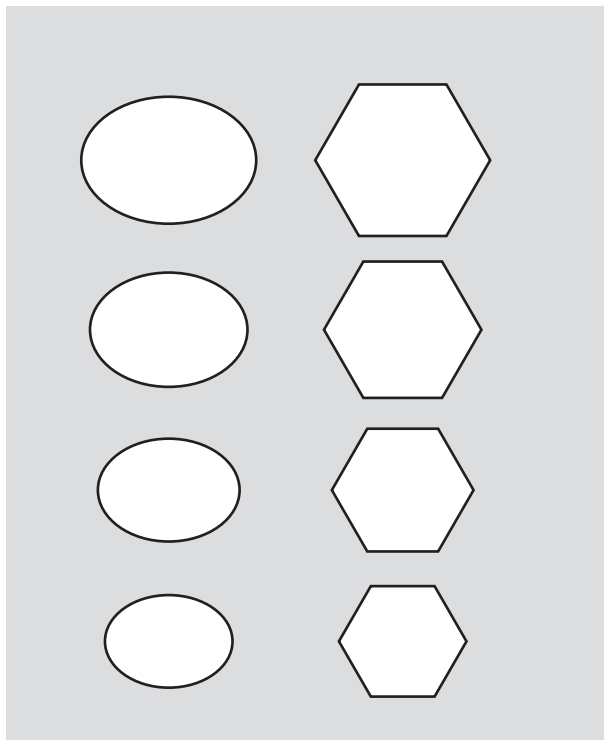
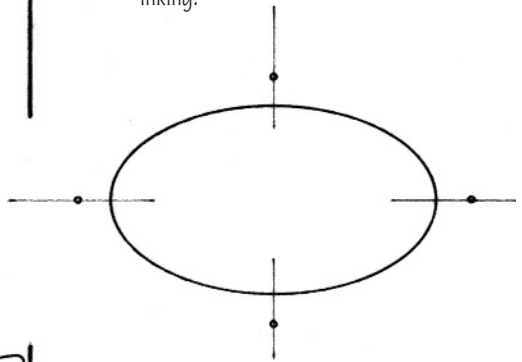
- Protractors are semicircular instruments for measuring and plotting angles.



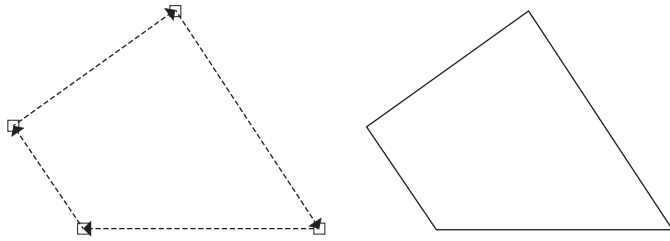
Templates

Templates have cutouts to guide the drawing of predetermined shapes.

- Circle templates provide a graduated series of circles commonly based on fractions and multiples of an inch. Metric sizes are also available.
- The actual size of a cutout differs from the drawn size due to the thickness of the lead shaft or pen tip.
- Some templates have dimples to raise them off of the drawing surface while inking.



- Templates are available for drawing other geometric shapes, such as ellipses and polygons, as well as symbols for plumbing fixtures and furnishings at various scales.



Digital Drawing Tools

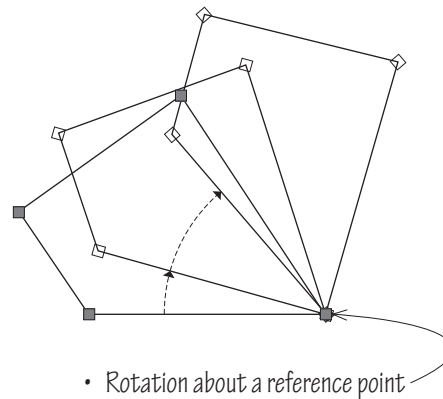
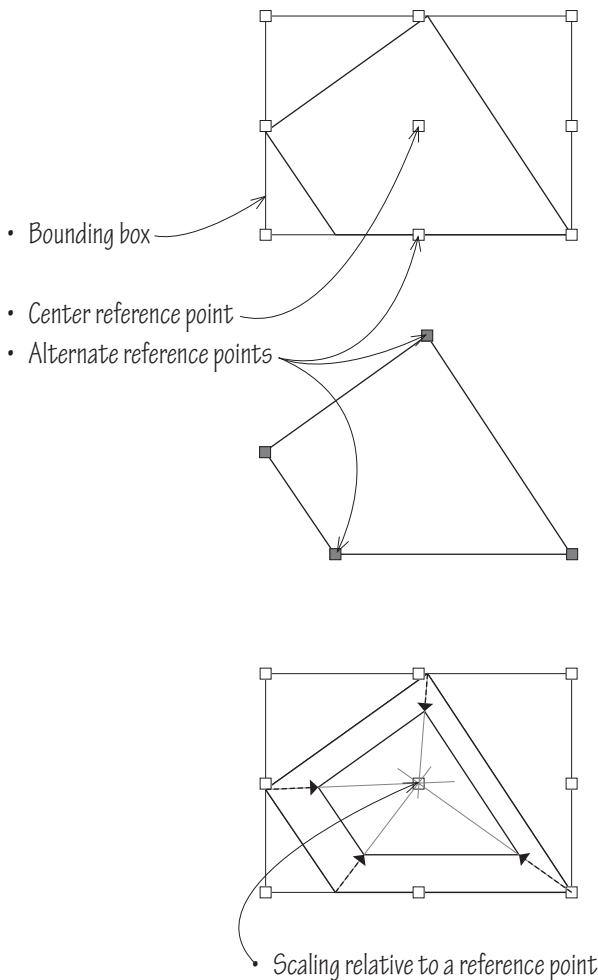
Analogous to traditional hand-drafting tools are the software capabilities of a 2D vector-based drawing program, which define lines and shapes as mathematical vectors. See pages 30–33 for information on digital drawing techniques.

