Production Manual

UVA SCHOOL OF ARCHITECTURE

Production Manual
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University of Virginia
School of Architecture

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Contents

Introduction

This Manual

The Production Manual is intended to empower your creative process, serving as an initial guide and continuing reference for a variety of analog and digital working methods.

This resource covers introductory conceptual skills and technical knowledge including common representational conventions, best working practices, and foundational strategies to convey your design ideas while developing good working habits and time management skills.

Throughout the Production Manual, additional resources including suggested readings and QR codes linking to relevant videos and information from LinkedIn Learning, YouTube, and other sources supplement introductory instructions.

Like the continued development of this text, your design process and working methods will continue to evolve as you gain expertise and learn to employ your skills in an intentional way.

Drawing

Architectural Drawing

Why Draw?

Architectural drawing, whether analog or digital, is a fundamental skill in architectural design. It is both a process of observation and act of description. This kind of drawing, also referred to as drafting, is distinct from the sketch, which may be quickly rendered and may be less precise or variable in terms of how questions of scale and proportion are treated.

Regardless of the tools and processes used, architectural drawing allows architects to develop and think through their own ideas, to communicate designs to clients and collaborators, and to describe how buildings are to be physically constructed.

Understanding and consistently following foundational drafting conventions will assist you in clearly conveying your design ideas to others.

The following paragraphs discuss a selection of key terms and techniques in greater detail. Examples of student work are included alongside the text for reference.

Key Terms

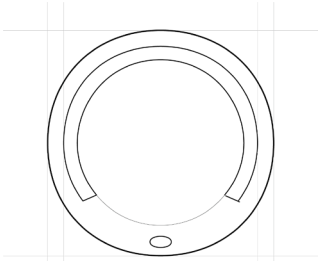
orthographic projection	a method for drawing of a three-dimensional object accurately on a two-dimensional surface, a parallel projection in which all the projection lines are orthogonal to the projection plane and all dimensions are accurately represented to a scale without foreshortening, typically referring to primary drawing views of plan, section, and elevation
plan	a drawing looking down on an object from above, can be a top view or a cut plan with a horizontal cutting plane
section	a drawing of a vertical cut through an object viewed horizontally
elevation	a drawing of the exterior of an object viewed from the side
axonometric projection	a drawing that shows a 3D view of an object in which the x, y, and z axis are all drawn to scale
ground plane	a representation of the surface or ground on which the object is placed or in which a building is embedded
lineweight	also referred to as "stroke", describes both the thickness and darkness of a line, 'heavier' lineweights are thicker/darker and convey information closer to the cutting plane, while 'lighter' lineweights are thinner/lighter and convey information further from the cutting plane
construction lines	also referred to as guidelines or regulating lines that extend across a page used as reference points for position and dimension between multiple elements or drawings
line type	the style of line in a drawing (continuous, dashed, etc.), different line types represent different information
cut plane	the supposed plane that cuts through an object to create a section or plan cut
composition	the way elements in a drawing are organized and arranged on a page together or the way a series of drawings are organized and arranged together

Orthographic Projection

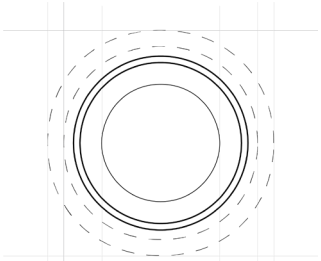
Orthographic drawing, while highly precise and information-rich, is also an abstraction. The horizontal and vertical planar 'cuts' that produce plans and sections rely on specific conventions to communicate conditions of solid, void, mass, and implied spatial depth. These conventions produce a graphic hierarchy, rendering spaces legible, despite the spatial compression and material occlusion produced by the orthographic projection.

Empty coffee cup in perspective

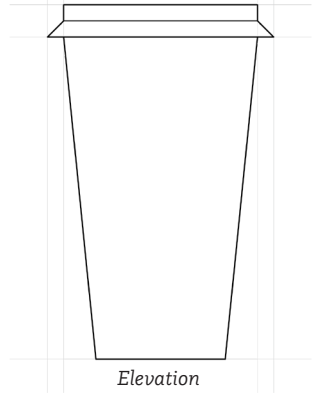
Orthographic projection provides a way to accurately draw three-dimensional objects through two-dimensional representation. An orthographic projection accurately maintains the dimensions and proportions of an object, meaning the drawing can be measured accurately to the dimensions of the object.



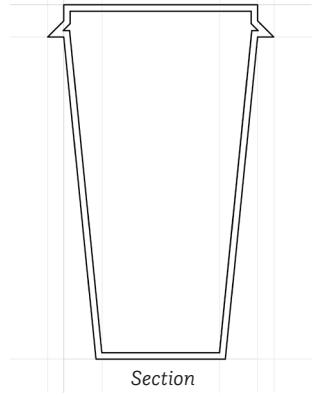
Plan (roof plan)



Plan (cut plan)



Elevation



Section

There is no foreshortening or perspective in an orthographic drawing. The most common types of orthographic projection used in architectural representation are plan, section, and elevation.

Plan describes a horizontal picture plane of an object or space, looking down from above. Plans can be simple top views, usually referred to as roof plans, or can be cut through an object in the same manner as a section while maintaining a horizontal view. Sections and elevations describe a vertical picture plane, viewing an object from the side. Elevations are side views of the exterior of an object or building, often from the front, back, left and right, or north, south, east and west elevations. A section is a cut through an object, showing interior spaces. When drawing a section, imagine a vertical plane cutting an object in two, then viewing into the object beyond the cutting plane (like slicing a pepper in half with a kitchen knife and looking inside).

The inherent abstraction of architectural drawing requires an equally necessary attention to specific conventions and notations that, while seemingly aesthetic or esoteric to the casual or untrained eye, are key to graphically communicating spatial hierarchy, functionality, solid/void conditions, or even materials and assemblies in plan, section, and elevation.

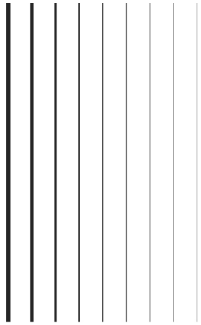
Controlling the "weight" or thickness of a line is the most common, and perhaps most important, method for establishing graphic hierarchy in a drawing.

Lineweight

Line or "stroke" weight refers to the thickness of a line in millimeters. For the purposes of hand drawing, mechanical pencils and drafting pens are available in a range of thicknesses.

The same convention has been adopted for CAD programs, which always included various methods for controlling the line thicknesses when printing, plotting, or rasterizing drawing output.

Specifying line weights within a drawing is a matter of calibration and there is no universal convention for doing so. However, many professional offices will designate internal graphic standards for their finished drawings, which include specifications for line weight, type, and color. Over time you will formulate your own set of graphic standards through experimentation, iteration, and feedback.



Lineweights

By convention the heaviest line weight in a drawing should be reserved for elements being cut in plan and section, including the line of the ground plane. Elements shown in profile, or of lesser importance will utilize a lighter line weight. You can include as many or as few distinct line weights as necessary in a drawing, but in general, designating a thin, medium, and heavy line weight within a single drawing will produce a clearly legible graphic hierarchy to help communicate the relative importance, properties, or spatial depth of orthographic elements in plan, section, or elevation.

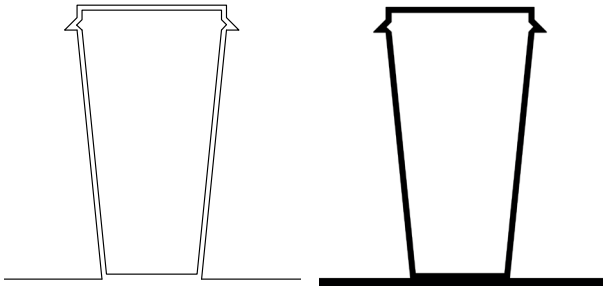
Drawings usually consist of multiple different lineweights, and allow description of depth within a 2D drawing. There are several lineweight conventions that allow drawings to be easily understood. Generally, lineweights can be described in a few categories listed below. As a guiding principle, decisions about lineweight always ultimately come down to making drawings that are as clearly legible as possible.

Section Lines

Section lines (also called 'section cut lines' or simply 'cut lines') are the heaviest lineweights in a drawing. They describe the edges of objects that intersect with the cutting plane in a section or cut plan. Sections lines can also be understood as the edge between solid material and void/space). This means that two section lines are needed to describe opposite faces of a wall, with the distance between them representing the thickness of the wall.

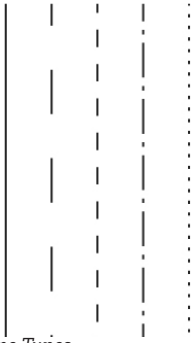
A specific kind of section line can be used to describe the ground plane. The ground plane is the line cutting through the ground on which an object rests or in which a building is embedded. This line represents the edge between solid earth below and open space and air above, and is sometimes slightly heavier than a typical section line to give the ground some extra visual weight.

When drawing a section through an object or assembly with multiple parts, such as a wall, multiple pieces of material are cut through. In certain drawings, such as technical construction drawings, it is important to draw all of the edges of each part of an assembly to understand how it is built. When describing architectural space, this information is usually unnecessary. Instead, a single section line can be used to describe the outermost edges of all the objects, as if they were glued together or made of a single material, including where a building connects to the ground. This means that the section line will clearly describe the edge between solid matter and inhabitable space.



Left: Sectional cut through coffee cup with ground plane; Right: Sectional cut through coffee cup with ground plan and poche

Sometimes you will see drawings in which the solid parts of a section cut are hatched with a pattern or solid color. This technique is called 'poche,' and is largely a stylistic choice — it is not necessary to describe a section cut. Very dark or black poche that obscures the legibility of adjacent lineweights should be avoided.

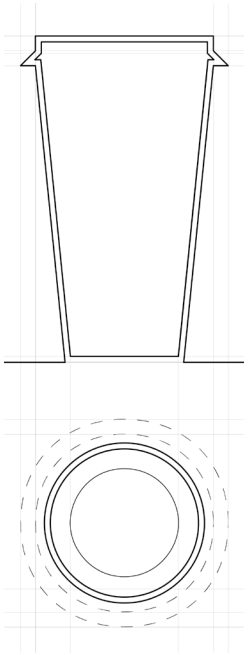


Line Types

Elevation Lines
Beyond the section cut, a range of elevational lines describe the edges of physical objects in the distance (horizontally in a section or below in a plan). Elevation lines are typically drawn in a hierarchy of lineweights calibrated to distance: closer objects are a heavier lineweight while more distant ones are lighter lineweight. This means that as elements become farther away, the lineweight decreases, but lines should always be drawn in a single lineweight, and not taper or fade along the length of a single line. All elevation lines should always be lighter than section lines so there is never any confusion about what is being cut through and what is being viewed in the distance.

Elevation lines can be further fine tuned by drawing finer details in lighter lineweights than larger volumes or surfaces. In elevation drawings, the ground plane is usually drawn as a section line, with a range of elevation lines describing all other parts of the drawing in the distance.

Construction Lines
Construction lines (also sometimes referred to as 'guidelines' or 'regulating lines') are the thinnest and lightest lines in a drawing. They do not represent physical objects, but instead project the edges of elements across a drawing. Construction lines are not limited to straight lines, but can be circular or curved in order to project non-linear edges into space. They are useful both for literally constructing a drawing, and for reading and understanding various alignments and dimensions in a drawing.



Construction lines are pulled from plan and section cut line in plan to draw dimensions in section.

Construction lines typically extend all the way across a drawing page, connecting multiple parts of a drawing or multiple different drawings to each other. These lines can be used as reference points for translating position and dimension between a plan and a section. Construction lines should be heavy enough that they are visible, but light enough that they are barely seen when viewing a drawing from a greater distance.

Testing Lineweights
When working on a drawing either by hand or on the computer, it is important to check that your range of lineweights is clearly legible in the way you intend. To test this, pin your drawing on the wall (with a test print if drawing digitally) and step back a few feet. Your drawing should be clearly legible from this distance. If you squint your eyes while looking at your drawing, the construction lines should disappear fist, followed by the elevation lines, until only the section lines are visible before you close your eyes. This quick test can help ensure that you have a clear hierarchy of lineweights.

Line Types
Line type describes the continuity of a line. Most lines are continuous lines, but dashed or dotted lines can also be used to describe different conditions. Like lineweights, there are certain conventions for line types that aid in legibility. Continuous or solid lines are used to show objects that are visible in a drawing. Dashed lines (or hidden lines) are used to show objects that exist behind or above the cutting plane. These are most commonly used to describe the edges of balconies, beams, or other protrusions occurring overhead if you were standing in a particular location in plan.

Dashed lines should only be used to draw critical elements — drawing all elements behind the cutting plane will reduce the clarity of the drawing. There are many other line types, but these typically symbolize specifics in construction drawings.

Constructing Multiple Orthographic Drawings

Once a plan, section, or elevation is drawn, construction lines can be used to facilitate other drawings without duplicating work and measurements. To do this, construction lines are used to translate dimensions and locations between points in different drawings. Construction lines will commonly be used to construct a vertical and horizontal grid that project edges of elements across the page. Construction lines are not limited to orthogonal orientations, and can also be drawn at different angles and are sometimes curved.

Most commonly, this will entail using a plan to construct a section, with a process as follows:

1. Start by drawing a construction line across the plan to represent where the cut is taking place. This marks your cutting plane.
2. Identify where you would like to draw your section, and draw a line parallel to the cutting plane. This will represent an abstracted flat ground plane.
3. Identify locations where lines in the plan intersect the cutting plane. At each of these locations, draw a construction line perpendicular to the cutting plane that extends across your section. This establishes horizontal relationships with the elements being cut through.
4. Offset the ground plane upward with a series of parallel lines. The distances between these lines should be measured to represent the vertical heights of elements in the section.
5. Once you have enough vertical and horizontal locations, begin delineating elements with section cut lineweights.
6. After the cut lines are established, use additional construction lines as needed to locate edges for elevation lines beyond the section cut.
7. Don't forget to draw your ground plane as an extension of the section cut lines.

It is important that sets of construction lines are drawn parallel to one another to maintain dimensional accuracy. If they are at an angle on the page, simply make sure that they are all drawn at the same angle when constructing a particular drawing. The angle pulled from one drawing to another is not arbitrary and must describe the orientation of a cutting plane or view being translated into a new orthographic projection. You can get creative with curving or concentric construction lines, as long as the distance between them does not change.

Composition

Since drawings are often constructed in relation to each other, their composition on a page should be considered. Following are some concepts to consider when laying out a drawing composition:

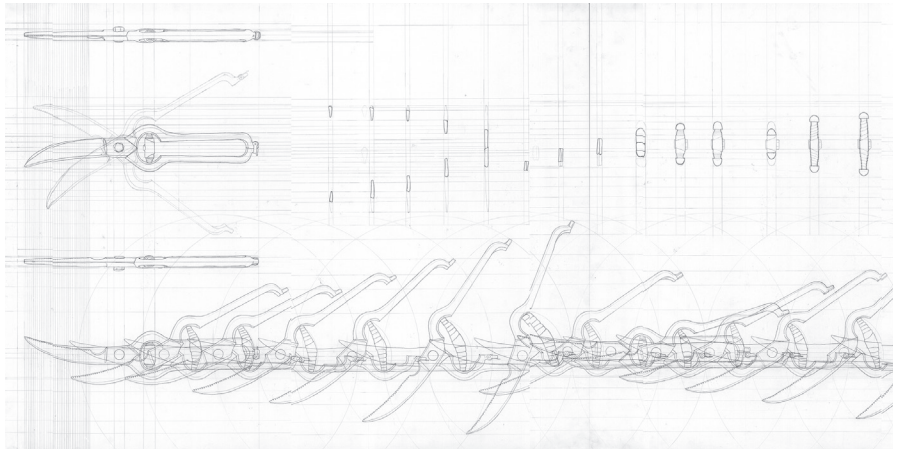
- A focal point (or points), are the primary subjects within a drawing. The viewer's eye is often drawn to and lingers on the focal point.
- Negative space, or the blank space on a page, can be very helpful to frame various elements or subjects. By leaving negative space on the page, more emphasis is brought to the subject and allows elements room to breathe.
- Contrast is the measure of difference between objects in a composition and can be shown through different lineweights, densities, scale, tone, and negative space.

Youtube: Quick Axonometric Tutorial

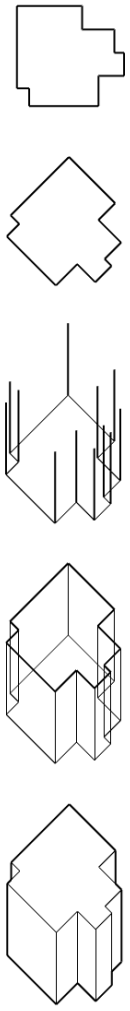
- Rhythm in a competition is a repetition of forms or drawings, such as a set of serial sections cut sequentially along the length of an object. Pattern and rhythm can emerge to create dynamic visual interest. Consider the spacing, density, and overlap to create rhythm and a sense of movement.
- Balance within a composition is constructed through a thoughtful choreography of these various compositional ideas.
- Finally, consider the clarity and legibility of your composition, and what it needs to convey to the viewer. Sometimes a single plan, section, or element needs to be closely read, and sometimes the relationships between parts or drawings are more important to convey ideas.

Axonometric Projection

Axonometry refers to a range of pictorial drawing conventions in which all parallel lines are represented as parallel. Like plan, section, and elevation, axonometric drawings are parallel projections that are dimensionally accurate without perspectival distortion. Axonometrics depict 3D views of an object in which the x, y, and z axis are all visible and drawn to scale. There are several types of axonometric projection, with the most common being the plan oblique axon (isometric is also commonly seen in digital modeling software). To construct a plan oblique axonometric:



Repetition and overlap create a sense of motion. Sections are aligned above elevations. Drawing by Elaine Cui, UVA SoA ARCH 1030.



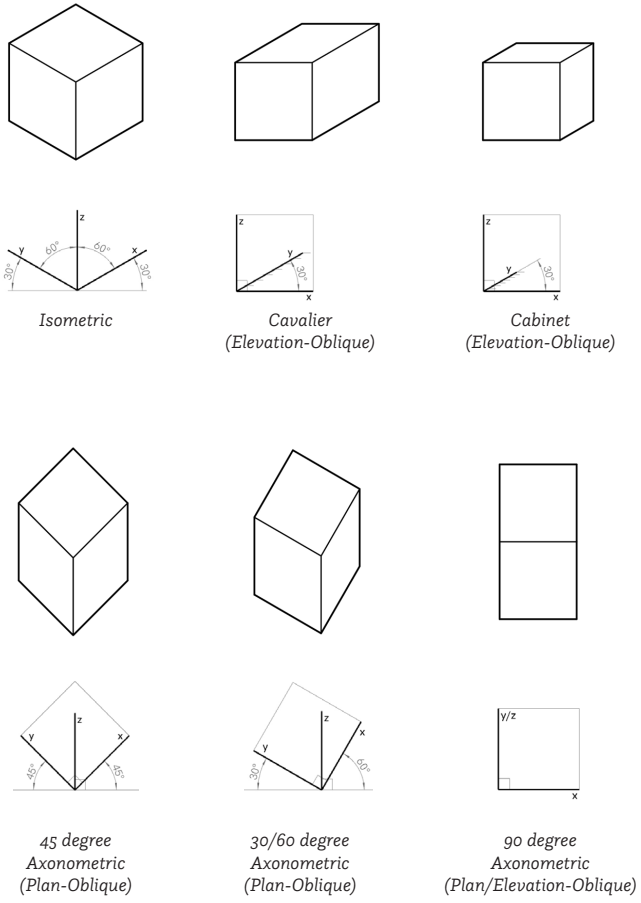
Constructing a plan oblique axonometric from a plan drawing.