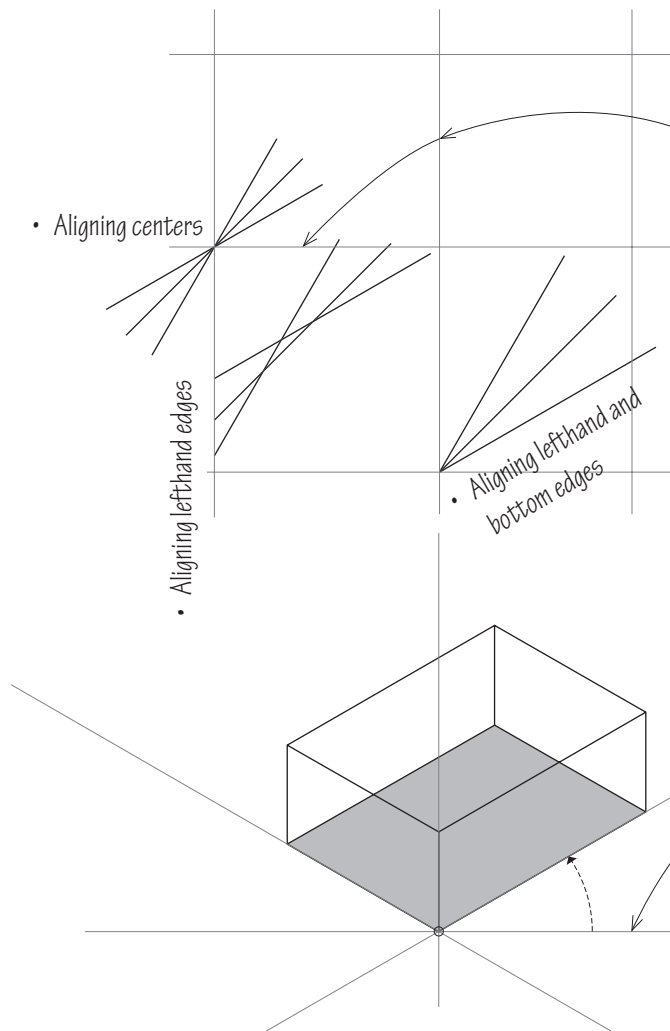
To aid in the editing and manipulation of lines and shapes created in drawing programs, we can call on a variety of digital reference points, guides, and templates.

Digital Reference Points

Lines and shapes drawn in vector-based drawing programs have reference points that can be used to locate them relative to the position of an origin point. Any of these reference points can also serve as the point around which a rotation can occur or from which a scaling operation can take place.

The default reference point is the center of a line or shape, or that of its bounding box. Other reference points can be set manually at each corner or the center of each side of the shape or bounding box. Some drawing programs may refer to reference points as anchor points.





Digital Guides

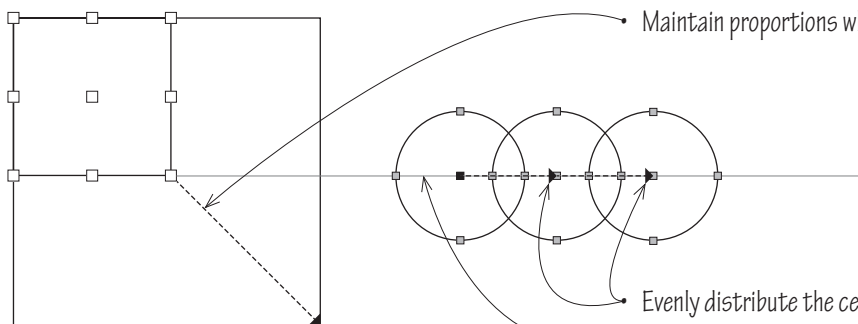
Digital guides and grids, along with snap-to commands, aid the precise drawing, moving, and scaling of lines and shapes.

- Guides help to align reference points and edges of lines and shapes.
- Grids are preset networks of spaced horizontal and perpendicular guidelines.
- By default, guides are unlocked so that you can move, modify, delete, or revert them, but you can also choose to lock them in place.
- Snap commands enable the reference points of a line, shape, or other object to align with the nearest guide, an intersection in a grid, or to the reference points of other shapes or objects.

Guides drawn at preset angles can be especially helpful in constructing isometric and oblique views. See pages 41–42 for these drawing types.

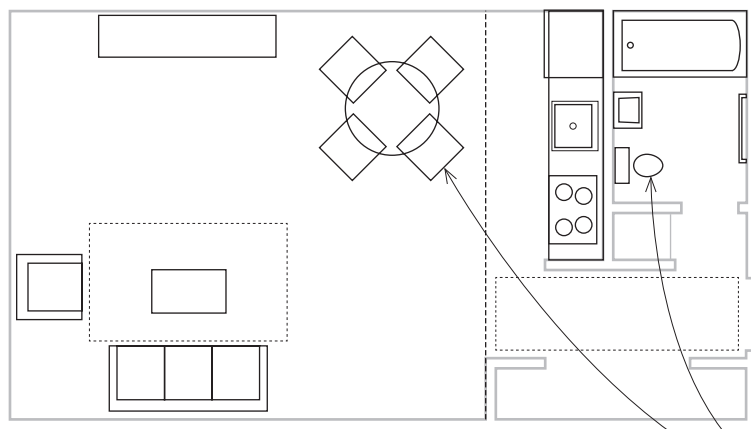
Smart Guides

Smart guides are temporary guides that appear when you create or manipulate lines, shapes, or other objects. They can:



- Maintain proportions when drawing or scaling shapes.

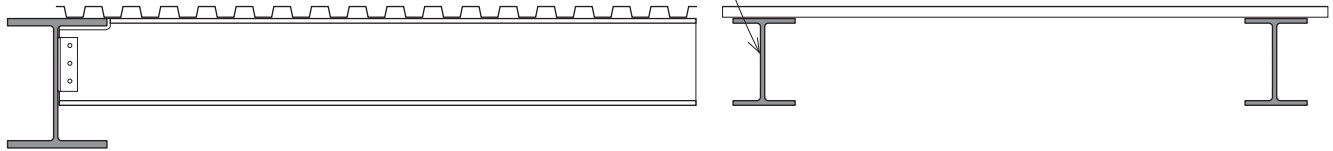
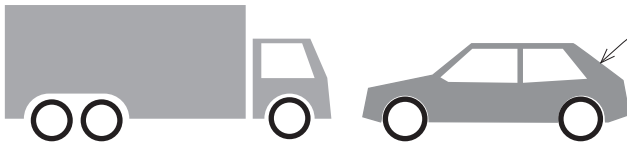
- Evenly distribute the centers and edges of digital objects.
- Constrain the movement of points and lines to a precise horizontal, vertical, or diagonal direction.
- Aid in aligning reference or anchor points of lines and shapes relative to those of an existing object.



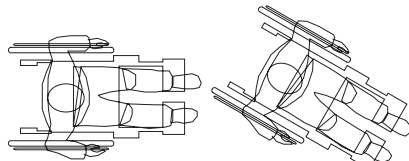
Digital Templates

2D drawing and computer-aided drafting (CAD) programs include digital templates of geometric shapes, furnishings, fixtures, as well as user-defined elements. Whether a template is physical or digital, its purpose remains the same—to save time when drawing repetitive elements.

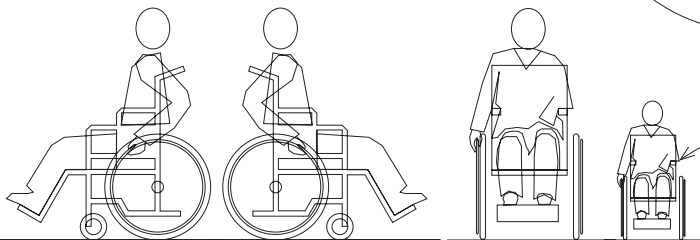
Digital template elements



Once placed, template elements can be manipulated—copied, scaled, rotated, or reflected—to satisfy the design task at hand.



- Copied
- Rotated



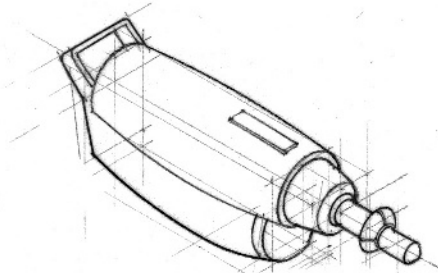
• Scaled

• Reflected

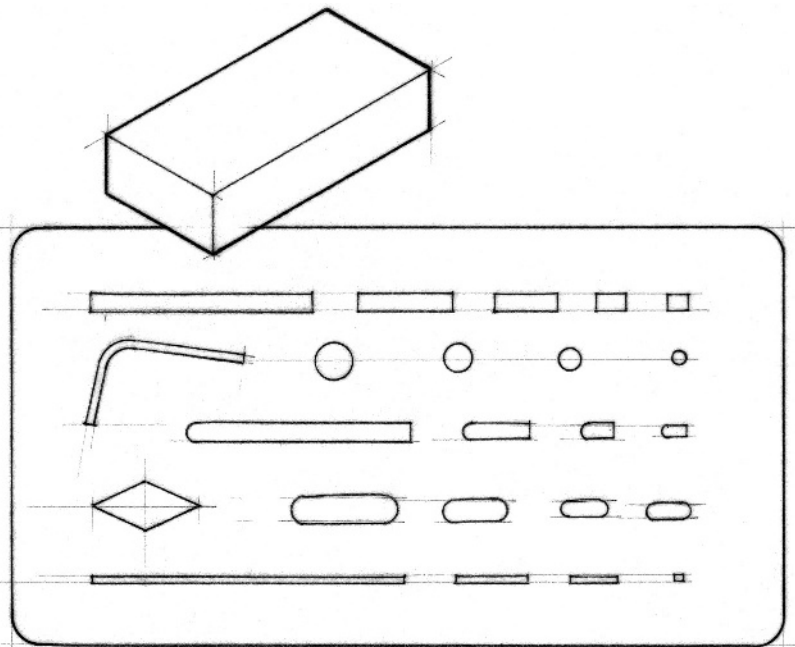
Erasers

One of the advantages of drawing with a pencil is the ability to easily erase pencil marks. Always use the softest eraser compatible with the medium and the drawing surface. Avoid using abrasive ink erasers.

- Vinyl plastic erasers are nonabrasive and will not smear or mar the drawing surface.
- Some erasers are saturated with erasing fluid to erase ink lines from paper and drafting films.
- Liquid erasing fluid removes pencil and ink markings from drafting film.



- Electric erasers are very convenient for erasing large areas and ink lines. Compact, battery-operated models are especially handy.