1. Start with a plan drawing.
2. Rotate the plan to the desired angle (30, 45, and 60 degrees are most common, but any angle is possible).
3. Draw vertical lines up from the plan to construct the heights of various edges and surfaces. The length of each vertical line should be measured accurately to describe the height of the object it delineates.
4. Connect lines at the top where there are continuous edges in the object. If the top of a wall is horizontal, the top edge will be parallel to the bottom edge. If the top of a wall is inclined, the angle does not need to be measured and can be drawn by simply connecting the tops of the two measured vertical edges.
5. As you construct the axon with construction lines, begin to use elevation lineweights to describe the visible surfaces, since many edges will be located behind others in the view. In the above example, edges that cannot be seen in the view are removed entirely.
6. There are different approaches to lineweight in axons. One strategy is to scale lineweight with distance, as typical with elevation lines. The other is to scale lineweight with the depth of space the line describes: If there is a large change in depth from one side of the line to the other, the lineweight should be heavier. This

usually results in heavier lines around the top and side profiles of an object, heightening a sense of depth in the drawing. Ultimately, clarity and legibility of a drawing should drive decisions about lineweight.

Remember that in an axon, vertical edges of objects are always vertical lines on the page. Edges of an object that are parallel in space are always also parallel on the page, regardless of their orientation.

Practice sketching axonometric projections, as this is a fantastic way to quickly draw and think through form and space in 3D.



Isometric

Cavalier (Elevation-Oblique)

Cabinet (Elevation-Oblique)

45 degree Axonometric (Plan-Oblique)

30/60 degree Axonometric (Plan-Oblique)

90 degree Axonometric (Plan/Elevation-Oblique)

Common Axonometric Projections and Axes

Analog Drafting

Why Analog Draft?
Analog or hand drafting is essential to learning the key components of architectural drawing. Before computer-aided design software was introduced, all drafting was done by analog techniques. These techniques are important to understand how a drawing is set up and produced.

Tools
Drafting Board
Provides a smooth surface to mount drawing paper. If unavailable, a clean and smooth table or desk will suffice, as long as it has at least one or two straight edges. Any raised marks or bumps in the surface will impact linework in your drawing.

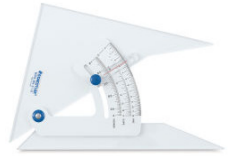
Drafting Tape
To mount your drawing paper. Sometimes found as drafting dots. In a pinch, other light tapes will work, but use caution to make sure your paper is not ripped upon removal.

Pencils
There are a few options for drafting pencils: traditional wood pencils; lead holders, which use 2mm lead; and mechanical drafting pencils, found in 0.3,0.5, 0.7, and 0.9mm lead sizes. A variety of lead hardnesses will help to achieve a range of lineweights. Typical lead hardness scale:
softest -> 4B, 2B, B, HB, H, 2H, 4H <- hardest

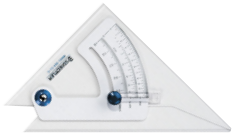
T-square

Pencil Sharpener
Used in the case of wood pencils, or a lead pointer in the case of lead holders. If using a non-mechanical pencil, you will need to sharpen frequently to maintain crisp and consistent lineweights.

Eraser
Any common pink, white, or black eraser should work. Kneaded erasers can be used to help clean up smudging.



T-square
Available in a variety of sizes and materials. Sometimes these include measurement marks, but this is unnecessary. Make sure the edges are smooth, as you will be drawing against these surfaces.



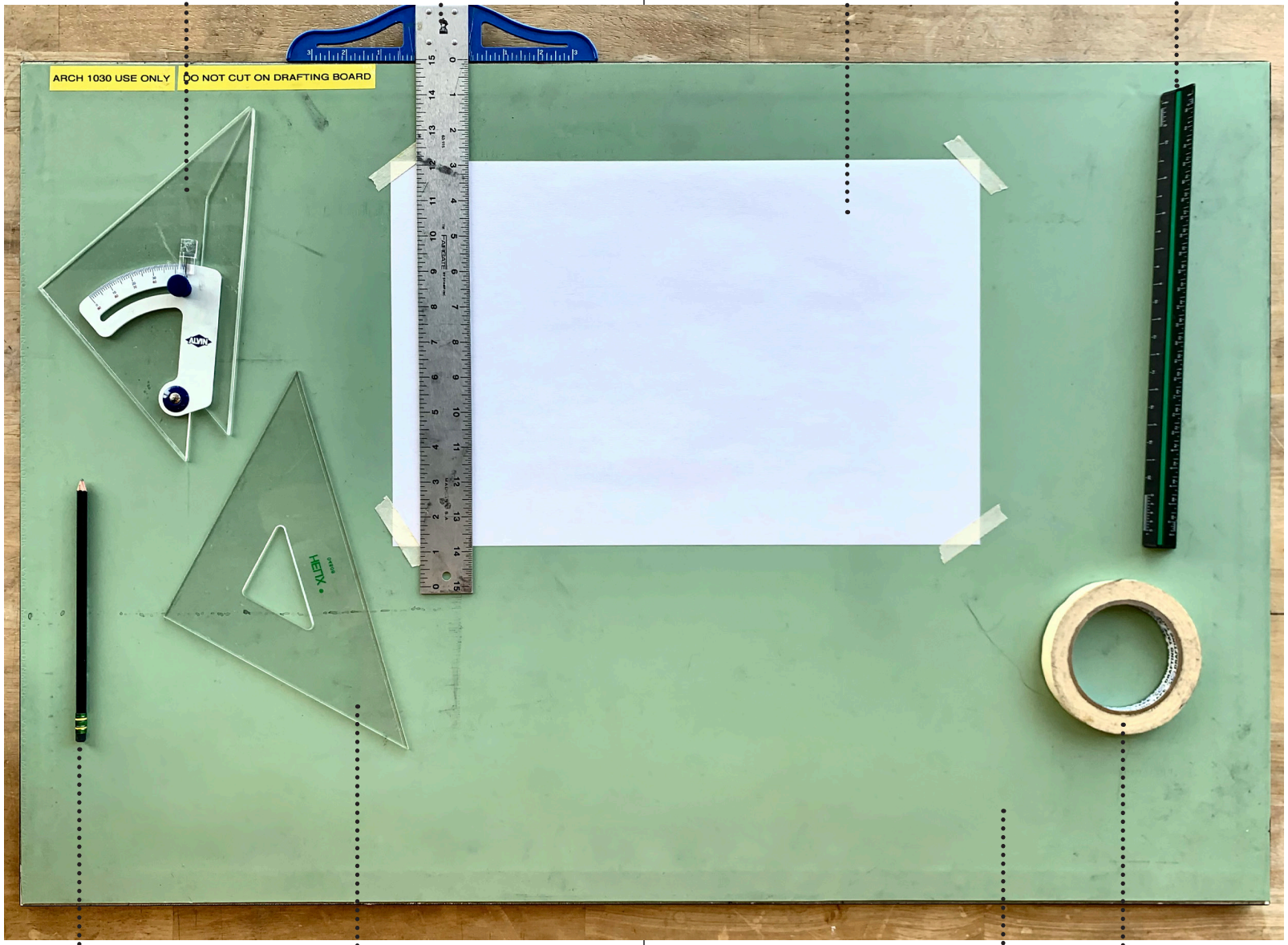
Drafting Triangles

Triangles
Used to create precise angled lines. Commonly available in 45-45-90 and 30-60-90, used to draw 45 degree and 30 or 60 degree lines, respectively. Adjustable triangles let you set a specific angle — they are typically expensive but extremely useful.

Architect's Scale

Architect's scale
An architect's scale is used to measure and draw accurately to scale. It typically looks like a triangular shaped ruler with several different measuring scales on each side. Make sure to use an architect's scale — engineer's scales look very similar but have entirely different measurement scales.

Compass
For drawing circles and arcs. If you plan on doing a lot of drawing, a nicer metal compass will be most reliable.



Adjustable Triangle

T-Square

Drawing Paper

Architect's Scale

Pencil

Triangle

Drafting Tape

Drafting Board

Analog drafting workspace and supplies.

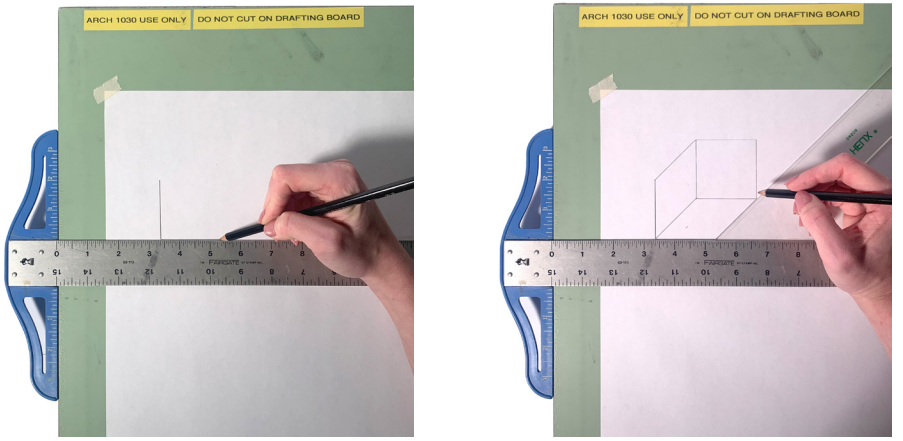
Drawing paper
Bristol and strathmore are common opaque papers, vellum and mylar are translucent papers. Usually a smoother paper is better. Beware of cold press paper, which usually has a lot of texture for other artistic media.

Drafting Preparation
You will need a clean, flat workspace to draft on. If a drafting board is unavailable, make sure your table or desk surface is clean and smooth, and that there are one or two straight edges upon which to slide your T-square.

Before you start a drawing, it is important to spend time planning out what you are going to do. This includes planning your sheet layout and size, including any margins. It helps to do some initial sketching in a sketchbook to have an idea of how you will construct your drawing composition.

Once you have a clean workspace and plan for your drawing, you will need to tape down your paper. First, align your paper with the drafting board using a T-square pressed firmly against the side of the board. The edge of your paper should be parallel to your drafting board. Apply drafting tape or dots to each corner to prevent the paper from moving as you draw. Now you are ready to begin drawing, first with a series of construction lines to locate the primary elements in your drawing.

Drafting Techniques
When drafting, it is important to draw all lines with the pencil against the edge of a tool (usually a T-square or triangle). Highly irregular non-linear lines sometimes require freehand drawing, but care should be taken to keep a controlled and consistent lineweight.



Left: Use T-square for accurate vertical and horizontal lines; Right: Use triangle with a T-square for accurate angled lines.

To draw a line, hold your drawing tool firmly against the paper so it does not slip, and drag your pencil along its edge. Apply even and consistent pressure to control your lineweight, and try to draw the line in a single stroke. The heavier you want to make a lineweight, the more pressure should be applied to the pencil when drawing. For a lighter lineweight, apply lighter pressure. Try not to change the angle of your pencil, as this can push your line in and out from your straightedge. A slight twisting motion of the pencil while drawing can help to maintain a consistent lineweight.

Horizontal and vertical lines can be drawn directly against a T-square against the edge of the drafting board. The 'T' top of the T-square is always placed on the edge of the drafting board to prevent angular movement and gives you the ability to slide it up and down or across the drawing. Angled lines should be drawn against a triangle that is resting against the T-square. It is very important to hold all drafting tools firmly against each other while drawing so they do not shift.

Lineweights

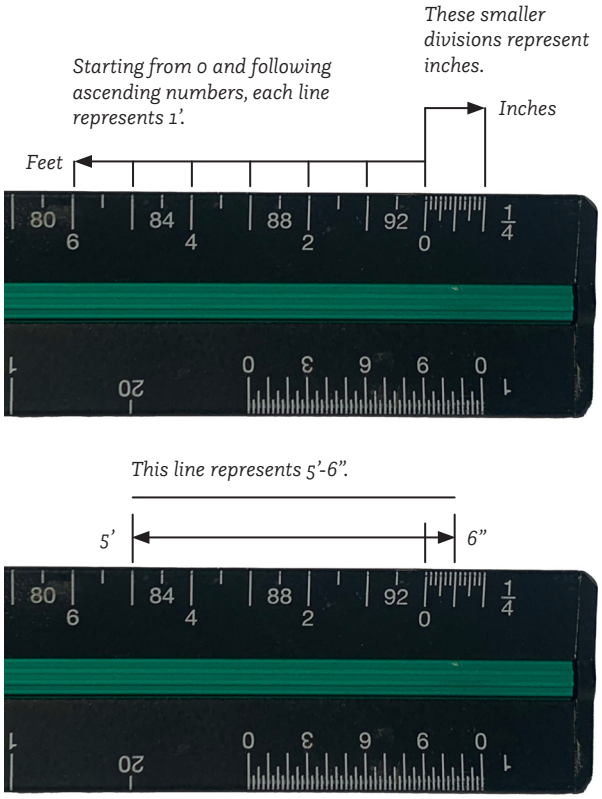
Lineweights are key in creating legible drawings that clearly describe three-dimensional space. When drafting with a pencil, having a few different grades of lead is needed to create a range of lineweights. Remember that H grades are harder leads while B grades are softer. Higher numbers denote more extreme hardness or softness. Harder leads make lighter lines. Softer leads make darker lines, but need to be sharpened more frequently and are more likely to smudge as you continue drawing.

Typically, 4H or 2H leads are used for construction lines. Elevation lines are usually drawn with H, HB, or B leads, depending on preference and how much pressure is applied. HB lead is roughly equivalent to a standard #2 pencil. Section lines are best drawn with a softer B or 2B lead. They will smudge easily, so take care not to rub hands or tools over the lines, and make sure your sharpen your pencil frequently to keep lineweights consistent.

Scale

We use different architectural scales to be able to accurately represent large objects through drawings that are proportional and measurable at a much smaller size. If you are drafting in a 1:1 scale, this means your drawings will be to the actual dimensions of whatever you are representing. There are many scales used in the architecture and engineering fields. Architectural scales in the United States use imperial units. Common imperial architectural scales, from smallest to largest, include:

1/16” = 1-’0”
1/8” = 1’-0”
1/4” = 1’-0”
1/2” = 1’-0”
1” = 1’-0”
3” = 1’-0”



Using an architect’s scale to measure and draw at a scale of 1/4”=1’-0”.

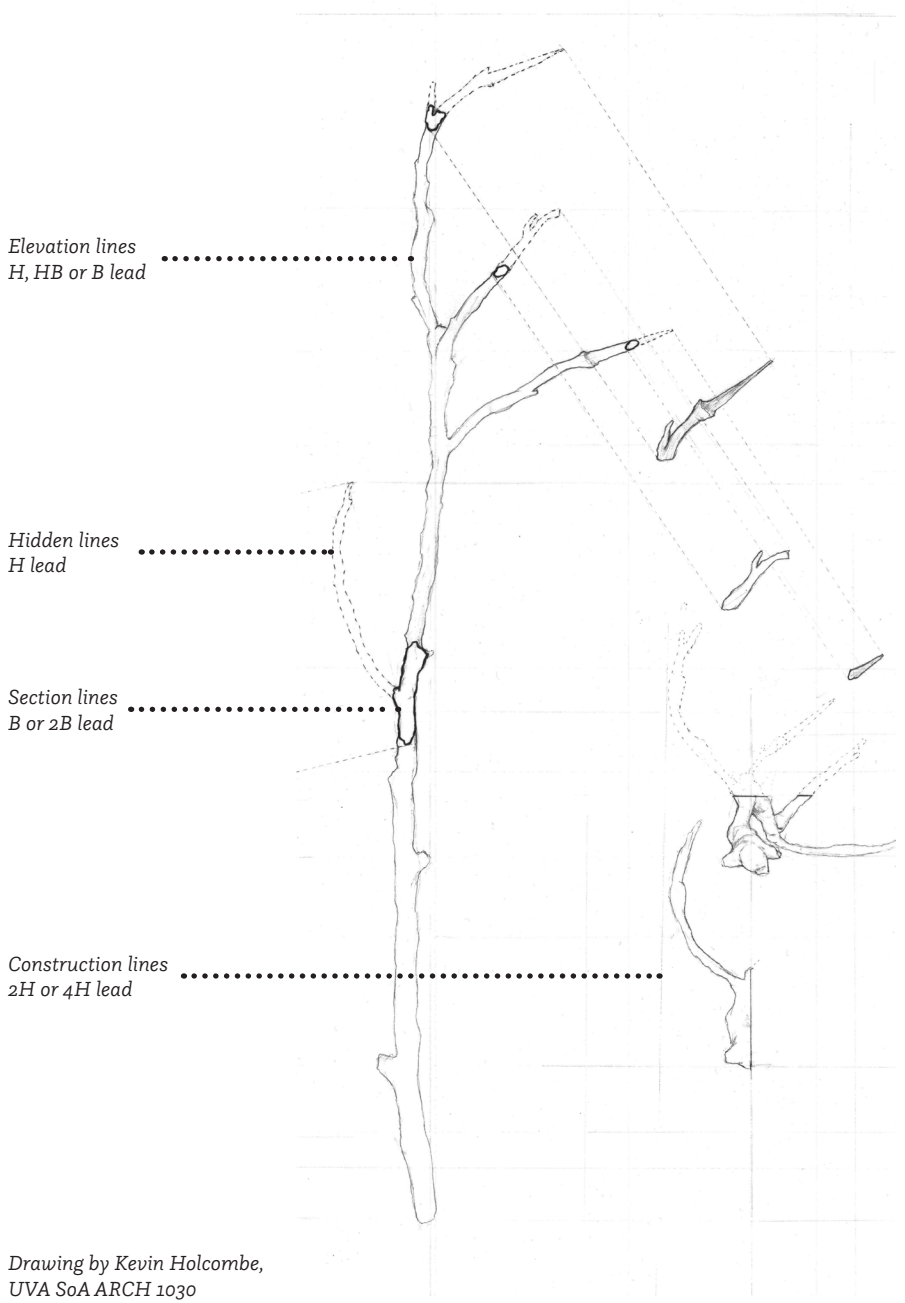
Drawing at a scale of 1/4” = 1-’0” means that every 1/4” in the drawing represents 1’ in real life. It would follow that 1”, or 4/4” in the drawing represents 4’ in real life, etc.

Using a Scale

Your architect’s scale is a wonderful tool to quickly draw and measure to scale without having to do any math or convert numbers in your head. Architect’s scales have several standard scales located on different edges, often with one scale read left to right and another read right to left. When using a scale, you will start measuring at zero and follow the ascending numbers to measure feet. Before the zero on the scale, there are a series of smaller lines — each of these lines represents one inch.

Cleanliness

Keeping drawings clean takes care and patience. Make sure your workstation and hands are clean before touching your paper. If you get graphite on your hands or drawing tools, make sure to wash immediately to prevent smudging. Drawing lines first as construction lines will help you to make sure that you are committing to heavier lineweights once you are sure of a line's location. This will mean you can minimize erasing in your drafting process.



Drawing by Kevin Holcombe, UVA SoA ARCH 1030

Computer Aided Drafting

Why Computer Aided Drafting?

Computer aided drafting (CAD) has been the predominant medium for the production of architectural drawings since at least the beginning of this century. Use of any computer aided drafting software requires an understanding of analog methods as many of the tools and functions used in design software are based directly or conceptually on analog tools and techniques used for on-site measurement, construction, or fabrication. The digital medium has also produced its own new methods for measuring, drawing, and modeling geometric forms which are based largely or entirely on the logic of computation rather than physical/ gestural/ mechanical analogs.

Which Program Should I Use?

The following section outlines tools and techniques for drafting using a digital, CAD-based process. While the tools and techniques are specific to digital drafting in AutoCAD and Rhino, the same processes would apply when using other CAD related software. Understanding the strengths and weaknesses of each program will help you better understand when to use them and how to best incorporate them into your design process.