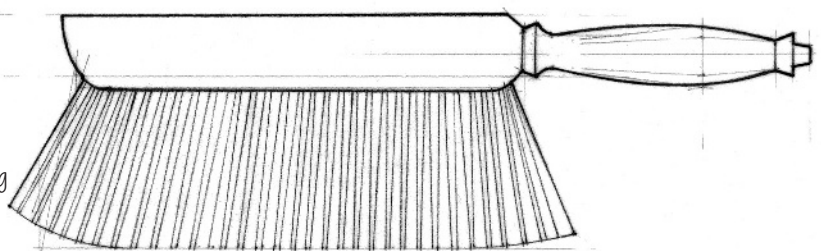


Erasing Shields

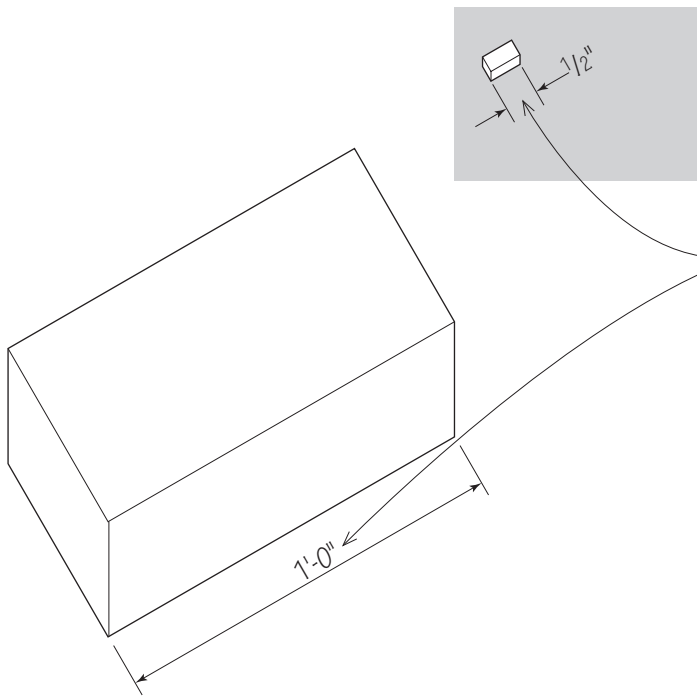
Erasing shields have cutouts of various shapes and sizes to confine the area of a drawing to be erased. These thin, stainless-steel shields are especially effective in protecting the drawing surface while using an electric eraser. Ones that have square-cut holes allow the erasure of precise areas of a drawing.

Other Aids

- Drafting brushes help keep the drawing surface clean of erasure fragments and other particles.
- Soft, granular drafting powder is available that provides a temporary protective coating over drawings during drafting, picks up pencil lead dust, and keeps the drawing surface clean. If used too heavily, the powder can cause lines to skip, so use sparingly, if at all.
- Pounce powder may be used to prepare drawing surfaces for inking.



DRAWING SCALES

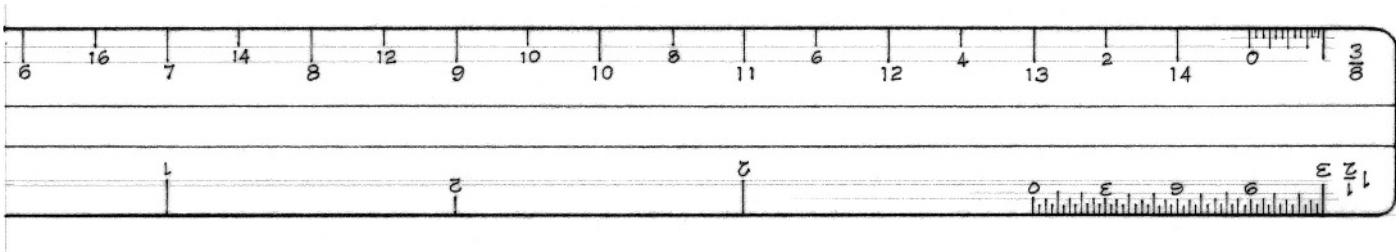


To construct an accurate representation of a design, we use a proportional measuring system. When we say a drawing is made to scale, we mean that all of its dimensions are related to the full-size object or construction it represents by a chosen ratio.

For example, when we draw at a scale of $1/2'' = 1'-0''$, each $1/2''$ in the drawing represents a foot in the full-size object or construction.

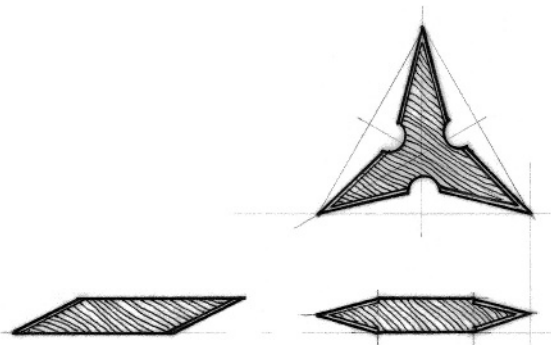
In a large-scale drawing, the size reduction is relatively small, while in a small-scale drawing, the size reduction is considerable.

Scale also applies to any of various instruments having one or more sets of precisely graduated and numbered spaces for measuring, reading, or transferring dimensions and distances in a drawing. There are three major types of drawing scales: architect's scales, engineer's scales, and metric scales.

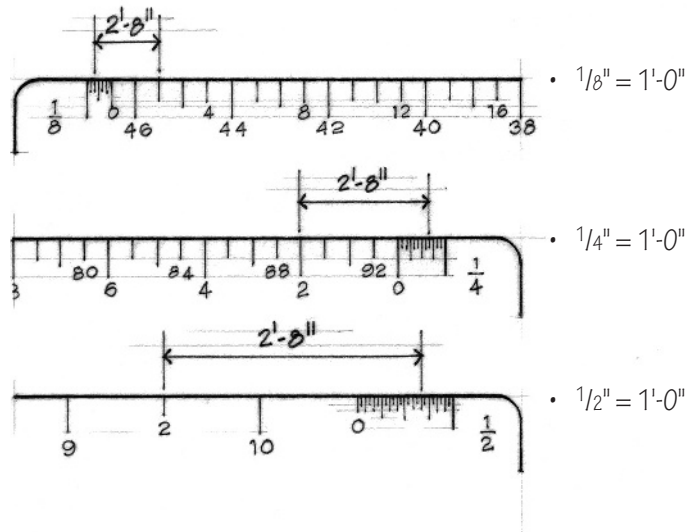


Architect's Scales

An architect's scale has graduations along its edges so that scale drawings can be measured directly in feet and inches.

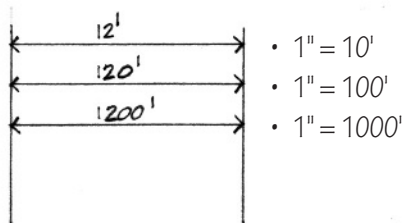


- Triangular scales have 6 sides with 11 scales, a full-size scale in $1/16''$ increment, as well as the following architectural scales: $3/32''$, $3/16''$, $1/8''$, $1/4''$, $1/2''$, $3/8''$, $3/4''$, $1''$, $1\ 1/2''$, and $3'' = 1'-0''$.
- Flat-beveled scales have either two sides with four scales or four sides with eight scales.
- Both 12" and 6" lengths are available.
- Scales should have precisely calibrated graduations and engraved, wear-resistant markings.
- Scales should not be used as a straightedge for drawing lines.