Key Terms

AutoCAD	a 2D and 3D computer-aided design and drafting software developed by Autodesk
Rhino	a 2D and 3D computer-aided design software developed by Robert McNeel & Associates
viewport	a window on screen that displays a specific view
units	property of measurement in a drawing or model, typically referring to digital workspaces
layer	a system of organizing objects and lineweight in digital software
command	terms that are used to direct drawing and editing operations in command based softwares like AutoCAD and Rhino
template	a file with preset settings, styles and layouts
model space	infinite workspace in digital drafting and modeling software
paper space	in AutoCAD, where the scaled version of a drawing is placed to simulate the actual piece of paper it will be printed on.
layout	in Rhino, where views of a model or drawing are placed at different scales to simulate a printed document(s)
detail	in Rhino, the view of a model or drawing within a layout
scale	a way of representing large objects in a smaller size that is still measurable and accurate
plot	refers to both a large scale print and a command for exporting and printing drawings

Digital Tools
The tools listed below are aids to manage the precision and tolerance of orthographic line drawings.

Operating System
The following examples are specific to Rhinoceros 3D (Rhino) and AutoCAD, but are largely standard features for most drafting or design programs.

Mouse
Like several other design programs, a computer mouse is absolutely necessary to properly use AutoCAD or Rhino. The program will function without one, but navigating a model will prove difficult and time intensive. Wired and wireless mice both work well, and a center scroll wheel will save you a lot of time in zooming in and out. Just use a mouse.

Getting Started

Start a new file. Name and save following the suggested File Management conventions found in the Documentation section of this manual.

Model Space vs Paper Space
Model space is where you are working at full scale and in some programs, where you are actively manipulating a design model in three dimensions. Layout space is where you can specify 2D drawings or views for printing at specific architectural scales.

Using Layouts
Layouts in Rhino or AutoCAD are used when you want to preserve the scale, view and view extents of a particular drawing to export as a PDF or raster image. The Layout space is also where drawing annotations, dimensions, scales, and other architectural symbols can be added to the drawing and can remain separate from the model space. Layouts can be used to output individual drawings to be used later in a program like Adobe InDesign, or can be composed within the layout itself to show multiple details and views of your drawings or digital models.

The real benefit of using a Layout is that it allows for the testing and calibration of line weights, types, and colors. Once established, these settings will allow you to focus on the drawing itself by simplifying the process of editing, testing, and outputting drawings.

Unit Settings
When first opening Rhino or AutoCAD, you will be prompted to determine whether your model space is based on Metric (meters and millimeters) or US Imperial dimensions (feet and inches). In general, projects constructed outside of the United States, use metric units. Canada, although officially a metric country, has a mixed system, sometimes using metric and sometimes using U.S. imperial for projects.

In drafting and modeling programs like Rhino and AutoCAD there are pre-set model-space templates for both systems. It is also possible to change the model space units of a working file at any time.

What Unit Should You Draw In?
In general, it is recommended that you choose a unit appropriate to the smallest level of detail or tolerance you want to draw at. When drawing a site-scale plan, for example, you may choose to work in meters or feet. When drawing at the architectural scale, it may be easier to work in increments of inches or millimeters, although this is a matter of preference.

Tools & Best Practices: AutoCAD

Why AutoCAD?

AutoCAD is a recommended software program for digitally developing and exporting 2D drawings as it has several functions that make it easier to visualize and control lineweights and layouts. Drawings can be constructed entirely in AutoCAD, or base linework can be exported from Rhino as a .dwg file and opened or inserted into AutoCAD. Unlike post-processing drawings in Illustrator, AutoCAD is a fully functional drafting program, so lineweights can be set throughout the process and drawings can continue to be developed. Exporting or printing a drawing for a desk crit is one command away, encouraging iteration and saving you a lot of time in your workflow.

Program Download

AutoCAD is free for students by creating an Autodesk educational account with your university email at: https://www.autodesk.com/education

Several years of AutoCAD will be available. The most recent year is recommended, but any should work for most applications. Some versions may include a 'Produced by an Autodesk educational product' label when exporting drawings. If this label does appear, it can be easily deleted in Adobe Acrobat when viewing your exported PDF.

Operating System

The examples presented here are shown in Autodesk AutoCAD for Windows. AutoCAD is also available for macOS, but was initially developed and for many years was only available for Windows. The interface and location of some commands and settings will be different on macOS, but the concepts are all the same. It is recommended that you use AutoCAD for Windows, for ease of use working between programs.

Commands

AutoCAD functions with toolbar buttons to activate commands, but also a command prompt (along the bottom of the screen by default) to type commands. Toolbars are helpful to find new command and learn them, but typing commands will prove the fastest, so it is recommended to try this mode of working from the beginning.

Workspace

Viewports

AutoCAD as a 2D drawing program works exclusively in the default top view. This one viewport fills the entire screen and is the only view you will need while drafting.

Workspace Appearance Settings

It is helpful to customize AutoCAD's default visualization settings to suit your preferences, and to have drawings look closer to their finished state while drafting. Most settings can be changed with the preferences command, which will open the AutoCAD Options dialog box, accessed by typing the *Options* command and pressing *Enter*.

LinkedIn Learning: The AutoCAD 2023 Interface

Drafting Commands *(Bold letters indicate shortest keystrokes)*

Utilities

Units	Sets the display formats for coordinates, distances and angles.
Pan	Pans the drawing.
Properties	Opens properties panel.
Layer	Opens layer properties panel.
MView	Creates and controls layout viewports.
Plot	Plots a drawing to a plotter, printer, or file.

Creating

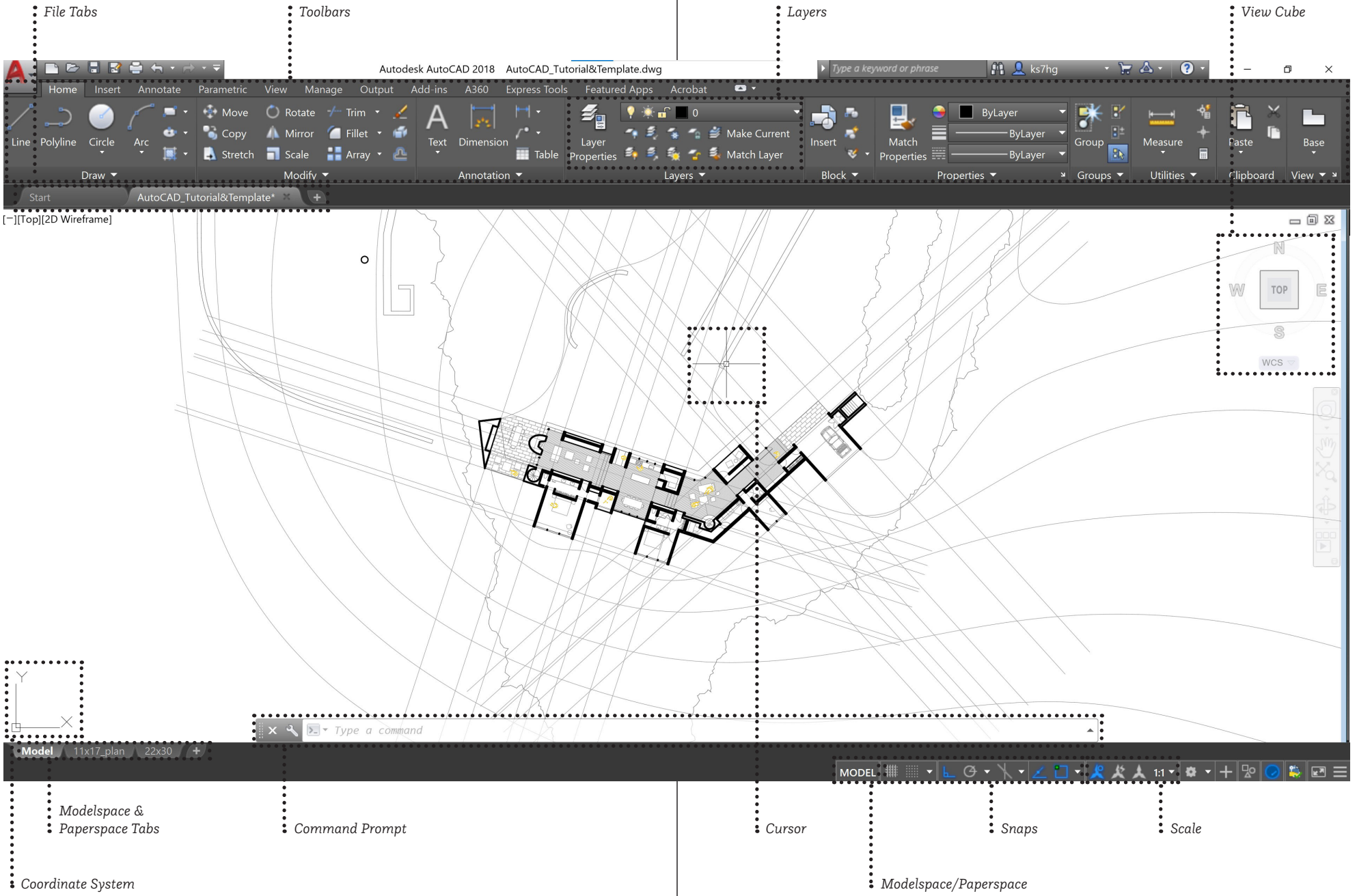
Line	Creates a line with two points.
Pline	Creates a line/curve with multiple points.
Rectangle	Creates a rectangle with specified length and width.
Circle	Creates a circle from specified radius.
Ellipse	Creates an ellipse from length and width radius.
Polygon	Creates a polygon with specified number of sides.
Arc	Creates an arc from a combination of points.

Editing

Move	Move selected objects.
Copy	Copy selected objects.
Trim	Trim lines from selected cutting boundaries.
Extend	Extend lines to a selected boundary.
Scale	Scale selected objects.
Rotate	Rotate selected objects.
Mirror	Mirror selected objects.
Offset	Offset selected lines a specified distance.
Array	Creates an array of selected object.
Join	Joins lines together.
Hatch	Hatches a pattern in a closed area.
Pedit	Edit single/multiple polylines.
E**x**plode	Explodes a polyline into segments.
Group	Creates a set of objects that will be selected as one.
Ungroup	Makes group of objects individual objects again.
Qselect	Creates a selection set by filtering object type and property.

Best Practices

Purge	Removes unused items (layers, blocks etc.) from drawing.
Overkill	Removes duplicate/overlapping lines.
Matchprop	Applies properties of a selected object to other objects.
Redr**a**w	Refreshes display in all viewports.
Regen	Regenerates the drawing from within the current viewport.
Attach	Inserts references to external files.



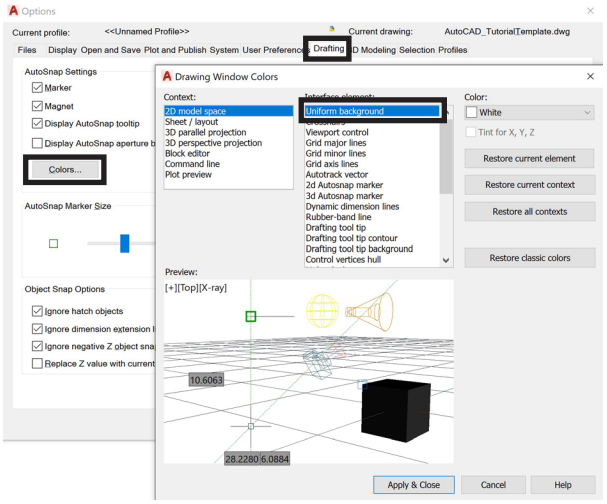
AutoCAD Modelspace Workspace.

In *Options>Drafting>AutoSnap Settings>Colors...* you can change the Uniform Background color to white. This is recommended so that drawings will look as close as possible to their printed state on white paper while drafting.

In *Options>UserPreferences>Windows Standard Behavior>Right-click Customization...* find and check the box for Turn on time-sensitive right-click. This will mean that right-click will automatically begin enter into the most recently used command. This makes it very fast to quickly repeat a certain command many times. Holding *right-click* for a few seconds will still open the normal *right-click* drop-down menu.

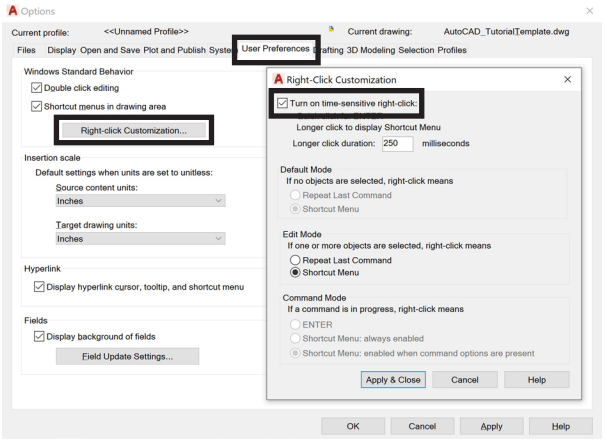
Units

When opening a new file in AutoCAD, you will be given the option to select a template. The default "acad" template will do, and should automatically set your file units to inches. If you need to work in metric, the "acadiso" template will set your units to millimeters.



Options>
Drafting>
AutoSnap Settings>
Colors...

LinkedIn Learning: Working with Pallets and Dialog Boxes



Options>
User Preferences>
Windows Standard Behavior>
Right-click Customization...

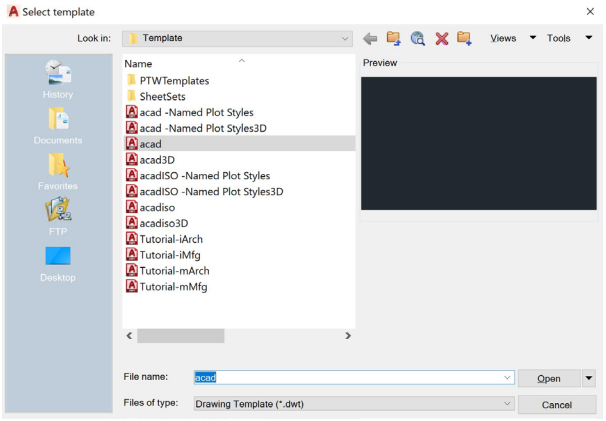
You can change how units are visualized (decimal, fraction, etc.) using the units command.

Drawings in AutoCAD are usually drafted at full scale, meaning that a 3' hallway will measure 3' in AutoCAD when measured with the distance command. This makes it easy to think about the actual size of your design and to input the real world dimensions when drawing. Drawings can be scaled to a specific architectural scale when exporting, which will be discussed in detail below.

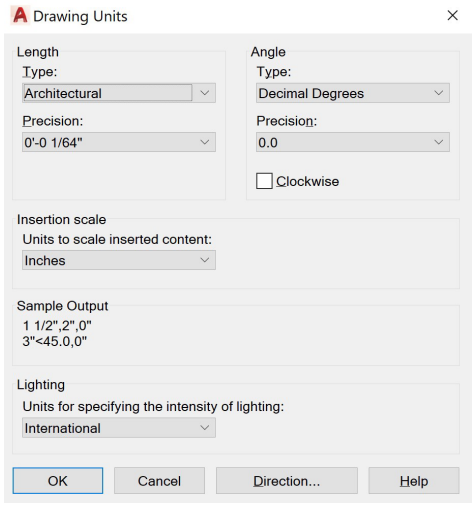
Model Navigation

Your model can be navigated using commands, but it is best to learn to do this quickly with your mouse and a few keyboard shortcuts:

Pan: *mouse wheel click+drag*
Zoom: *mouse wheel scroll*



Default Templates.



Units menu.

Mouse wheel click+shift+drag will orbit the viewport into 3D view. If this happens by accident, you can use the View Cube on the screen to navigate back to top view.

Selecting Objects

Objects in your model can be selected by *left-clicking*. If objects are closely overlapping, AutoCAD will select the top object.
Left-clicking on the screen but not on an object will mark the corner of a selection box that will be closed by left-clicking again. Clicking to the right will produce a blue selection box with a solid line edge, and only objects entirely inside the selection box will be selected. Clicking to the left will produce a green selection box with a dashed line edge, which will also include any objects partially inside the selection box.

Left-click+drag is used to freeform select (lasso) an area, and the same rules for dragging to the right or left apply.

LinkedIn Learning: Setting Drawing Units

LinkedIn Learning: Using Zoom and Pan

Layers & Lineweights

Layers

Like many other design programs, AutoCAD functions with a series of layers in which various objects are created. In AutoCAD, layers can be used strategically to set lineweights.

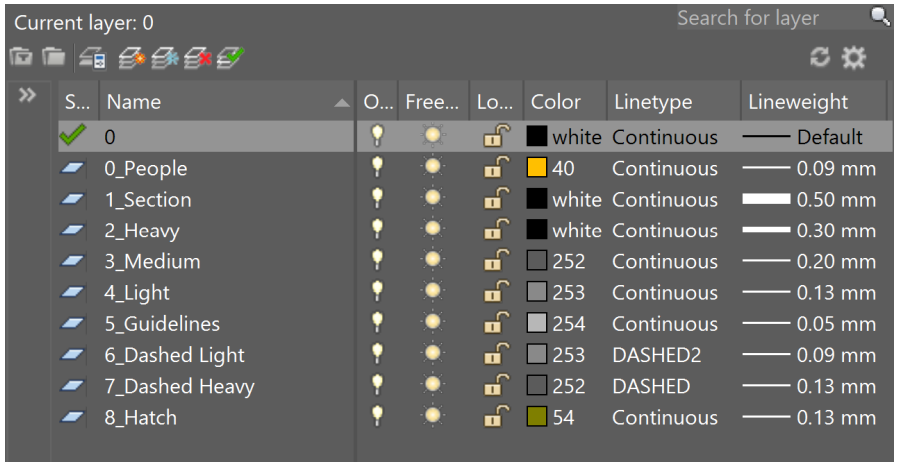
Before beginning to construct your drawings, you should set up layers for your lineweights. To keep your drawings and file organized, you should always set lineweights by layer and not by individual objects. If you need to edit your lineweights at any point, this can easily be done with the layers panel, and you won't need to remember to go back and manually change individual lines and objects in your drawing. To confirm your lineweights are set by layer, select your drawing and in the Properties panel, make sure that 'Linetype,' 'Print Color,' and 'Print Width' are all set to 'By Layer.'

If you need to reassign the layer of all objects on a particular layer, you can use the quickselect command (*QSelect*) to select all objects on a single layer and reassign them to a different layer.

Lineweights

In the Layers panel, you can create a new layer for each lineweight in your drawing, and set the color, linetype, and print width for each of these lineweight layers. For lighter lineweights, lowering the lineweight and also changing the color to a lighter gray instead of black is an effective strategy. When you make your drawing and need to assign lineweights to lines, you can simply select those lines and add them to the proper layer you just created.

To help visualize your heavier lineweights on the screen, use the command *LWdisplay* and set it to ON. This will artificially thicken lineweights above a certain threshold, usually around 0.30mm. To more



Layers Properties Manager

d accurately view your lineweights relative to the final drawing, you can view and even continue working on your scaled drawing in a Paperspace print layout, as discussed below.