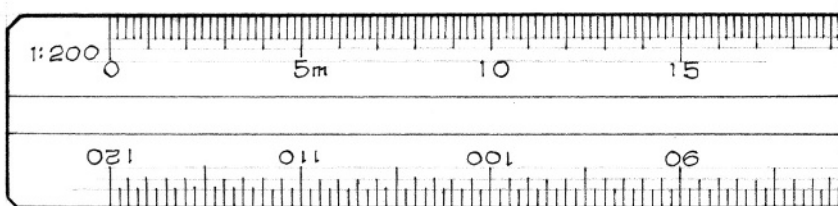
To read an architect's scale, use the part of scale graduated in whole feet and the division of a foot for increments smaller than a foot.

- The larger the scale of a drawing, the more information it can and should contain.



Engineer's Scales

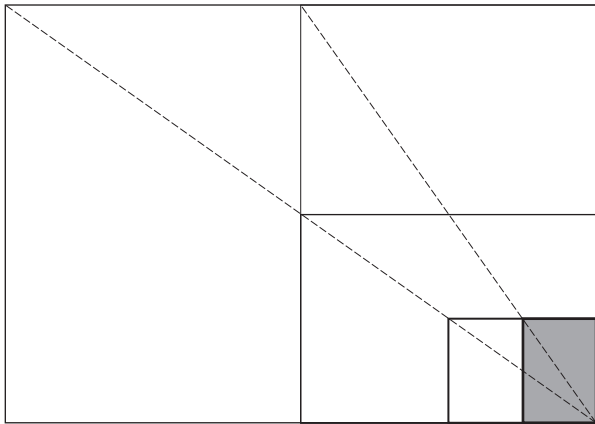
An engineer's scale has one or more sets of graduated and numbered spaces, each set being divided into 10, 20, 30, 40, 50, or 60 parts to the inch.



Metric Scales

Metric scales consist of one or more sets of graduated and numbered spaces, each set establishing a proportion of one millimeter to a specified number of millimeters.

- Common metric scales include the following:
 $1:5$, $1:50$, $1:500$, $1:10$, $1:100$, $1:1000$, $1:20$,
and $1:200$.



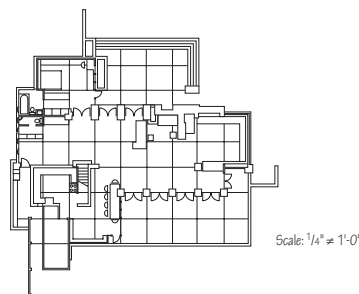
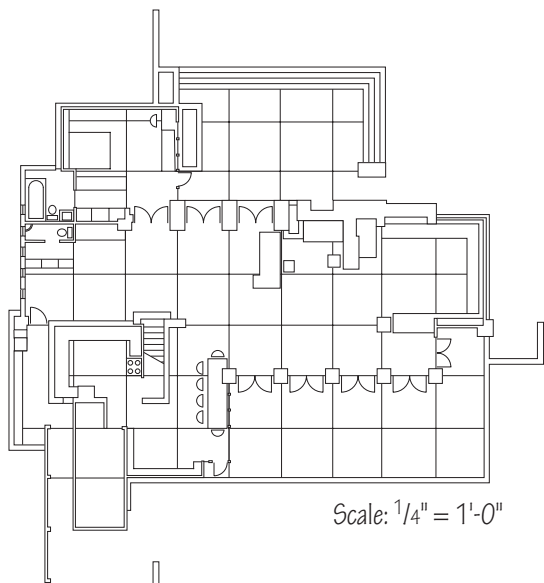
Digital Scale

In traditional hand-drafting, we think in real-world units and use scale to reduce drawings to a manageable size. In digital drawing, we actually input information in real-world units, but we must be mindful to distinguish between the size of the image viewed on a monitor and the scale of the output from a printer or plotter.

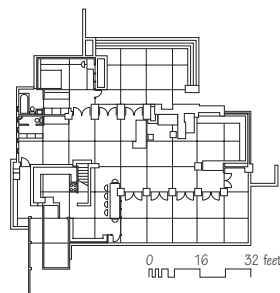
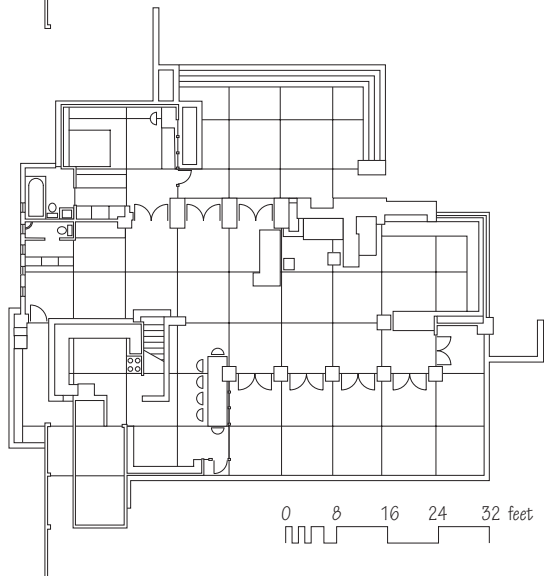
Screen Resolution

When creating images for on-screen display, we should be thinking in pixels per inch (PPI). Computer monitors typically display images at 72 or 96 PPI but high-resolution monitors may display more pixels per inch.