Layouts & Printing

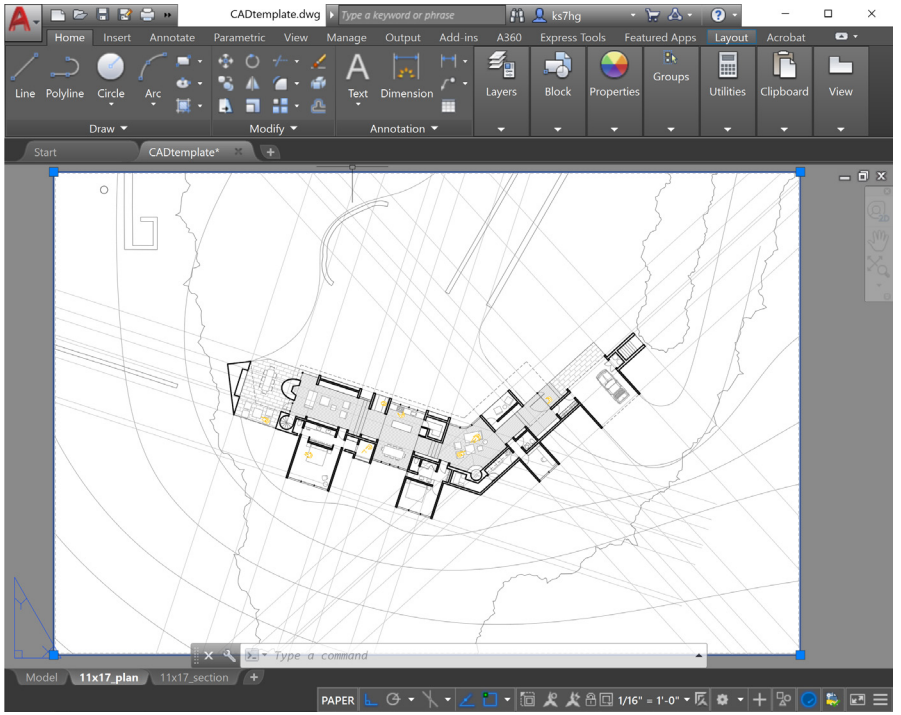
Layouts

AutoCAD allows you to work on your drawings at full scale in what is called 'Modelspace.' You will know you are working on your drawing in Model-space when the 'Model' tab at the bottom left corner of your screen is selected. AutoCAD also allows you to setup and work in 'Paperspace,' in which you set the paper size and scale for your drawing(s). This means you can visualize all lineweights accurately, and also print directly from your Paperspace layout.

Paperspace layouts will also be visible in the bottom left corner of your screen next to the 'Model' tab. These tabs will be labeled 'Layout,' and you can create new layouts, rename them, and change their settings here.

To edit a Paperspace layout, right-click on the layout tab you want to edit and select 'Page Setup Manager...'. The pop-up window will allow you to see a list of your layouts and their page sizes and basic settings. You can click 'New...' to create a new layout or click the layout you want to edit and click

LinkedIn Learning:
Using the Layer Tools



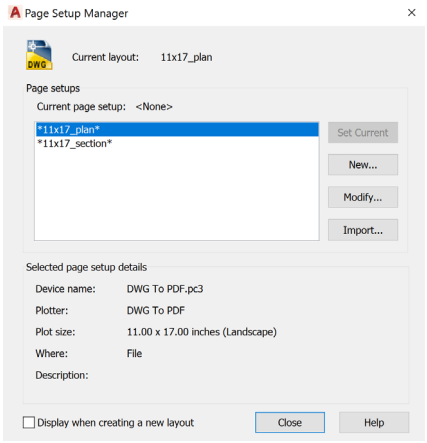
Paperspace layout.

'Modify...'.

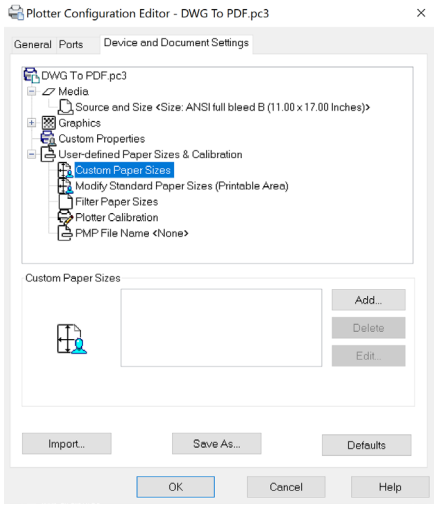
This will open another pop-up window in which you can customize your layout. The following settings are the most commonly used:

- Printer/plotter: Recommended to set to 'DWG to PDF.' This will create and save a PDF file when you use the 'plot' command to print. It is also possible to set this to print directly to a printer or plotter, but is not recommended as Acrobat will streamline PDF files for printing
- Paper size: Select the page size you will be printing on. You can create custom page sizes for plotting by clicking on the 'Properties' button next to the printer name, and choosing 'Custom Paper Sizes' and 'Add...' to create a custom size.
- Plot area: Leave this set to 'Layout.'
- Plot scale: Make sure this is set at '1:1.' It is better to set scale through your drawing.

LinkedIn Learning:
Changing Linetype Scale



Page Setup Manager.



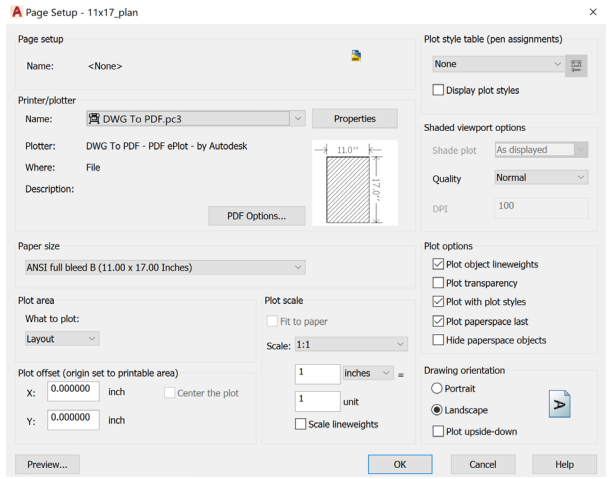
Creating custom page sizes.

- Plot options: These should be fine left with the default settings.
- Drawing orientation: Select 'Portrait' or 'Landscape' as desired.

Drawing Placement & Scale

Once your layout is created with paper size, etc. you can position and scale your drawings on the page. You can place one or multiple drawings on the page by using 'viewports' that reference your drawings in Modelspace. To create a new viewport, type the *MView* command. You can move and resize this viewport as you would any rectangle or line object.

LinkedIn Learning: Defining Your Page Setup



Page Setup.

You can zoom to your drawing by double-clicking within the viewport, or by clicking the 'PAPER' button at the bottom of the screen to change it to 'MODEL.' You can toggle this button again or press the *esc* key to switch back to paper mode. You will see that this allows you to toggle between zooming in and out on the page/layout vs. zooming in or out on the drawing within a viewport.

To accurately set the scale of a drawing within a viewport, select the viewport rectangle and select a scale from the list at the bottom of the screen. You can also create custom scales by selecting 'Custom...' at the bottom of the list. Once your placement and scaling of the drawing is set, you can click the padlock icon next to the selected scale in order to prevent accidental rescaling.

You will notice that all lineweights will be accurately displayed once the drawing size and scale are set. You can either reference this as you continue to work on your drawings in Modelspace, or work on them directly in Paperspace - just make sure you are drawing in the model viewport and not on the paperspace layout.

LinkedIn Learning: Adding Scaled Viewports

Printing

Once all these settings are established, you can quickly and easily print your drawings either to a PDF file or directly to a printer or plotter by using the Plot command when you are viewing the desired Paperspace layout tab. It is usually recommended to print to a PDF file and then use Adobe Acrobat to print your PDF to a printer or plotter.

Using and Printing Lineweights

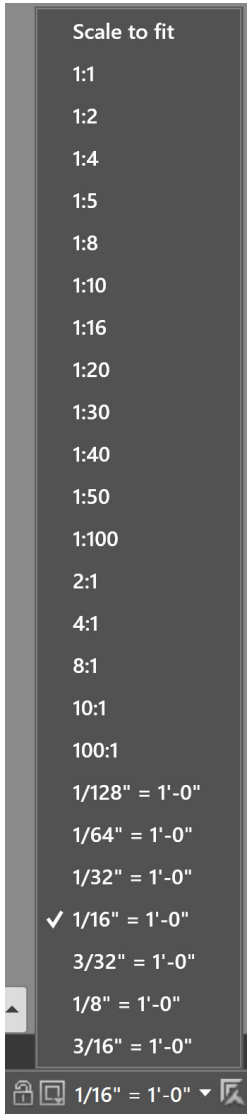
Like stated in the drafting chapter, an architectural drawing typically has about 5 lineweights. The size and scale of a drawing will dictate the spectrum of line weights that are appropriate. These lineweights are commonly used and a good starting place, however, it is important to always test print and adjust to find out what works best with the scale you are working in.

LTScale

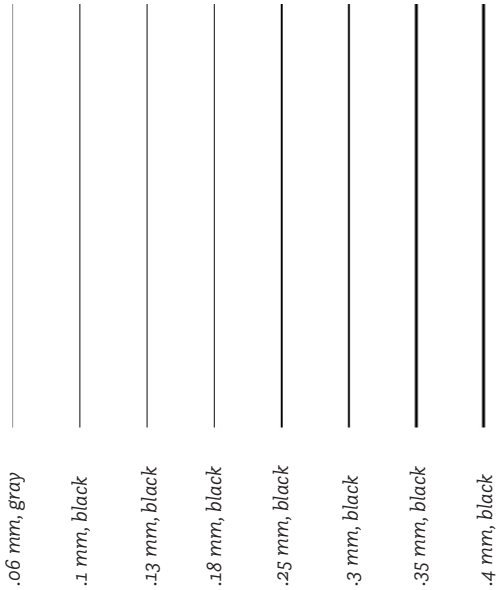
LTScale is a scale factor used in controlling the scale of linetypes in drawings. If this scale is changed, the appearance of linetypes in drawings change. If the LTScale is set to 1, dashed lines will be specified in the same units as the drawings. It is important to consider what scale a drawing will be printed at when selecting an LTScale since the LTScale will scale down with scaling of a drawing. Since most architectural drawings will be at a scale much smaller than the actual object, it may be necessary to try out increasing the factor of the LTScale for visibility of dashed lines. If dashed lines are at a LTScale that is too small, they will appear as solid lines.

CTB Plot Style

CTB is a color dependent plot style, which is stored in .ctb files. CTB plot styles creates a relationship between the color of a layer and the printing



Viewport scale options & lock button at bottom left.



Example lineweight settings.

thickness of a lineweight. CTB is commonly used in architecture firms, where standardization between complex drawings across the office and with collaborators is necessary. CTB files are not conducive to viewing lineweights as you draw, and are unnecessary when lineweights are set by layer.

LinkedIn Learning: Printing and Plotting

Construction lines:
Lightest lineweight. Show relationships between elements and drawings.

Dashed lines:
Light or medium lineweight. Show object above cut line.

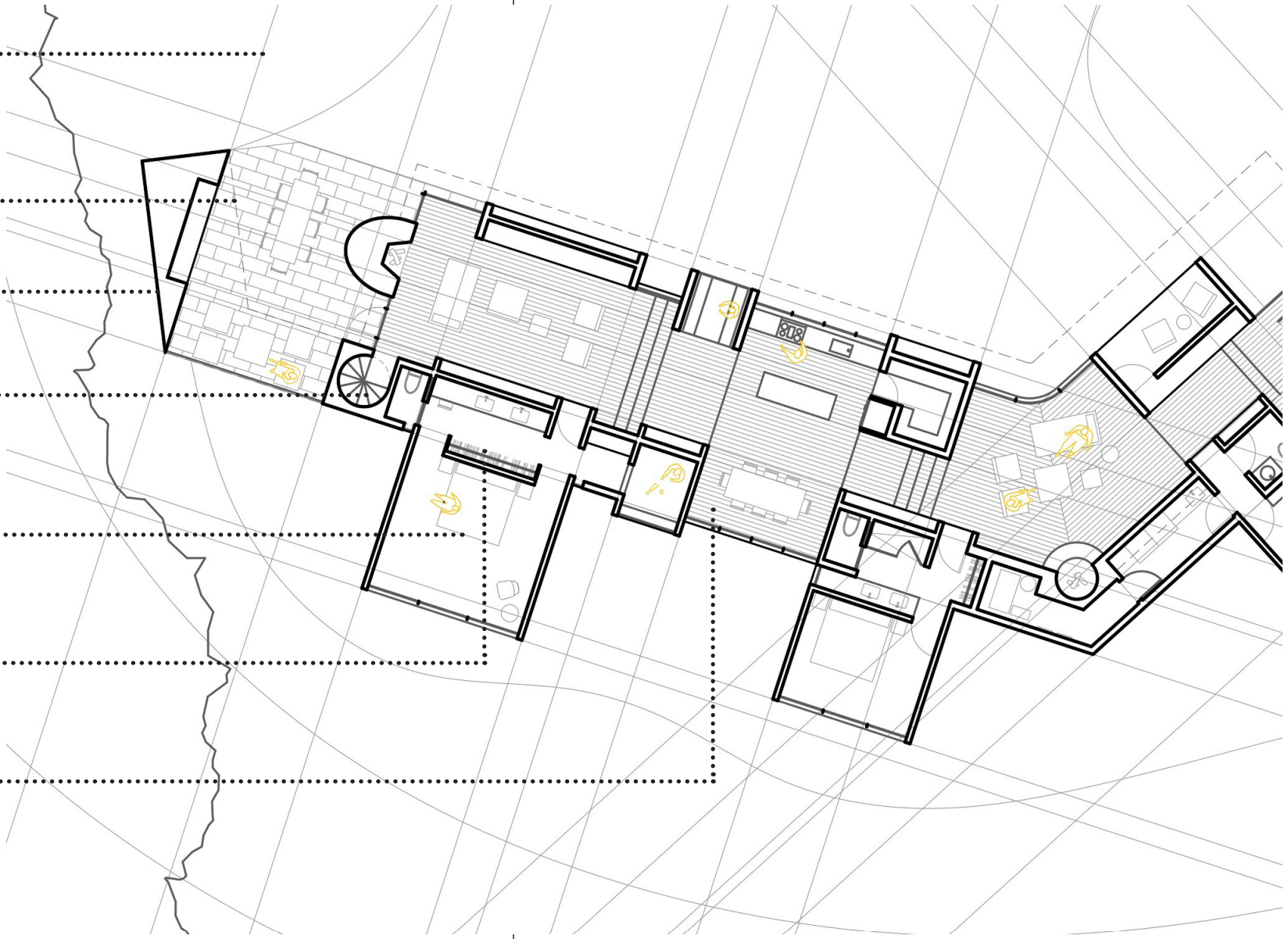
Section cut lines:
Heaviest lineweight. Show objects being cut through.

Medium elevation lines:
Show closest elements after cutting plane.

Light elevation lines:
Show detail elements or those in distance including furniture and fixtures.

Extra light elevation lines:
Show smallest detail elements or those farthest away.

Hatch/paving pattern:
Used to show material quality or spatial hierarchy.



Example lineweight display in paperspace layout.

Tools & Best Practices: Rhinoceros

Why Rhino?
Rhino is most well known for its 3D modeling tools, however it is also equipped with drafting tools for developing and exporting 2D drawings. One of the benefits of drafting in Rhino is the ability to test aspects of the design in 3D within the same file. As in AutoCAD, lineweights and linetypes can be set within the program, allowing for exporting and printing directly from the layouts without additional post-processing work.

Operating System
The examples presented here are shown in Rhinoceros 7 or 8 for Windows. Rhino is also available for macOS, and is very comparable in performance to the Windows version. The interface and location of some commands and settings will be different on macOS Rhino, but the concepts are all the same. It is recommended that you use Rhino for Windows, for ease of use working between programs, many of which were developed primarily for Windows.

Program Purchase
Educational licenses for Rhinoceros 7 and 8 are available at a discounted rate. 90 day free trials are also available of the latest release.

Commands
Like AutoCAD, Rhinoceros is a command based software, meaning that many tools are available to you within toolbars and icons present on the screen, but also through the command prompt, into which you can type commands to activate tools and input dimensions, angles, and other information. The toolbars are sorted by type of operation or element, so are very helpful in locating commands, especially when you are new to the software.

You can begin typing a command either before or after selecting objects, by simply typing on the keyboard. You will see your typing appear in the command prompt line near the top of your screen. You do not need to click on or select this bar before you start typing. Once you start typing a word, Rhino will provide a dropdown list of possible commands that sound similar or are related to the word you are typing – this is very useful to find new commands that do specific things.

Once you type the command or select it from the provided list, press enter and the command prompt will help to walk you through the command. This is a great way to discover new functions within commands, or to learn how to use new commands.

In the example provided, the *Line* command has been entered, and Rhino asks for *Start of line*, prompting you to click in one of the viewports to select the point where the line starts. Rhino also provides a series of options that change how the line is created, and you can select any of these options by either clicking on it in the command prompt or by typing the underlined letter in your chosen option and pressing enter (in this case for example, B will create a line that extends in both directions from the start point).

Drafting Commands *(Possible Aliases and shortcuts in parentheses)*

Utilities

DocumentProperties	Opens the document properties menu
Save As	Creates a copy of the current file
ZoomSelected (ZS)	Focuses to selected objects

Measuring

Distance (DI)	Find distance between two points
Length	Find length of a line
Area (A)	Find area of 2D shape

Creating - 2D

Point	Draws a point
Line (L)	Draws a line with two end points
Polyline (PL)	Draws multiple lines connected by points
Curve	Draws a curve with control points
Rectangle	Draws a rectangle
Circle	Draws a circle from center and radius
Ellipse	Draws an ellipse with two defined radii

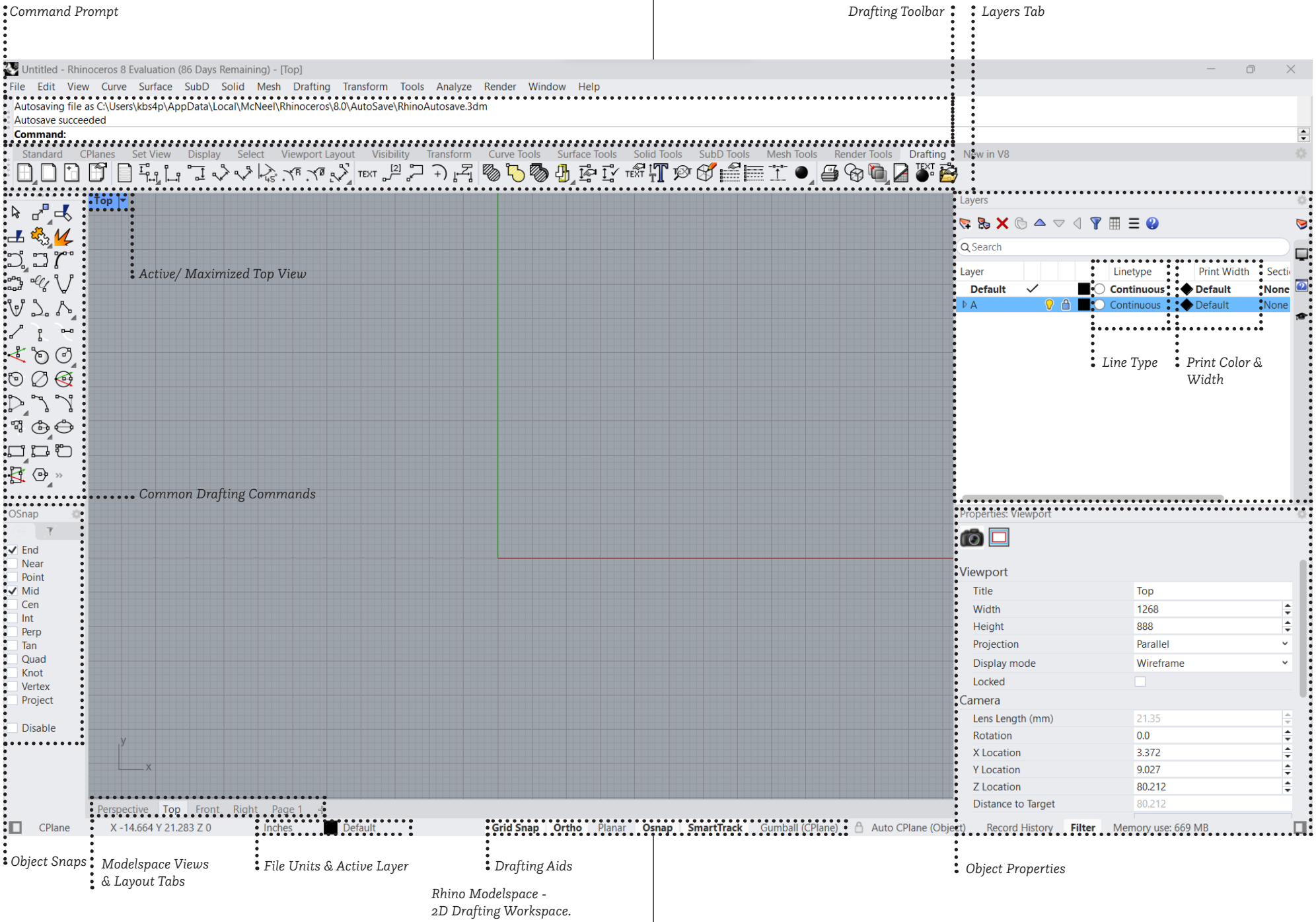
Editing

Move (M)	Moves any object
Copy (C)	Copies any object
Trim (TR)	Trims intersecting objects
Split (SP)	Divides objects into parts using a splitting line or object
Extend (ET)	Extend lines to a selected boundary
Scale (S)	Scale selected objects
Scale1D (S1)	Scales in one dimension
Rotate (RO)	Rotates an object on xy plane
Mirror (MI)	Mirrors an object about an axis
Offset (OF)	Offsets a curve from original location a specified distance
Array (AR)	Arrays an object in x, y, and/or z axis
ArrayCrv	Arrays an object along a line or curve
CloseCrv (CC)	Closes an open curve
Explode (EX)	Explodes an object into its parts

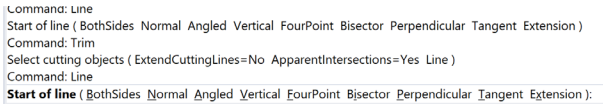
Join (J)	Joins objects that are touching
Group (GR)	Groups objects to be selected together
Ungroup	Ungroups objects that are grouped
Hatch	Fills the space within a boundary curve with a pattern
Hide (H)	Hides objects from view
Show (SH)	Shows hidden objects

Best Practices

Save (Ctrl+S)	Saves a copy of your file
Undo (Ctrl+Z)	Undo the last change or command
Purge (PU)	Removes unused items (layers, blocks etc.) from drawing.
SelDup+ Delete	Selects duplicate/overlapping lines for removal.
MatchProp	Applies properties of a selected object to other objects.