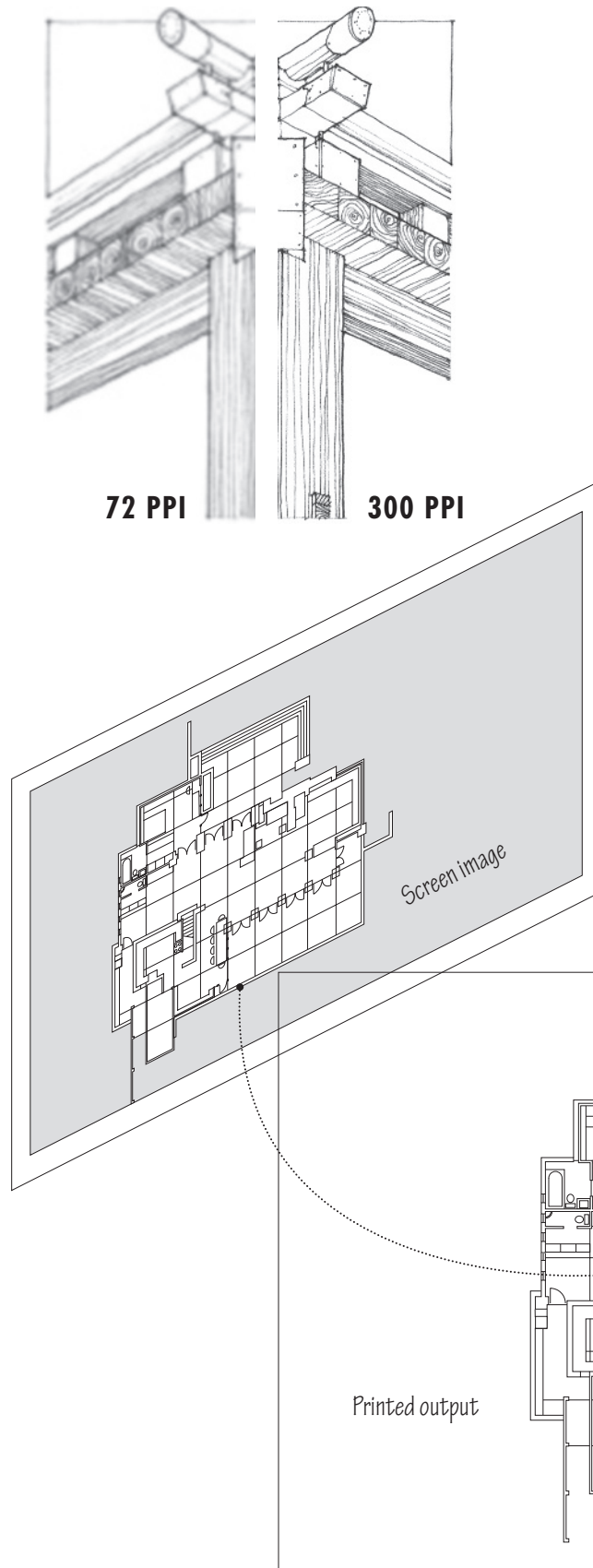
- Screen resolution affects the size of the images we see on a monitor. An image on a low-resolution monitor may appear larger than it would on a higher-resolution monitor because the same number of pixels are spread out over a larger area.



- When viewing a drawing on a monitor, numerical scales, such as $1/4'' = 1'-0''$ or $1/2'' = 1'-0''$, are not meaningful because the digital image can be easily reduced to view more context or enlarged to zoom in on details.



- Graphic scales are more useful because they are reduced and enlarged along with the drawings to which they refer.



Print Resolution

Print resolution, measured in dots per inch (DPI), refers to the dots of ink or toner a printer, plotter, or other printing device can place within an inch to output graphics and text. Most printers print the same number of dots horizontally and vertically. For example, a 600 DPI printer will place 600 tiny dots across one inch horizontally and 600 dots in a vertical inch.

- In general, the more dots per inch a printer is capable of outputting, the sharper and clearer the printed image. Correspondingly, the lower the DPI of a printer, the less fine detail it can print and the fewer shades of gray it can simulate.
- Because screen resolution is typically lower than print resolution, low-resolution images that look fine on-screen will almost always print poorly.
- It is important to check the scale of the output from a printer or plotter to ensure that any numerical scale used is correct.
- As is the case when viewing a drawing on screen, graphic scales will ensure that dimensions and other measurements can be made accurately on any printed output.

DRAWING SURFACES

The transparency of tracing papers and films makes them effective for overlay work, allowing us to copy or work on a drawing while seeing through to an underlying drawing.

Tracing Papers

Tracing papers are characterized by transparency, whiteness, and tooth or surface grain. Fine-tooth papers are generally better for inking, whereas medium-tooth papers are more suitable for pencil work.

Sketch-Grade Tracing Paper

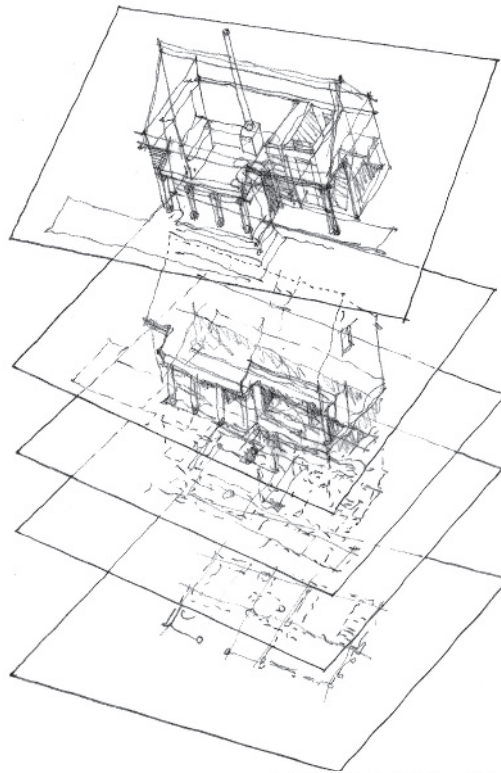
Inexpensive, lightweight tissue is available in white, cream, and yellow or buff colors in rolls 12", 18", 24", 30", and 36" wide. Lightweight trace is used for freehand sketching, overlays, and studies. Use only soft leads or markers; hard leads can tear the thin paper easily.

Vellum

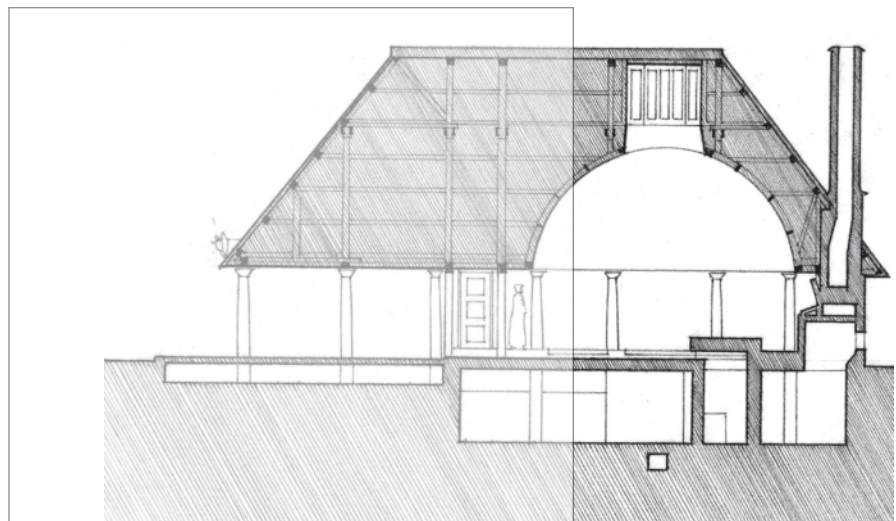
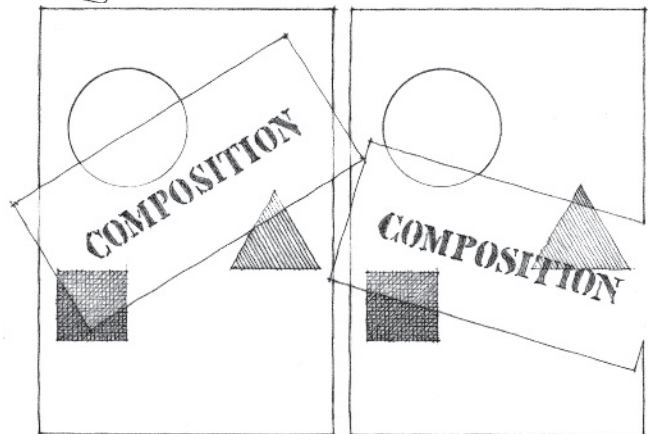
Vellum is available in rolls, pads, and individual sheets in 16, 20, and 24 lb. weights. While medium-weight 16 lb. vellum is used for general layouts and preliminary drawings, 20 lb. vellum with 100% rag content is a more stable and erasable paper used for finished drawings. Vellum is available with nonreproducible blue square grids, subdivided into 4 × 4, 5 × 5, 8 × 8, or 10 × 10 parts to the inch.

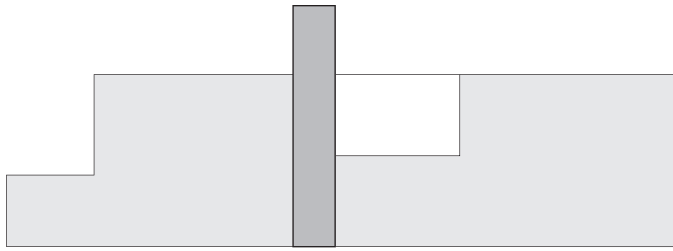
Drafting Film

Drafting film is a clear polyester film that is durable, dimensionally stable, and translucent enough for clear reproductions and overlay work. The film is 3–4 mil thick and available in rolls or cut sheets. One or both sides may have a nonglare, matte finish suitable for pencil or ink. Only compatible leads, inks, and erasers should be used. Ink lines are removable with erasing fluid or a vinyl eraser saturated with erasing fluid.

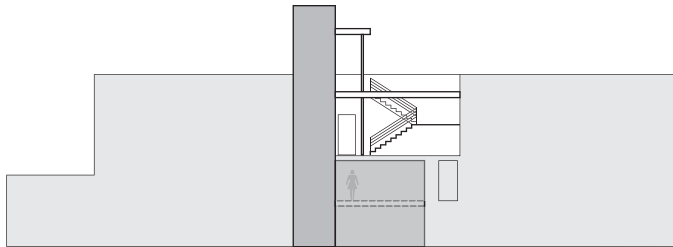


- Drafting tape or dots are required to fix a sheet of vellum or film to the drawing board. Do not use normal masking tape, which can tear the paper surface upon removal.