Rhino Modelspace - 2D Drafting Workspace.



Line command options.

The vast majority of 2D commands in Rhino are the same as in AutoCAD, but a few of the shortened commands will be different (for example, *MI* will mirror in AutoCAD, but minimize the program in Rhino). It is recommended to update these shortened commands with Rhino aliases so that your workflow can be the same in both programs.

Aliases

You will find over time, once you familiarize yourself with the names of commands and their results, that typing commands is much faster. Since you will often repeat commands many times when constructing a drawing or building a model, this small amount of time saved can have a significant effect on overall drawing or modeling time.

Aliases are essential to working efficiently within any CAD modeling or drafting software. Rather than typing out the entire command name, two or three letter combinations can activate the operation and save you valuable time. Many programs contain default aliases, but you can customize them to suit your workflow. Below are a few of the default aliases in Rhino:

M	_Move
O	_Ortho
ZS	_ZoomSelected
POn	_PointsOn

For common commands, you can add custom aliases one by one to Rhino within the 'Aliases' menu in 'Document Properties' or you can import a text file containing a longer list. For instance, if you are partial to AutoCAD, you can import those drafting aliases into Rhino to unify the commands across programs. When adding aliases, it is important to not only consider an intuitive abbreviation, but also the position of your fingers on the keyboard and the proximity of certain keys to each other. Aliases should not require you to reach awkwardly across your keyboard or input complex and lengthy abbreviations. They also cannot repeat, so you will have to consider which commands you use the most and abbreviate as needed. Refer to the *Drafting Commands* page within this section for alias suggestions.

Workspace

Viewports

The Rhino workspace by default consists of four viewports: Top, Perspective, Front, and Right. As in AutoCAD, it is recommended to use the Top viewport for all 2D drafting. Double-click on the Top viewport to maximize the view to full screen.

Workspace Appearance Settings

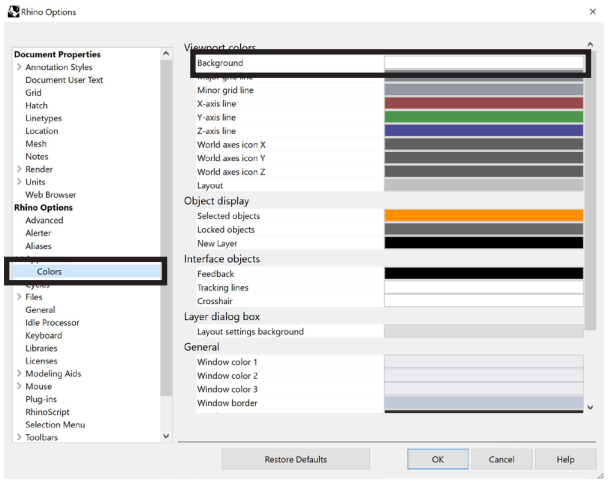
It is helpful to customize Rhino's default visualization settings to suit your preferences.

File>Properties will open the Document Properties dialog box. In this box under *Rhino Options>Appearance>Colors*, you can set the Background color to white or light gray. This will more closely mimic the appearance of your drawings when printed on a white page.

Units

Drawings in Rhino are usually drawn at full or 1 to 1 scale. Units can be changed under *File>Properties (opens Document Properties dialog box)>Units>-Model.* Here you can switch between feet, inches, meters, and other units, and also select the display preference for fractions or decimals.

Linkedin Learning: Viewport Navigation



Document Properties>
Appearance>
Colors>
Viewport colors

When units are changed, Rhino will provide the option to automatically scale all objects in the file. This is helpful if you had been drawing in meters but meant to be in feet, for example.

Setting your units to feet versus inches will have an effect on how you input dimensions when drawing. If set to inches, you can input dimensions in inches with just numbers (12 = 12”), but will need to input dimensions in feet by specifying the units (12’ = 12’), and vice versa if units are set to feet (12 = 12’ and 12” = 12”).

When creating a new file in Rhino, you will have the option to choose from several templates with preset units. The “Small Objects” versus “Large Objects” options will only effect the default tolerance when taking measurements. It is suggested to begin with “Small Objects – Inches” or “Small Objects – Feet.”

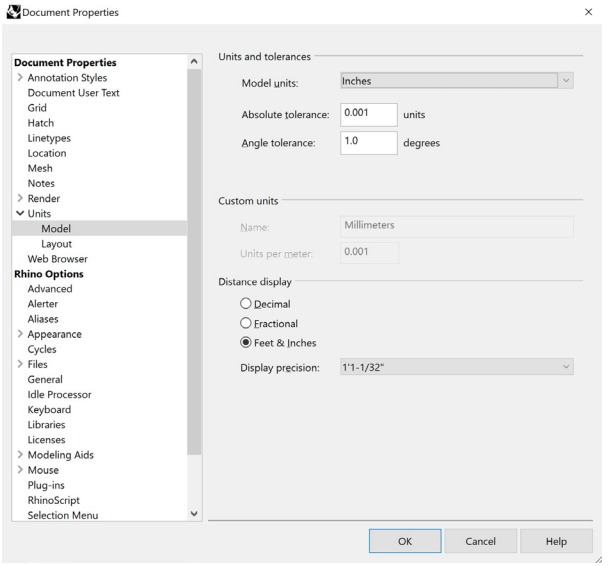
Model Navigation

Your drawing can be navigated using commands, but it is best to learn to do this quickly with your mouse and a few keyboard shortcuts:

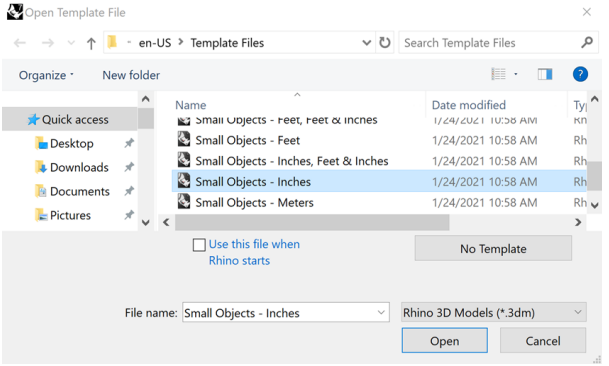
Orthographic viewports:

Pan - *right click & drag*
Zoom - *mouse wheel*
or *Ctrl+right-click+drag*

Linkedin Learning: Setting and Fixing Rhino Preferences



Document Properties



Selecting file units from template file options.

Linkedin Learning: Selecting Objects

Selecting Objects

Objects in your model can be selected by left-click ing on them in any viewport. If objects are closely overlapping, Rhino will sometimes provide a small dropdown menu for you to select which object to select.

Left-click+drag is used to select multiple objects. Dragging to the right will produce a selection box with a solid line edge, and only objects entirely inside the selection box will be selected. Dragging to the left will produce a selection box with a dashed line edge, which will also include any objects partially inside the selection box.

Snaps

Along the bottom and side of the Rhino workspace, you will find a toolbar with several snapping options. You'll find many of these options particularly helpful when drafting or modeling in Rhino. The snaps listed below are the most critical for drafting in Rhino. Refer to the *Digital Modeling* section for additional snaps options.

Grid Snap

Grid Snap will automatically move your cursor to the closest point on an invisible grid in each viewport. This is usually limiting, but can be helpful in certain situations. You will likely find yourself working with *Grid Snap* turned off most of the time, but don't forget it is there when working with a grid with uniform spacing may be advantageous. The size of the Grid can be changed by right-clicking on *Grid Snap* and choosing *Settings...* from the drop-down menu.

Ortho

When *Ortho* is turned on, movement of the cursor when using a command will be limited to the orthogonal directions (x, y, and z axis). This is very helpful, and can be toggled on and off on the fly. You can also temporarily bypass the *Ortho* snap in the middle of a command by holding *Shift*. If *Ortho* is turned off, holding *Shift* will temporarily enable it.

Osnap

Osnap is short for Object Snap, an incredibly useful tool that will insure you are connecting objects precisely with zero tolerance. There are several *Osnap* options that can be individually enabled/disabled. The ones listed below are most commonly enabled when drafting:

End – endpoint
Mid – midpoint
Cen – center of curve/surface

Linkedin Learning: Selecting Objects

Int – intersection
Perp – point of perpendicular intersection
Tan – tangent point
Quad – quadrant point (maximum x/y coordinates) of circle or ellipse
Project – this option projects the point you are snapping to onto the Rhino construction plane (xy plane by default)

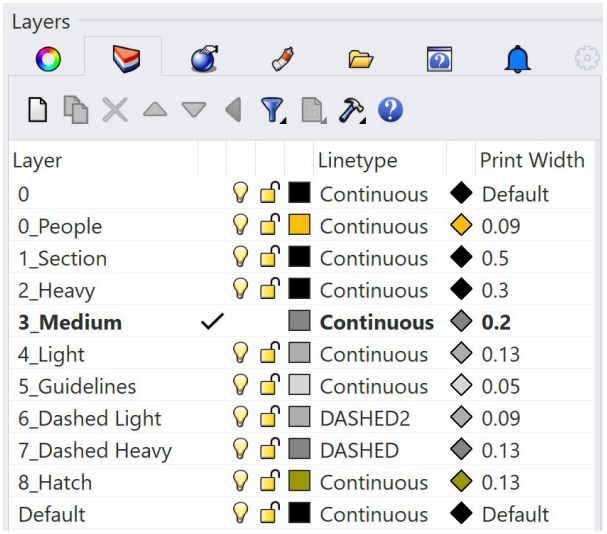
SmartTrack

SmartTrack is a function that will create impromptu guidelines to snap to. When *SmartTrack* is enabled, this guideline can be created automatically by hovering the cursor over an *Osnap* point, or manually by pressing *Ctrl*.

Layers and Lineweights

Layers

Like many other design programs, Rhino works with a layer system that is used to organize and structure your models and drawings. The layers menu can be found on the right side of your Rhino workspace under a tab with an icon that looks like a slice of red, white, and blue cake. All your layer settings can be controlled from this menu.

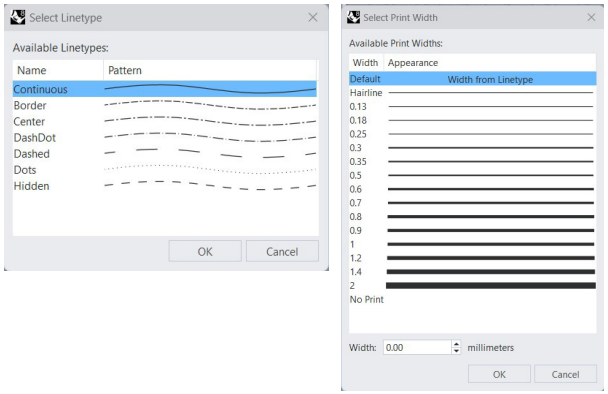


Layers menu

Before beginning to construct your drawings, you should set up layers for your lineweights. To keep your drawings and file organized, always set the lineweight by layer and not be individual objects. By clicking on *Continuous* under the *Linetype* column, a menu of available linetypes will pop up. Several common linetypes can be accessed here. You can also create custom linetypes in *File>Document Properties>Linetypes*. This location will also show you the specific scale of the dash patterns for each linetype.

The square to the left of the *Linetype* column specifies the color of the linework in Model Space and the diamond to the right specifies the color your linework will print to. Typically print colors are set to black or potentially to another gray-scale value.

Print Width controls the width of the line when printed - commonly referred to as the line weight. The number indicates the thickness of the printed line in millimeters. When changing this setting, even with the 'Print Preview' setting activated, you will likely see little, if any, change in the lineweight on your screen in Rhino. This is a limitation of the software and you will need to conduct multiple test prints to calibrate your lineweights.

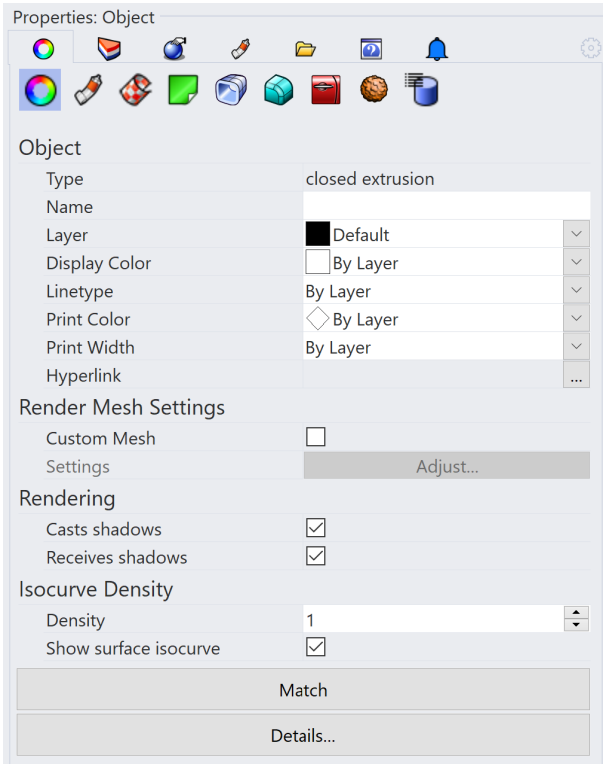


Setting Layer Linetypes & Print Widths

Settings

The visibility of layers can be toggled with the lightbulb icon, and the ability to select layers can be toggled with the lock icon next to each layer name. The display color of all objects on a layer can be changed by clicking on the colored box just to the right of the lightbulb and lock icons.

New layers can be created with the page icon at the top, and layers can be renamed by right-clicking on their name and selecting *Rename Layer* from the dropdown menu (this will not work if you are in the middle of a Rhino command – if this happens, use Esc to cancel the command and try again). Layers can be rearranged by dragging them around or by using the arrow icons at the top. Layers can also be nested into other layers as sublayers which is helpful for keeping files with many layers organized, and to be able to easily toggle visibility and locking of many sublayers at once.



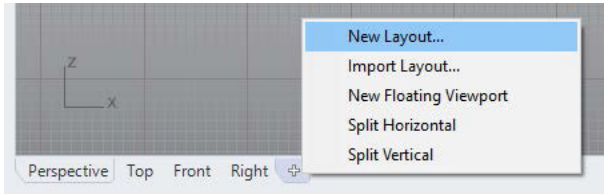
Object Properties menu.

Assigning Object Layer

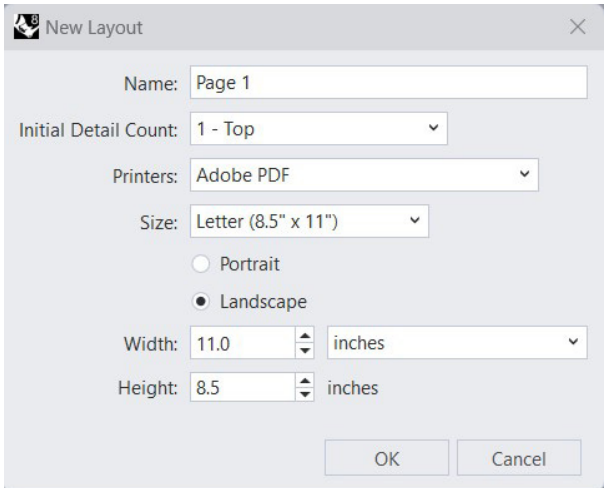
The check mark next to a layer name indicates the currently selected layer. New objects created in Rhino will automatically be assigned to the current layer. There are also two ways to change the layer of an existing object:

- Select the object(s) then right-click on the layer you want to assign the object(s) to. From the dropdown menu, choose 'Change Object Layer' or 'Copy Objects to Layer'.

- Select the object(s). Under the 'Object Properties' menu tab located next to the Layers menu tab, select the Layer to assign the object to from the Layer dropdown list.



Creating a Layout



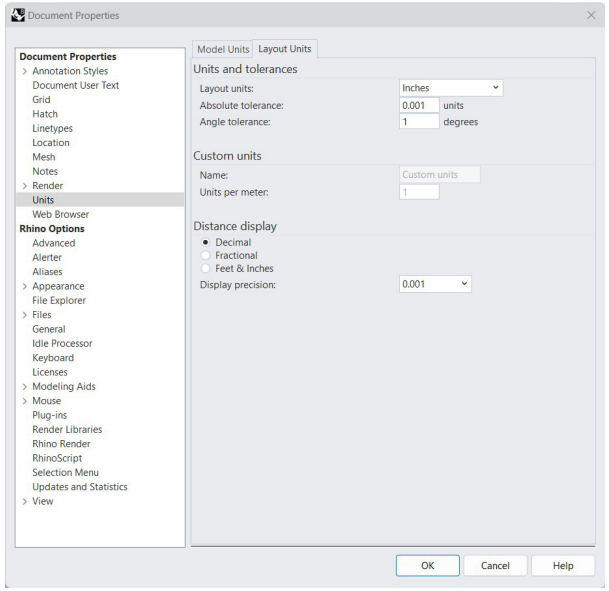
Layout Settings

Layouts & Printing

Layouts

At any time when drawing in Rhino, you can use the *Print* (Ctrl+P) command to print a drawing. When used in Model Space, the command will capture the current contents of your active viewport. Printing directly from Model Space however can be difficult to scale and will produce an inconsistency in the placement of the drawing on the page. This will be problematic to work with if you are trying to iterate or build up the complexity of a drawing over time.

Using a layout is the best way to precisely scale the output of your drawing, maintain consistency in the output location of your drawing, quickly change or edit the paper size of drawing output, and add annotations, symbols, titles, and dimensions to a drawing.

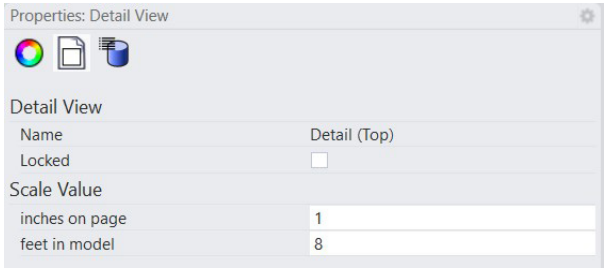


Adjusting Layout Units

When starting a new drawing in Rhino, if you intend to print from a layout, you will need to create one by clicking the '+' icon on the bottom left of the workspace. This will open a dialog box where you can choose the size of the layout, the 'Printer' (which can be set to Adobe PDF or Rhino PDF), and allow you to name the layout. It is recommended to name the layout something that helps you identify either the drawing type you will be outputting from the layout (e.g. "plan," "section," "elevation,", etc) or the size of the layout, or both. All of these settings can be adjusted later by simply right-clicking the name of the layout you created and accessing the 'Layout Properties.'