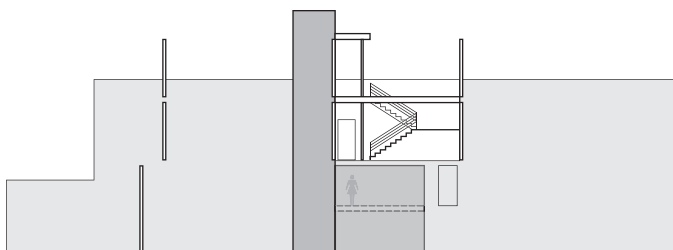




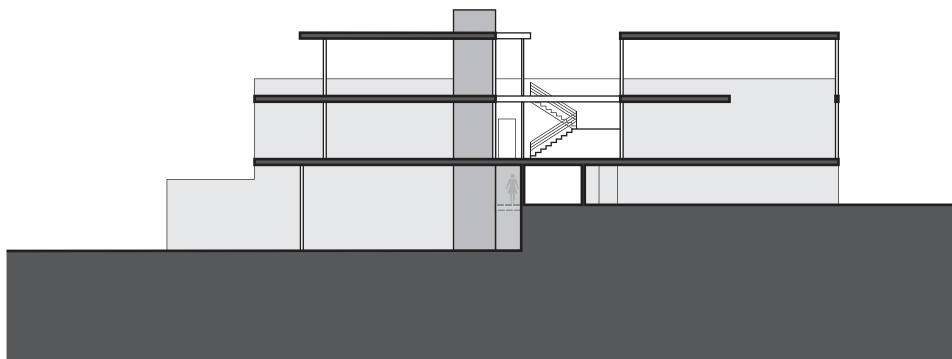
Layer 1



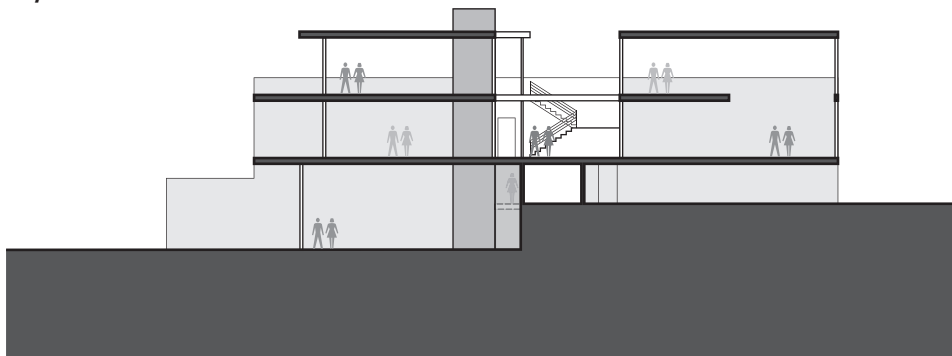
Layer 1 + 2



Layer 1 + 2 + 3



Layer 1 + 2 + 3 + 4



Layer 1 + 2 + 3 + 4 + 5

Digital Layers

CAD and 3D-modeling programs have the ability to organize sets of information in different layers. While these levels or categories can be thought of and used as the digital equivalent of tracing paper, they offer more possibilities for manipulating and editing the information they contain than do the physical layers of tracing paper. And once entered and stored, digital information is easier to copy, transfer, and share than traditional drawings.

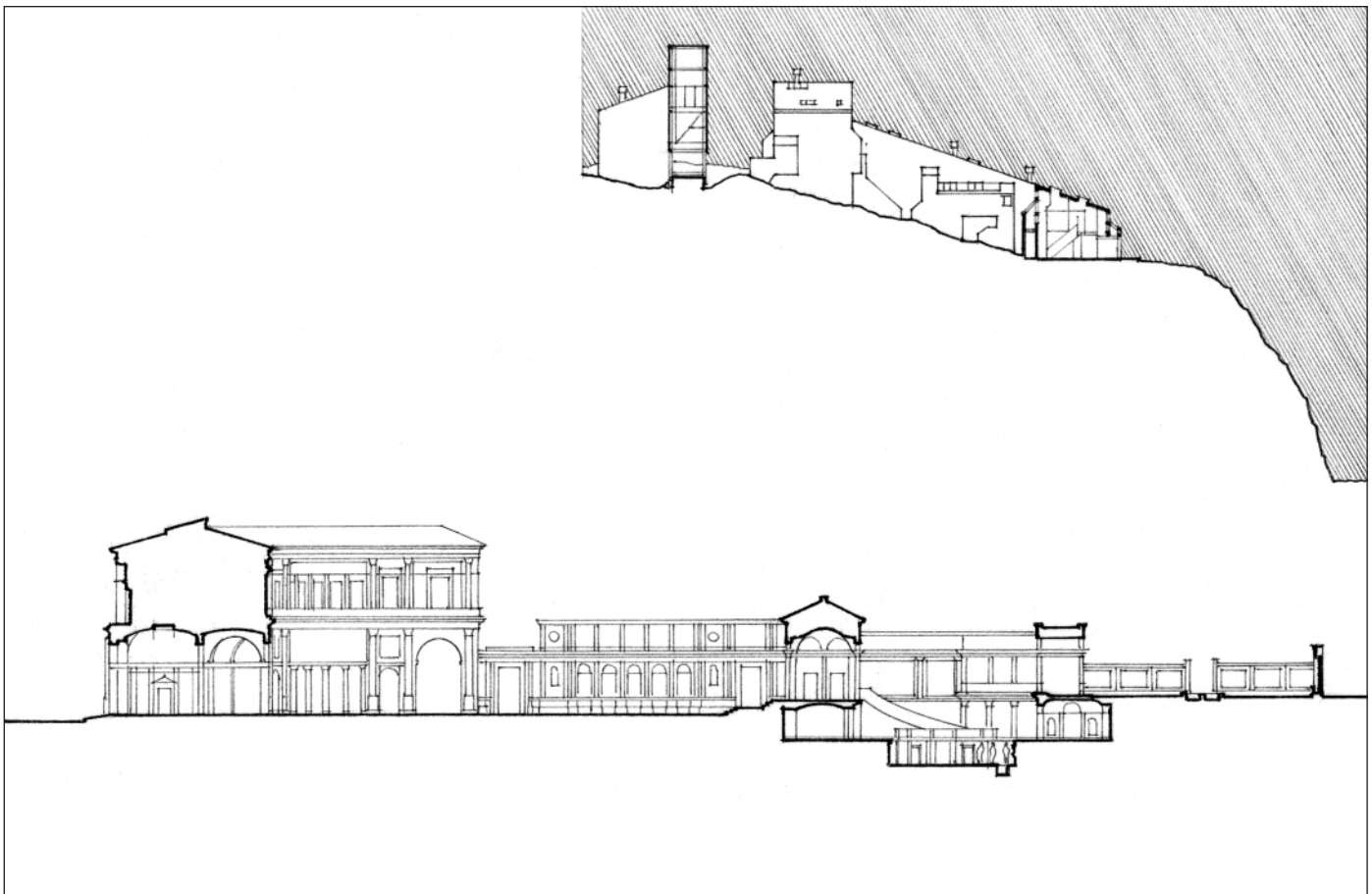


Illustration Boards

Illustration boards have a paper facing laminated to a cardboard backing. Illustration boards are available in single ($1/16''$) and double ($3/32''$) thicknesses. 100% rag paper facings are recommended for final presentations.

Coldpress boards have a degree of texture for pencil work; hotpress boards have relatively smooth surfaces more suitable for inking.

Some brands of illustration boards have white facing papers bonded to a middle core of white stock. Cut edges are therefore consistently white in color, making them useful for constructing architectural models.