The Detail

When you create a layout in Rhino, it will automatically create a Detail. The Detail will appear along with a gray rectangle that represents the paper size of the layout. The area within this gray box is what will be captured by the Print command.
Like other Rhino geometry, the Detail can be moved, copied, rotated, scaled, or deleted. Multiple details can also be added within a single print Layout. The Properties of the Detail can be ac-



Detail Properties

cessed to precisely scale your print output. Printing drawings to scale is an extremely important skill to build into your practice.

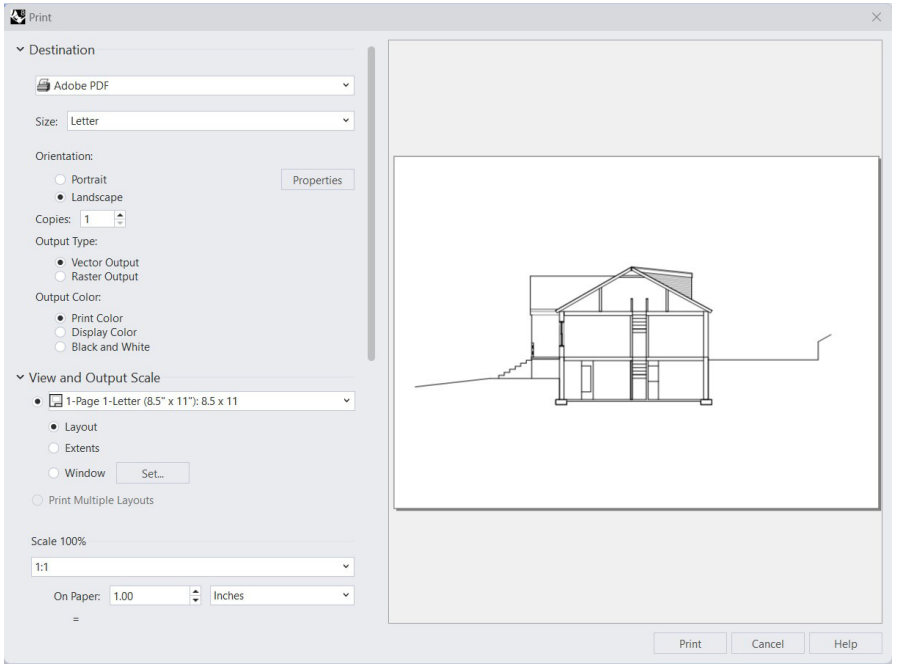
The Detail will be created on whichever layer is active when you created the layout. It is advised to create a new layer called 'Detail' to organize this specific type of geometry and keep it separate from other drawing layers. The detail has several important properties, including the ability to control the scale of the view it displays.

When any geometry in Rhino is selected, the properties tab will display information, including what layer it is contained within, as well as information about how it is being displayed, how it will print, and even details about its specific data type and location within the Rhino model space. Selecting the Detail when in the Properties panel will create a special dialog box (the small paper-shaped icon) that will allow you to precisely control the scale of your drawing output. Here, you should attempt to set your drawing scale to something that works well with your drawing units and frames your drawing nicely on the page. You can also set the detail to 'Locked,' which will prevent you from inadvertently changing you set view location or scale. In this example, the drawing scale is set to 1/8"=1'-0" or 1 inch on the layout in Paper Space is equal to 8 feet in Model Space.

Printing

Once your drawing scale is established and your linetypes, lineweights, and print colors are specified, you can quickly and easily print your drawings to a PDF by typing *Print* or *Ctrl+P* or navigating to *File>Print*. You also have the option to print directly to a printer, however it is advisable to print first to PDF to check your lineweights and optimize the file for printing.

Once you hit *Print*, the Print menu will pop up. Within the 'Destination' submenu, first specify the printer, in this case AdobePDF, page size, and orientation. The page size should correspond to your layout dimensions, in this example Letter size or 8.5"x11". Next specify page orientation to either Portrait or Landscape, again matching your layout. The preview window adjacent to the settings will adjust as make changes. For 'Output Type' specify 'Vector Output' and for 'Output Color' specify 'Print Color'. This ensures that your linework will be crisp and match the colors you specified in your layer settings. Within the 'View and Output Scale' menu, make sure your layout is selected and that the scale is 1:1. There are three additional submenus, but their default settings typically do not need to be adjusted. When finished making adjustments, hit the 'Print' button in the lower left corner. This will prompt you to save the file. Remember to include the date and relevant title in your file name prior to saving.



Rhino Print Menu

Modeling

Architectural Modeling

Why Model?

Models, physical or digital, are essential to the design process. Their scale and scope shift in relation to spatial, tectonic or material inquiries, providing a three dimensional format for the visualization and simulation of architectural elements and assemblies. They are a medium within which plan and sectional ideas are tested and where the intersections of spaces and elements are negotiated and refined. Whether they are created for exploration or representation, they provide an experiential and familiar means for observing and evaluating architectural form and space.

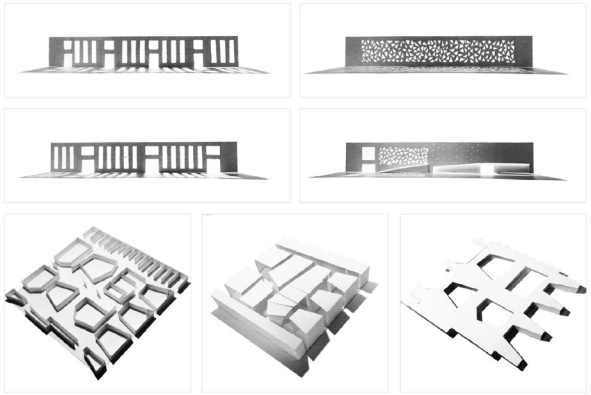
Physical concept models are an integral part of the design process, allowing for quick, yet precise, explorations of organizing spatial ideas and systems. They serve as a generative tool, initiating a feedback loop of design development, evaluation, and revision. This ability to work in iteration is essential to exploring a set of design ideas and moving a project forward. Consistency in scale, medium and method allow for comparative analysis of design iterations, however variations in technique, material, and resolution can result in new readings (and misreadings) of proposed spaces and structures.

Key Terms

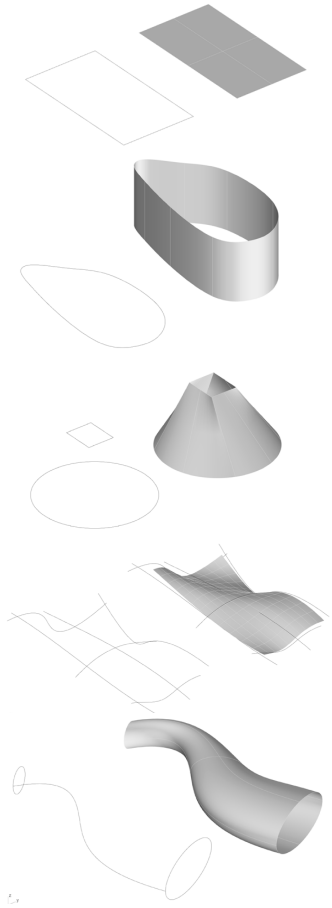
model	a three-dimensional representation, esp. on a small scale, of a person or thing or of a projected or existing structure; esp. one showing the component parts in accurate proportion and relative disposition
iteration	a procedure in which repetition of a sequence of operations yields results successively closer to a desired result
medium	1. Any raw material or mode of expression used in an artistic or creative activity 2. an intermediate agency, instrument,or channel; a means; esp. a means or channel of communication or expression
surface	A continuous extent having only two dimensions (length and breadth, without thickness), whether plane or curved, finite or infinite; an entity such as constitutes the boundary of a solid object or separates two adjacent portions of space
extrusion	a 3D object made from a base plane or curve
polysurface	two or more surfaces joined together, often to create a solid
isocurve	line expressing the subdivisions of a surface
solid	a surface or polysurface that encloses a volume
closed (geometry)	often a solid, can be thought of as watertight, with no open edges or missing faces. A closed line is any closed 2D shape, where the start point is touching the end point
open (geometry)	a solid object is open if it has missing faces, a curve is open if its end points do not connect

Digital modeling allows for conceptual formal, spatial and material explorations often at 1 to 1 scale. Working within a digital environment allows for the translation of 2D geometry (points and lines) to 3D surfaces and volumes, offering designers a way to digitally inhabit the space of their proposals. With these advantages comes possible limitations.

Digital model space is weightless and infinite, causing the apparent suspension of objects and omission of gravitational loads and forces. Tectonics can quickly become an afterthought and unnecessary scales of investigation can be pursued. Digital models can easily become complicated and contain massive amounts of information. It is imperative to recognize the level of detail required of your investigation and to only model what is needed. Remember, the 3D model is not the project. It is one of the many tools used to develop a design idea and does not have to include every detail of the design.



Study Models by Abduref Hussien, UVA SoA ARCH 3020 Studio



Translation of 2D Linework to 3D Geometry in Rhino

Physical Modeling: Tools & Materials

Why Physical Model?

Modeling by hand and with easily manipulatable materials can enable a quick and focused investigation of spaces and structures. It is important to keep in mind that study models are not precious. They are a way of actively working through a design idea and can reflect the process, similar to a sketch. The following section includes common materials and tools for working precisely and efficiently with physical models.

Sheet Materials

In most planar model making applications, Bristol paper and chipboard are the most common materials, but other paper sheet materials are commonly available and can be good for specific techniques.

Papers

Thick, smooth, matte finish white papers such as Bristol are great for making paper models. They are easy to cut cleanly and are thick enough that they can be scored for folding but flexible enough to also make curving surfaces. The relatively thin edge means that care should be taken to not over-apply glue. Thick papers in various colors and textures can be used to great effect in a model but can also be distracting from the overall form if not used in intentional ways – they are usually reserved for special applications only.

Bristol paper.

Chipboard.

Chipboard

Chipboard comes in a variety of colors (usually brown, gray, and white) and thicknesses (commonly 1/32” or 1/16”, and up to 1/8”). The various thicknesses are sometimes referred to as single-ply, double-ply, or triple-ply. It is usually best to use chipboard that is the same color on both faces except under certain circumstances. The thinner chipboard will cut easily in one to three passes with a knife, but the thicker chipboards may take many passes to cut through cleanly.

Museum board.

Museum Board/Matboard

Museum board and matboard are similar to white chipboard but will have a very particular surface finish and can often be found in a variety of colors on one side. These materials can make very nice models and are designed to be used for art framing. Be aware that the acid-free archival quality sheets can cost several times more than chipboard.

Butterboard.

Butterboard/Pulpboard

Butterboard is generally lighter and less dense than chipboard and is very easy to cut and bend into curves. It is usually a cream or off-white color, and models made in butterboard will tend to yellow quickly in storage for long periods. Pulpboard is similar in appearance but may have some color variation and a more textured surface.

Corrugated cardboard.

Corrugated Cardboard

Corrugated cardboard can be salvaged from shipping boxes or purchased in large clean sheets. It is good for building thickness quickly and is quite rigid due to the corrugated interlayer. Care should be taken to cut it cleanly, and it has a very distinctive appearance, so should only be used in specific circumstances.

Foam Core
Like corrugated cardboard, foam core is thick and rigid, and is usually found in white or black. It's surface will often have a slightly shiny satin finish, which will appear differently than the more matte finish of paper or chipboard. Care needs to be taken to cut it in a way that the inner foam layer does not tear (use a very sharp blade and several lighter scoring passes with a knife). Foam core has a very distinctive appearance, and many have strong opinions against using it, so it should be used only under specific circumstances. Another version, Gator board, has plastic faces and is extremely rigid, but also much more difficult to cut.

Foam core.

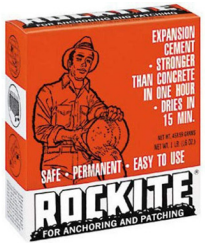
Basswood
Basswood can be found in sticks, sheets, and blocks in various dimensions for use architectural models. Sheets and sticks around 1/16" or thinner can be cut easily with a knife. Pieces up to 1/8" can be cut slowly by hand, but will require more cuts with a knife. Basswood sheets can be cut just like other sheet materials, but will cut more easily parallel to the grain and will require a few extra cuts across the grain. It can be easily sanded and attached with wood glue. Basswood is recommended over balsa wood, which is softer, more fragile, and often has distracting grain.

Basswood.

Solid Materials
Wood and foam are the most common solid modeling materials. There are many other material options that fall into this category, but often require specific tools or techniques.

Wood
Wood is an extremely versatile material that can be transformed in numerous ways with specific tools. Wood from different tree species can be drastically different in appearance, density, and other qualities. It is possible to carve or shape smaller pieces of softer woods at a desk, but wood is best manipulated with designated woodworking tools in the woodshop.

Cast Materials
A variety of cast materials can be formed into molds through either heat or chemical or processes. Always follow manufacturer's safety instructions when casting.



Rockite.

Rockite & Plaster
Rockite and plaster are purchased as powders that become very hard and solid when mixed with water and cast. They can pick up very fine details from molds. Rockite is gray and looks like concrete without stone aggregate. Plaster is white or off-white. Both can be tinted with ink or pigment or combined with sand, stones, or other aggregates.

Wax & Glycerin
Wax and glycerin are solid at room temperature and are formed by heating until liquid and pouring into a mold. Both are relatively soft and can be carved by hand. Translucent options are available for both, producing interesting visual effects. Both can be tinted to various colors with ink or pigment.

Plastics & Resin
Many types of plastics, resins, and rubbers are available, and are cast by mixing specific proportions of two different liquids. These are usually expensive and produce fumes, so are only recommended for very specific applications.

Tools
Investing in quality tools that will work reliably over time will improve both quality and efficiency in model making.

X-Acto
The X-Acto precision knife is a very versatile tool that can be used for everything from large straight cuts to curves, to very small and intricate detail work. Because of its size, it is held like a pencil for very fine control. Different blades are available for different applications, but the standard #11 blade will work well in most cases. Since the point is very sharp and tapered, be aware that the tip can break off if you are cutting with a lot of pressure. Keep extra blades on hand to replace dull blades frequently. Use a safety sharps container or wrap the blade in tape before disposing.

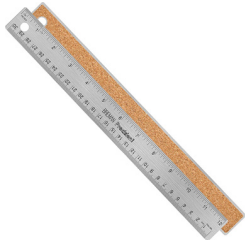
X-Acto knife.

Olfa
Olfa is the most common brand of snap-off utility blades. They are very useful for long, straight cuts through thicker or tougher materials. The handle is thicker than an X-Acto, meaning it is easier to cut with more pressure. They come in smaller and larger sizes, and the larger size is recommended to better complement the use of your X-Acto. Blades can be incrementally snapped off when they become dull by carefully extending one segment of blade past the metal end of the knife, locking it in place by tightening the thumb screw, holding the exposed blade segment under the edge of your cutting mat, straightedge, or thick sheet material, and angling up with the handle of the knife.

Olfa knife.

Snapping off a blade segment.

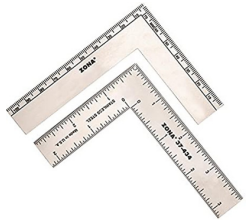
Straightedge
A good metal straightedge/ruler is critical for model making. A cork or foam backing strip will help to make sure that the tool does not slip when cutting – make sure the non-slip side is down! Your straightedge can also be used to measure and mark longer dimensions before cutting. DO NOT use your plastic drafting tools (scale, triangles, French curves, etc.) as an edge for cutting – this will cut into the edges of the tools, making them unusable for drafting.



Metal straightedge/ruler.

Architect's scale.

Architect's Scale
An architect's scale is very handy for measuring in inches, but also in measuring dimensions at several model scales, so that you can think in real-world dimensions while building a scale model. The different faces of the tool allow measurement at different architect's scales, so make sure you are using the correct side!



Miniature L-square.

Miniature L-square/Triangle
Also available as a miniature triangle, this metal tool is very useful for measuring small lengths and to use as a straightedge when cutting intricate details. It does not have a non-slip backing, so use caution it does not slide when cutting against it. It is also very helpful to use as a guide to ensure surfaces are perpendicular when gluing.

Cutting mat.

Cutting Mat
All cutting should always be done on a cutting mat, for safety and to protect your other work surface. Cutting mats are designed with layers of plastic and rubber to ensure you can cut into them but not through them, and so that they will not be destroyed even after years of cutting (this is why some are marketed as "self-healing"). DO NOT ever cut directly on your drafting board or other surface used for drawing including your desk, as the cut marks will ruin the surface.

Clamps.

Clamps
Clamps come in a variety of types, shapes, and sizes, from small spring clamps to long bar clamps. They are useful for holding materials tightly together when gluing. Make sure your clamps do not indent or mark paper products or wood materials – avoid over-tighten and make sure they have rubber surfaces where they attach to your material (a few layers of paper towel can also to cushion as well).

123 Blocks
123 Blocks are made of steel, often with threaded holes, measuring exactly 1 inch by 2 inches by 3 inches. They are a versatile tool due to their exact dimensions, perpendicular faces, and weight that makes them very stable. Use them for positioning and weighing down pieces during gluing and assembly. A block on either side of a vertical sheet of material will make it easy to glue precise perpendicular intersections.

123 blocks.

Consumables

White glue
Sobo and Elmer's are popular brands. White glue is versatile and dries relatively clear. It will be slightly rubbery when dry.

Wood glue
Titebond is a popular brand. Wood glue is usually very yellow in color, so care should be taken not to use more than necessary. It is better for modeling with basswood than paper products but dries harder and more rigid than white glue, which is useful in some cases. Wood glue works best when glued with some pressure between surfaces (clamps or weights).

Superglue
Loctite and Zap are popular brands. Superglue comes in a variety of formulas and viscosities, from liquids to gels. It dries strong but sometimes brittle, and some formulas harden quicker than other adhesives. Many superglues will soak into paper products and produce unsightly stained areas, so are generally not recommended for use with paper products. Superglue will glue your fingers together, so use extra care to not get any on your skin or near your face.

White glue.

Wood glue.

Superglue.

Gorilla glue.

Gorilla glue
Gorilla glue is a specific formula that is designed to expand to fill gaps. Any exposed glue will appear bubbly or foamy when dry. It is recommended only for specific applications.

Tape
Tape is not recommended for model construction, as it is usually very visually distracting in your completed model. Lighter adhesive masking tapes such as painter's tape are sometimes useful for holding corners tightly together when gluing, but are removed after the glue is dry, making sure to not tear or rip the surface of the material.

Sandpaper
Sandpaper provides an abrasive surface to file or sand down certain materials. All sandpaper has a number representing its grit or coarseness. Lower grits (60, 80, 100) are coarser, while higher grits (220, 320, 400) are finer. If smoothing a surface, sand first with a coarser grit and then a finer one. Sandpaper can be used by hand, or taped to a smooth block of material to make a sanding block. To smooth edges of basswood or chipboard, place a sheet of sandpaper on a smooth clean surface, and drag the edge of your material across it.

Sandpaper.

Techniques: Sheet Materials

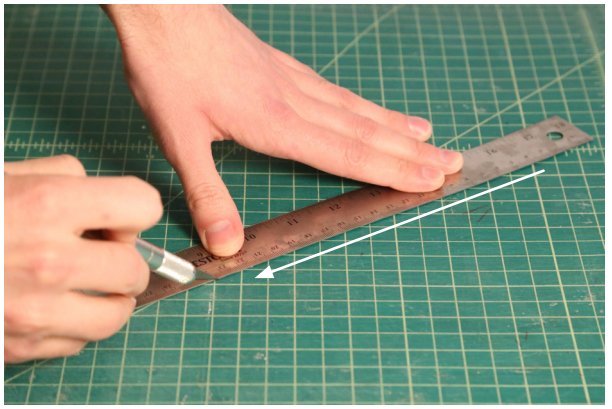
Measuring

Except for quick and messy study models, it is usually necessary to accurately measure pieces to cut throughout your model making process. Drawing guidelines on your material is often a great strategy – use a sharp pencil so your marks are very accurate. You can use your straightedge ruler, scale, and triangles to measure and mark lines, but remember to only cut against your metal straightedge.

Cutting

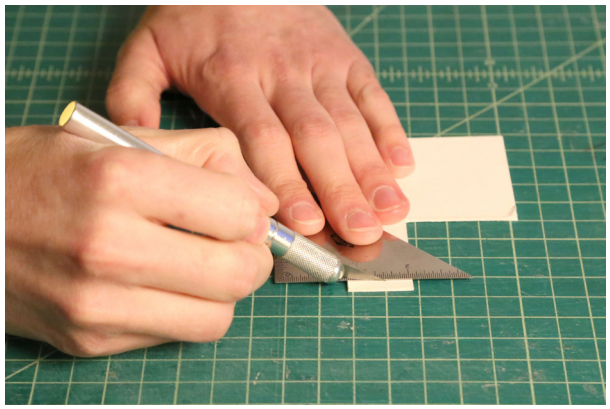
Take extra care when cutting to make sure that your cuts are precise and clean, and to ensure you do not injure yourself. Here are some things to keep in mind:

1. Make sure your blade is very sharp. A dull blade will produce less precise cuts and require you to use more pressure when cutting, meaning you are more likely to slip and injure yourself.
2. Cut against your metal straightedge whenever possible. Make sure the non-slip side of the straightedge is down, and that your fingers holding down the tool are well away from the edge and out of the line of the cut.

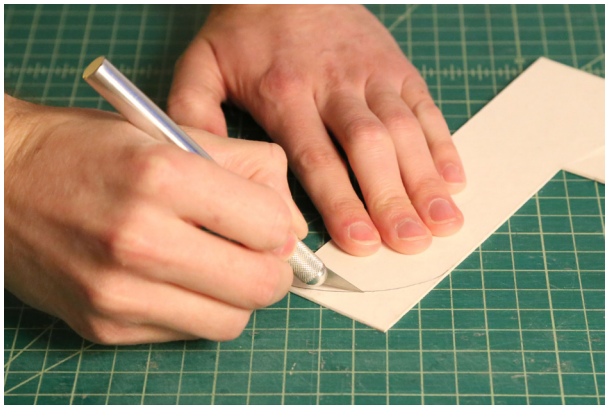


Cutting with a straightedge – keep fingers away from line of cut.

3. Keep your blade perpendicular to the surface being cut. This will ensure that your cuts are cleaner and more precise, and that the edge of the material you cut is straight for ease of gluing.
4. It is better to make several lighter passes to cut through a material, rather than use too much pressure to try to cut through in one go. Some very thin materials can be cut in one pass, but most will require multiple lighter cuts. Make sure your straightedge does not slide or move between passes with your blade.
5. Curved cuts can be done freehand with an X-Acto. Make sure the material you are cutting is held down so it does not slip, and follow th above advice regarding multiple lighter passes and perpendicular blade position.



Cutting small details with a miniature L-square or triangle.



Cutting a curve.

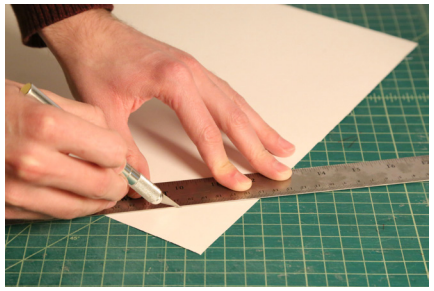
Scoring and Folding

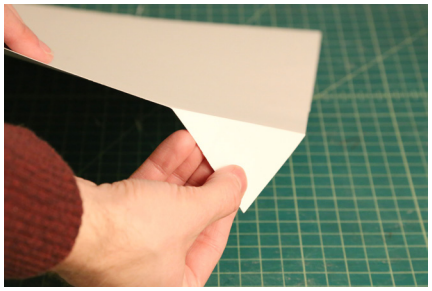
Scoring is an effective strategy for making very precise and crisp folds in your material. This is particularly true of Bristol paper, and some thinner chipboard, although it becomes less effective the thicker the material. To make a score, measure your line and use your metal straightedge as if you were going to cut the material, but make only a light pass across the material with your knife, using even pressure across the length of the score. This should cut only part of the way through the material. If you cut too deep, the material will split apart when folded, and if you cut too lightly, it will be difficult to fold along the line. It is better to start lighter, as you can always make another light scoring pass if needed (just be very careful to align your straightedge precisely over the same line).

Gluing

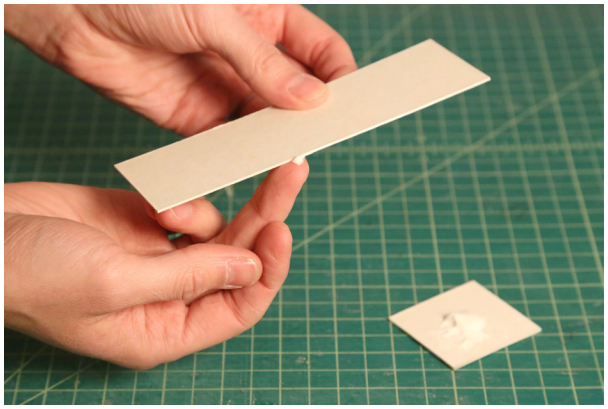
White glue is the most common adhesive for assembling models in paper and chipboard. There are a few things to keep in mind when gluing:

Scoring and folding for a sharp edge.

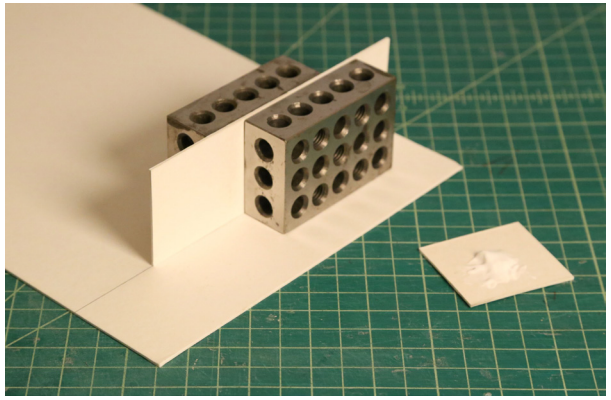




Applying glue to an edge.

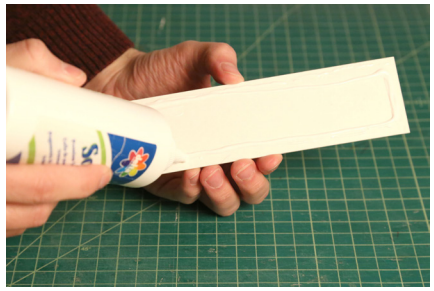


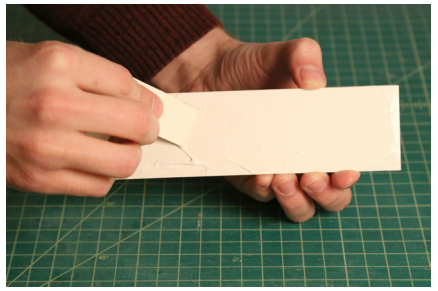
1. Amount – Use enough glue to cover a thin layer on the surface, but not so much that it drips everywhere when the pieces are pressed together. If any oozing does occur, you can use a scrap strip of paper to carefully wipe it off.
2. Application – In some instances, you will want to apply glue directly from the bottle to the surface (do this with superglue). In most cases (particularly when applying glue to thin edges of material) you will want to apply glue differently. On a scrap piece of material, deposit a small amount of glue (around the size of a coin). Touch this glue with your finger so that a drop adheres to your fingertip. Transfer this glue to the edge of the material by sliding and gently rolling your finger down the length of the material in a smooth, continuous motion. Beware of paper cuts – pressure is not needed. You can also use a strip of scrap Bristol paper or chipboard to apply the glue. If joining material in a T shaped connection, always apply glue to the thin edge of the material, not a line in the middle of a flat face.

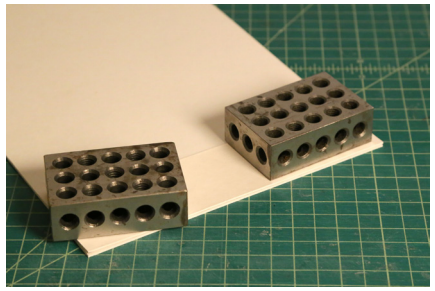


Positioning with 123 blocks.

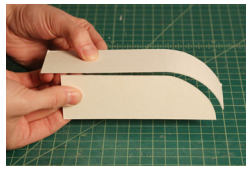
3. Positioning – Once glue is applied, gently press your materials together, avoiding sliding and shifting them around, as this will spread glue farther away from the joint. Use 123 blocks, clamps, or other weights to hold objects in position while the glue dries whenever possible.
4. Visible sides – Sometimes your model will have interior surfaces and volumes that will not be visible in the completed model. In these cases, be mindful of which edges will show more than others, and try to keep any tabs or messy glue joints hidden as much as possible.
5. Laminating – To laminate two surfaces face-to-face, apply a modest line of glue around the perimeter of the surface, and use a small scrap of rigid paper or thin chipboard to spread the glue evenly across one of the two surfaces. Try to cover the surface as evenly as possible, and avoid large amounts of glue built up in concentrated areas. Use the paper spreader to make sure glue reaches to all edges, which will prevent the edges from delaminating once glued. Once glue is applied, properly position the pieces, press them gently together, and use 123 blocks or other flat heavy objects to keep the surfaces pressed while the glue dries. If a lot of glue oozes out along the edges, apply a thinner layer of glue in the future.







Laminating – spreading glue and weighing down.



Pre-bent curved surface before gluing.

Curves

Bristol paper, some thinner chipboards, and butterboard can usually be bent into smooth curves without producing excessive creasing. This is most effectively accomplished by gluing against another surface that has been cut to the desired shape. When gluing curved surfaces, it is both more difficult and more critical to make sure the material is held tightly together and does not spring back toward flat while gluing. You can use the same positioning tools to do this including using a small tab of tape, but you may have to be a bit creative in how this is accomplished. It is also helpful to pre-roll or bend your material to the approximate curve you want using your hands before trying to glue it in this position. See directions in “Cutting” above for producing clean curved cuts.

Techniques: Casting

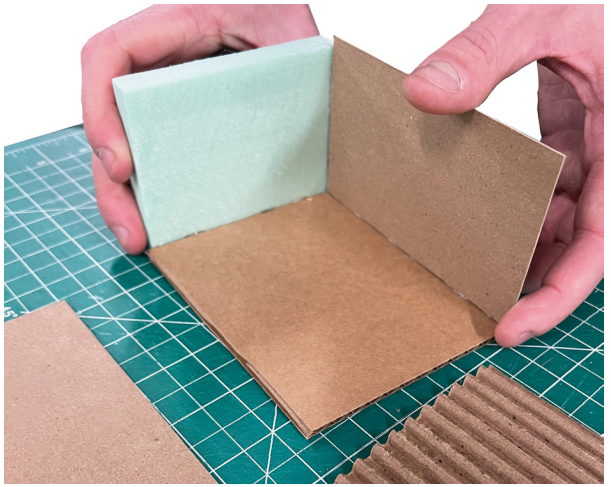
Mold Preparation

The most critical and time consuming part of casting is the creation of a reliable mold. The mold is a vessel into which you will pour a liquid casting material. The mold will determine the form and texture of the final cast model.

When designing a mold, you can think about it as an inversion of the solids and voids in your model (or a boolean difference operation in Rhino). If you have a rectangular block of solid material inside your mold, this will become a rectangular void once the model is cast and the mold is removed. Generally, molds are single use and will be destroyed to reveal the cast model, with a few exceptions including reusable silicone molds.

Below are some guidelines for mold preparation:

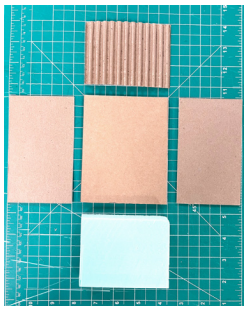
1. Consider building your mold such that your model is cast upside down. The top surface of the poured casting material will be the least refined surface once cast, so it is usually best to plan for this to become the bottom of your finished model.



Building mold using glue to secure edges.

2. Molds must be watertight. The best way to avoid leaks in your mold is to cover all seams with a bead of hot glue on the outside of the mold. It is helpful to build the mold a bit taller than needed with a fill line drawn around the top.
3. Gravity will limit some possible forms. You will be pouring a liquid into your mold, and concealed complex geometries that wrap up and down may prevent your casting material from flowing into all parts of the mold. This may mean casting your model in another orientation or casting it as multiple parts.
4. Be careful with very small details or thin linear or planar elements, which will be very fragile. For larger planar surfaces, around 1/4" is a good minimum thickness.
5. The inside of your mold is the important side. Glue oozing out of the mold will not affect the cast, but glue oozing on the inside of the mold will be legible in the completed cast.
6. Mold materials - molds can be made with a variety of materials to varied effects. You are encouraged to experiment with different mold materials with two considerations in mind:

   a. Cast materials will take on the texture of your mold, meaning that your mold materials



Mold pieces.

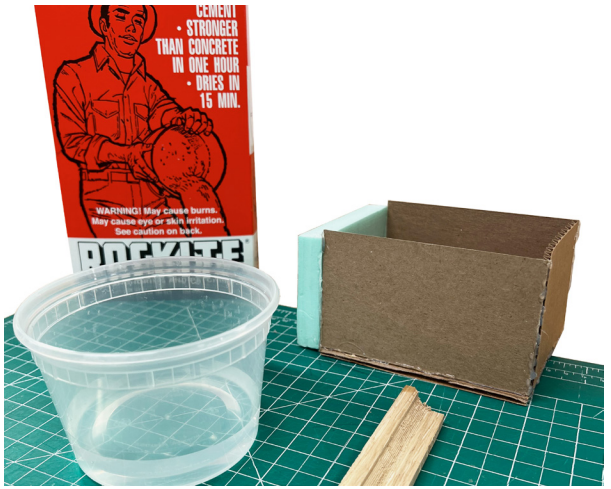
will have a large effect on the appearance of your cast model. Materials such as chipboard will give a matte finish to the cast, while acrylic or other smooth plastics will make the cast material appear glossy and polished. Wood will often convey the texture of its grain to the cast material, while styrofoam will create the impression of the foam bubbles which make up its surface. Other materials such as fabric and tin foil will lend unique textures to your cast model.

b. Mold materials will need to stand up to water and pressure. Porous and absorbent materials such as chipboard, cardboard, and foam-core can usually withstand the moisture of the cast for long enough to serve as productive mold materials. If you are making a very large mold that will hold a lot of cast material or have large flat surfaces, the mold materials will need to withstand the pressure of the liquid cast material, which can be quite heavy. Large flat surfaces in particular are at risk of bowing outward under pressure, which can be minimized by using a more rigid mold material or by reinforcing the surface with some perpendicular reinforcing strips on the outside of the mold.

Workspace Preparation

Once your mold is prepared, you will need to prepare a workspace for casting. You will need the following:

- Large tray or plastic drop-cloth (to help contain material in the event of a leak or spill).
- Completed mold.
- Casting material (rockite or plaster powder).
- Water (a bottle or cup of clean tap water).
- Mixing stick (a wood strip or other implement).



Casting supplies.

- Emergency leak repair (a hot glue gun is ideal, but a roll of masking tape can also help to patch minor leaks).

Mixing

Once your workspace is ready and your materials are on hand, you can proceed with mixing your rockite or plaster (instructions will be given for rockite here and a few differences for plaster are noted):

Mixing workspace.

1. In a clean plastic cup or bucket, mix together a small quantity of rockite and water. Mix these together with your mixing stick, making sure that there are no lumps or dry patches at the bottom. When mixing plaster, it is advisable to sift the powder into the water and let it soak for a minute or two before mixing. Always reference any specific mixing instructions on the product you are using.
2. Your rockite mixture should be about the consistency of pancake batter. It should be thicker than water but not as thick as honey. When poured into a container, the top should be flat and level and not create a mound.
3. Continue alternating between adding rockite and water and mixing until you have enough rockite mixed. Add water conservatively, as too

Consistency should be similar to pancake batter, no thicker than pictured here.

much water will require a lot more rockite to balance the mixture.

4. Try to mix a little bit more material than needed to fill your mold, as mixing two little and having to do a second pour will produce a visible line in the cast.

Pouring

Once your mix is ready proceed with pouring into the mold:

1. For an even cast, pour slowly and consistently into a single point in the mold, letting the liquid spread out across surfaces to fill the volume.
2. Once your mold is full, vibrating the mold will help to settle the material and work trapped air bubbles to the surface. This can be accomplished by tapping repetitively on the side of your mold for a minute, or, in durable molds, by pressing the top of an orbital sander or other vibrating tool against the side of the mold.

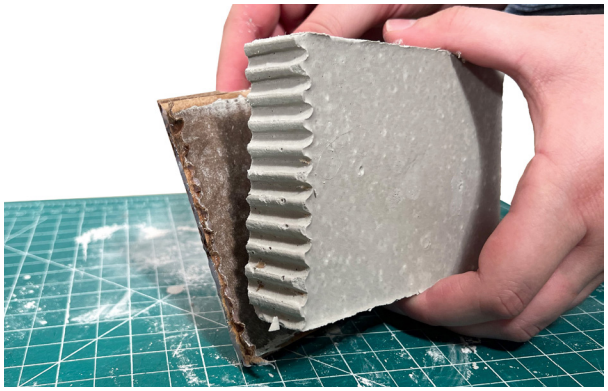
Removing the Mold

Timing for removing the mold is critical so that your mold does not adhere to your cast. If you need to leave your mold unattended after casting, you will need to use a mold release agent such as Vaseline to coat the interior of the mold and ensure you can remove your cast. This will usually effect the texture of your cast, so the alternative is below:

Pour slowly and consistently in a single location. For complex molds, rockite can be mixed slightly thinner than pictured here.

Curing Rockite.

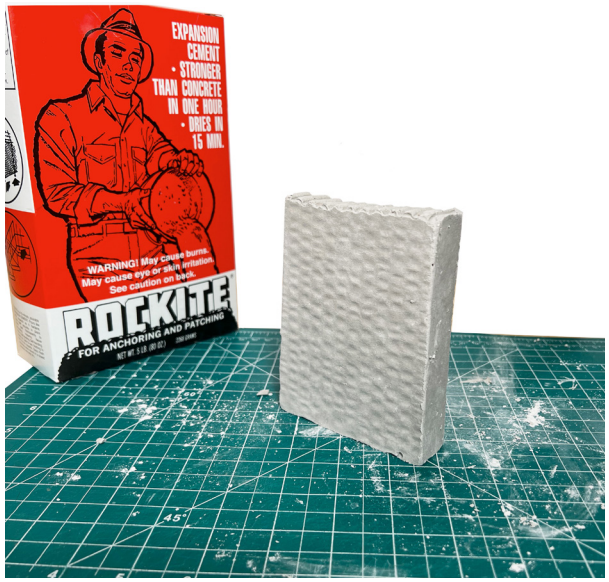
1. After pouring, let your mold sit until you can rub a fingertip across the exposed cast surface without rubbing any material off. Then, wait an extra minute or two for good measure. With rockite, this usually takes about 10-15 minutes after pouring.
2. At this point your cast will be solid but still warm and damp. Begin carefully removing the mold from your cast, taking care not to apply pressure to sharp corners or small parts, which are at risk of breaking.
3. Once your mold is removed, any mold material that has adhered to the cast (for example,



Removing the mold.

paper pulp from chipboard) can be removed by rubbing with a fingertip or eraser. It is best to do this immediately, as the longer you wait the dryer and more adhered the material will become.

4. Your cast is complete! Admire and share your hard work.



Completed cast (note rippled face due to moisture warping face of corrugated cardboard mold).

Digital Modeling: Tools & Materials
In a simple, conceptual sense, 3D digital modeling is a process of translating 2D geometry (points, and lines) into surfaces and volumes. One way to think about this process is to consider the materials, assemblies, and part-to-whole relationships of your projects. Conceptualizing the process should be critical toward the modeling strategy itself. Decisions about which parts of the modeling process employ additive or subtractive techniques should be tied to a larger set of questions that explore the construction logic, organization of the plan and section, programmatic use and functionality, and spatial sequences of a project.

Why Rhino?
There are a number of different 3D modeling softwares available to you and many of them share commands and workflows for generating and manipulating 3D surfaces and solids. This manual focuses on 3D digital modeling in Rhino as it is widely used by students and practicing designers for studying and developing designs in 3D.

We've touched on Rhino's 2D capabilities, but it is most well known for it's 3D modeling tools. This section builds on the previous Rhino section, focusing on the 3D modeling tools and best practices. Please review the section on digital drafting tools and techniques for information regarding file navigation, layer settings, object properties, and more.

Operating System
The examples presented here are shown in Rhinoceros 7 or 8 for Windows. Rhino is also available for macOS, and is very comparable in performance to the Windows version. The interface and location of some commands and settings will be different on macOS Rhino, but the concepts are all the same. It is recommended that you use Rhino for Windows, for ease of use working between programs, many of which were developed primarily for Windows.

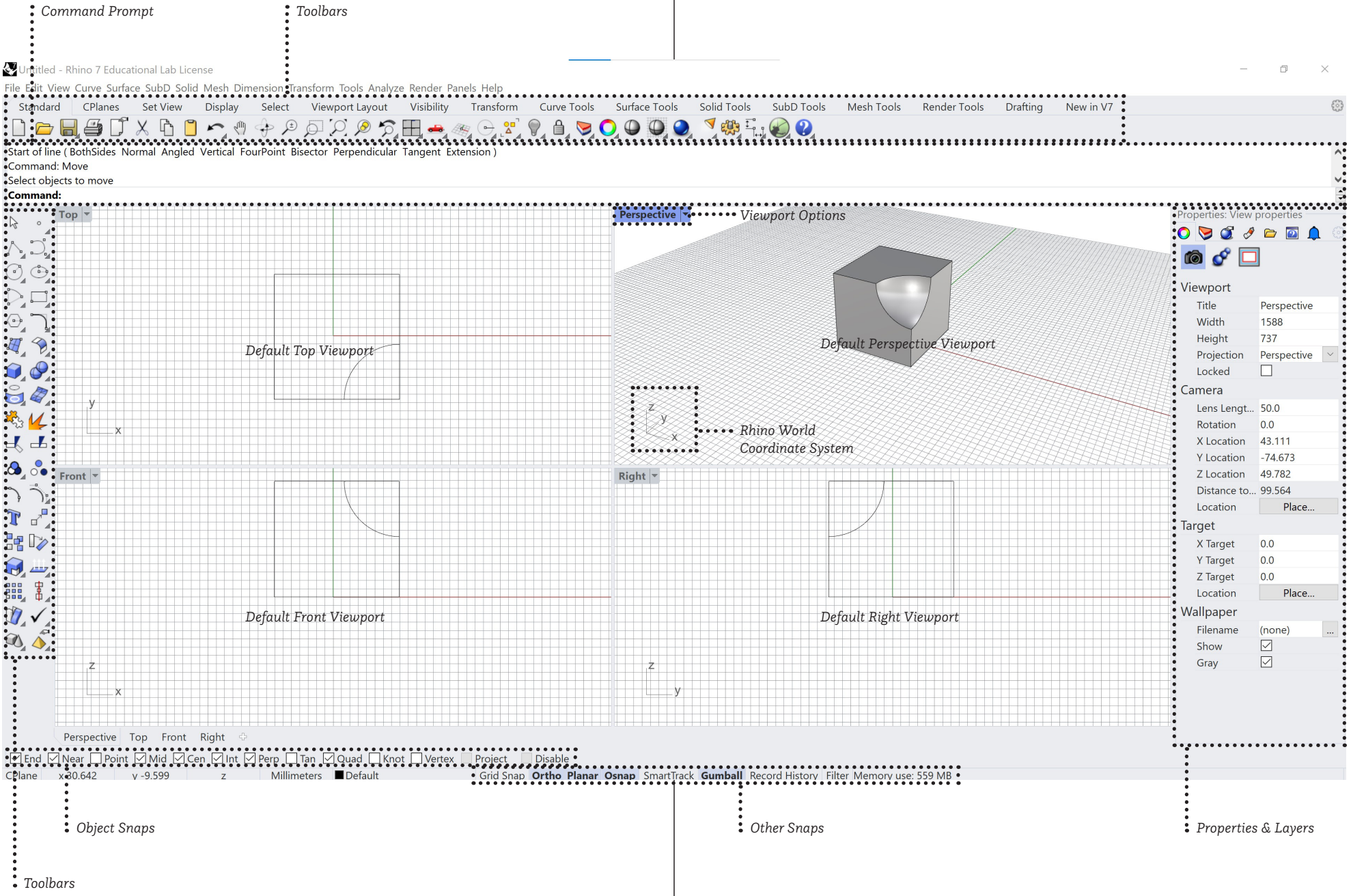
Commands
Many of the commands covered in this section describe common ways in which 2D geometry can be used to generate a 3D surface or solid volume in Rhino. This is by no means an exhaustive list as there are multiple methods for achieving this translation, but it covers the most common commands for working fluidly with points, lines, surfaces, and polysurface solids.

The Help menu, located adjacent to the Properties and Layers menus, is useful to keep open when you first start working in Rhino. When you initiate a command, it outlines the steps required to perform the action and describes each option within the submenu with illustrations and detailed steps.

Mouse
Like several other design programs, a computer mouse is absolutely necessary to properly use Rhino. The program will function without one, but navigating a 3D model will prove especially difficult and time intensive. Just use a mouse.

Modeling Commands	*(Possible Aliases or shortcuts in parentheses)*
Generating a Surface from Linework	
PlanarSrf (PS)	Generates a planar surface from planar curves
ExtrudeCrv (EC)	Extrudes a curve into a surface (or solid)
Loft	Lofts disconnected lines together into a surface
Patch	Creates a surface from complex curves or points
Sweep1	Lofts perpendicular lines into a surface
Revolve	Revolves a line about a radius to create a surface or solid
Generating a Polysurface Solid from a Surface	
CreateSolid (CS)	Creates a closed polysurface from individual surfaces
ExtrudeSrf (ES)	Extrudes a surface into a solid
OffestSrf (OS)	Offsets a surface from original destination a specified distance
Inset	Insets a surface from original location a specified distance (New in Rhino 8)
Modifying a Surface or Polysurface Solid	
Scale (S)	Scales in 3 dimensions
Scale1D (S1)	Scales in one dimension
Move (M)	Moves any object
MoveEdge (ME)	Moves an edge of a solid
MoveFace (MF)	Moves a face of a solid
Copy (C)	Copies any object
Trim (TR)	Trims intersecting objects
Rotate (RO)	Rotates an object on xy plane
Rotate3D	Rotates an object in z plane
Mirror (MI)	Mirrors an object about an axis
Boolean2Objects	Cycles through Boolean operations (Difference, Intersection, Split)

Cap	Closes open polysurfaces with a planar surface
Array	Arrays an object in x, y, and/or z axis
Explode (EX)	Explodes an object into its parts
Join (J)	Joins objects that are touching
Group	Groups objects to be selected together
Ungroup	Ungroups objects that are grouped
Hide	Hides objects from view
Show	Shows hidden objects
Extracting 2D from 3D	
DupFaceBorder (DF)	Extracts a boundary curve of a surface or polysurface
DupEdge (DE)	Extracts a curve from selected surface or polysurface
ExtractIsocurve	Extracts surface isocurves as separate curves
Section	Extracts a planar curve or points at the intersection of a defined cut line and an object within Rhino
Contour	Creates a series of sequential planar curves at points of intersection through a surface or solid
ClippingPlane (CP)	Plane that clips away geometry in specified viewports
ClippingSections	A series of clipping planes through selected objects
ClippingDrawings	Extracts sections and background geometry of Clipping Planes and projects the linework to a defined plane - typically the World Top plane
Make2D	Extracts selected object edges and outlines in a specified view and projects them to a defined plane - typically the World Top plane
Additional Modeling Aids	
UndoViewChange	Reverts back to previous camera view
ZoomExtents (ZE)	Widens the view to include all objects within the file
ShowSelectedObjects	Allows you to show certain hidden objects rather than all
NamedView (NV)	Allows you to save a specific view and return to it



Rhinoceros workspace.

Workspace

Viewports

The Rhino workspace by default consists of four viewports: Top, Perspective, Front, and Right. Any modeling work can be done in any of the four viewports, and you can switch between viewports mid-command. This can be helpful to move things in certain directions in a very controlled way. *Left-clicking* on the name of a viewport in the upper left corner will yield a variety of options.

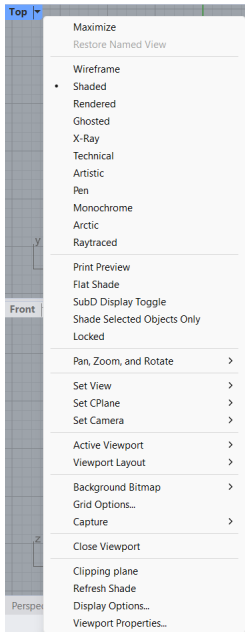
Double-clicking on the name of a viewport in the upper left corner will toggle between the four viewport layout and a single, full window viewport. This can also be changed via tabs at the bottom of the Rhino workspace. The view in each viewport is completely customizable, including isometric views which can be found in the viewport options drop-down menu under *Set View>Isometric*.

When working on a 3D model, you may find it helpful to work primarily in the Perspective viewport, but you continue to use the other orthographic views to precisely snap to certain elements. In this case, you can make the Perspective viewport larger than the others by clicking and dragging the intersection of the viewport windows.

Display Modes

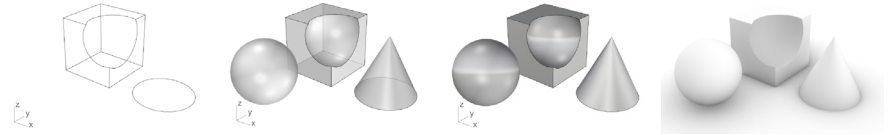
When building a digital model, display modes not only affect the precision with which a model is constructed but also the way in which it is perceived and understood. Rhino's default display modes offer a range of visibility options and lighting effects.

New display modes can be created or existing modes can be modified to facilitate and focus the reading of the model. Your most commonly used viewports will likely by *Shaded, Ghosted, Rendered, Monochrome*, or *Arctic*.



Viewport options drop-down menu.

Linkedin Learning: Display Modes



Wireframe *Ghosted* *Shaded* *Rendered*

Display Modes

The default display modes for a view can be adjusted by clicking on the drop down menu of any view. Default options include *Wireframe, Shaded, Rendered, Ghosted, X-Ray, Technical, Artistic, Pen, Monochrome, Arctic* and *Raytraced*. Certain modes use less processing power, allowing you to model efficiently.

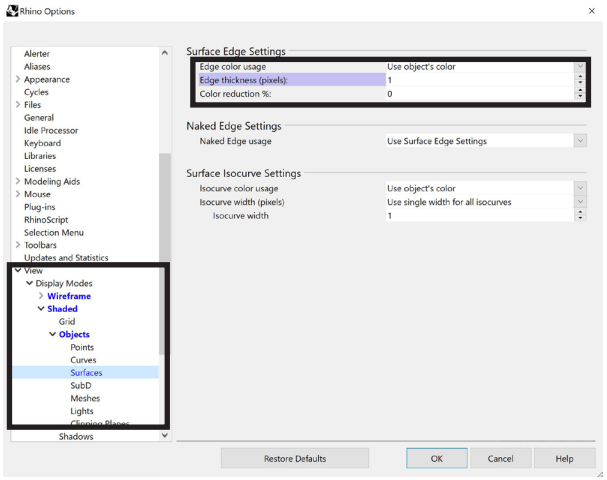
Wireframe is the lightest, but *Shaded, X-Ray* and *Ghosted* also work well. It is not recommended to use the other display modes while actively modeling as they render in real-time and tend to slow down your computer or obscure line, surface or solid snaps, edges and extents. The *SetObjectDisplayMode* command can be used to change a specific object's display mode within the view while maintaining the display mode of the view itself.

To create a custom Display Mode or to modify an existing mode, navigate to *Rhino Options>View>DisplayModes* in *Document Properties*. Here you can select a certain display mode (such as *Shaded* or *Ghosted*) and fine tune the display settings. If you select an existing mode, create a copy, rename it, and adjust the viewport, shading, visibility and lighting settings as needed.

Under *Objects>Surfaces>Edge Surface Settings*, reducing the edge thickness (pixels) to 1 will display the edges of objects in a much finer lineweight, and make the linework of your models less distracting.

Linkedin Learning: Exploring Viewport Features

Linkedin Learning: Viewport Navigation



Document Properties>
View>
DisplayModes>
Objects

In the same DisplayMode settings, you can disable "Show Isocurves," which will eliminate visualization of lines dividing surfaces in your model. These can be helpful when modeling surfaces with complex geometries, but are usually distracting when working with planar surfaces.

Changes made to DisplayMode settings will only have an effect on the selected display mode, so if you want certain characteristics to carry over to other views, you will need to change these settings on all the display modes you choose to use.

Model Navigation

Your model can be navigated using commands, but it is best to learn to do this quickly with your mouse and a few keyboard shortcuts:

Perspective & Parallel viewports:
- Orbit - *right-click+drag*
- Pan - *Shift+right-click+drag*
- Zoom - *mouse wheel*
  - or *Ctrl+right-click+drag*

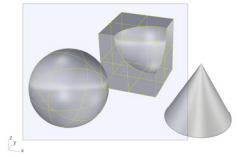
Linkedin Learning: Setting and Fixing Rhino Preferences

Zoom window, zoom extents, and zoom selected toolbar buttons.

Orbit will rotate the view around a fixed point in space. To reset this point on a specific object, use the Zoom window or *Zoom Selected* button (alternatively, select an object and use the *ZS* command).

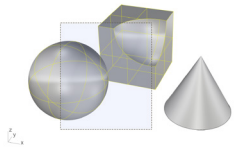
Selecting Objects

Objects in your model can be selected by left-clicking on them in any viewport. If objects are closely overlapping, Rhino will sometimes provide a small drop-down menu for you to select which object to select. To deselect objects, press down the Ctrl key while left-clicking on the object you'd like to remove from the selection. If objects are grouped or part of a polysurface or polyline, one click will result in a selection as opposed to clicking on individual items.



Left-click+drag to right = select objects entirely inside selection box.

Left-click+drag is used to select multiple objects. Dragging to the right will produce a selection box with a solid line edge, and only objects entirely inside the selection box will be selected. Dragging to the left will produce a selection box with a dashed line edge, which will also include any objects partially inside the selection box.



Left-click+drag to left = include objects partially inside selection box.

Snaps

Along the bottom of the Rhino workspace, you will find a toolbar with several snapping options. The previous Rhino section covers snaps related to drafting within Rhino. The ones listed here are additional snap options and settings primarily for modeling in 3D.

When building models in Rhino, it is often critical to be very precise in how objects are connected to one another. Several editing commands used to manipulate objects will not work properly if objects are not connected or intersecting properly. Problems like this usually arise from not using the correct snaps – it may look like two lines are perfectly

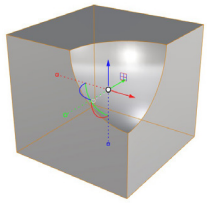
Linkedin Learning: Selecting Objects

connected to form a corner, but if you zoom in very close, you may realize that they are actually separated by a very small amount. Proper use of snaps will help to avoid these frustrations.

Planar
Planar snap is a tool that allows you to select a point at the beginning of a command, and automatically projects all other points to the same working plane as the first point. For example, if you wanted to trace the plan of a cantilever on the ground plane, you could use a combination of Planar snap and Object snap to achieve this. This setting is particularly helpful when 2D and 3D information exist within the same file.

Osnap
Osnap is short for Object Snap, an incredibly useful tool that will insure you are connecting objects precisely with zero tolerance. There are several *Osnap* options that can be individually enabled/disabled. A few of the snaps listed here are also listed in the previous Rhino section. They are included here to reiterate their significance in the modeling process:

End – endpoint
Near – nearest line/edge
Mid – midpoint
Cen – center of curve/surface
Int – intersection
Perp – point of perpendicular intersection
Tan – tangent point
Quad – quadrant point (maximum x/y coordinates) of circle or ellipse
Knot – knot point
Vertex – mesh vertex point
Project – this option projects the point you are snapping to onto the Rhino construction plane (xy plane by default)



Gumball tool.

Gumball
Gumball can be toggled on or off and is a tool that will appear in the Rhino viewports whenever an object is selected. It can be used to quickly move, rotate, or scale an object along the x, y, or z-axis, or to move an object around on the xy, yz, or xz plane. Use of the *Gumball* tool is a matter of personal preference – some find it fast and convenient, while others find themselves moving objects by mistake and prefer the precision of using move, rotate, and scale commands manually. Feel free to turn it on and off on the fly using the *Gumball* button in the snaps toolbar.

Layers

Layers are critical for keeping your files clean and organized so that you can model efficiently and make edits to large parts of your model in a quick and controlled way. There are many possible strategies for organizing your layers including by iteration, floor level, element, material type, or lineweight. It is recommended to experiment with a few strategies until you find the best method for you. Be aware of how long it is taking you to assign objects and make changes using layers – many basic operations can be repeated hundreds of times while building a complex model, so taking the time to reflect and improve your layer management strategy can save you substantial amounts of time when modeling.

A common strategy to try when starting out is to create layers for different categories of objects, which may vary depending on what you are modeling: frames, planes, and volumes for an abstract model; floors, walls, ceilings, and columns for a building; topography, streets, and buildings for an urban model; etc.

You can duplicate all of these objects as sublayers under layers for separate iterations, but your layers menu will become cluttered quickly. Another strategy for handling iterations is to construct a series of models in a row in Rhino (usually along the x- or y-axis), separated by a set distance so that it is quick and easy to move/copy objects between iterations and know they are located accurately.

Workflows

Workflows

Objects of design and architecture are often presented as the result of a clear operative process, making the journey of arriving at a design seem like a single path, where the final result was clear from the beginning, but in reality, the processes of design are far from linear.

Design is extremely iterative.

Iteration is a repeated process of thinking through making — in models and drawings — to develop, test, critique, and improve ideas. It requires risk taking and trial-and-error to arrive at the best possible design.

An iterative process can help you test, refine, and detail your ideas, and to discover new or unexpected possibilities. It is most productive to work iteratively in series, modeling or drawing multiple ideas quickly before stepping back to analyze, evaluate, and critique your designs either independently or with others.

Thinking through multiple, often different, solutions to a design problem helps determine what considerations take priority in developing the argument for your design solutions. This may involve testing several drastically different approaches to a design prompt before selecting a scheme or strategy to develop through further, focused iteration.

Working Across Media

Iteration often demands working across media and scales, through models and drawings, 2D and 3D, and analog and digital methods. The more adept you are at moving between different media, the quicker and farther your designs can progress. There are many methods for moving between design programs and between analog and digital production.

This section of the Production Manual presents a series of important workflows to help you move between various media and modes of production.

3D Modeling Workflows: Digital + Physical

Physical to Digital

When modeling by hand, it is important to work at a consistent scale for the ease of translation into digital drawing or model. To translate a physical model into digital model, measure directly from your physical model, and rebuild the model elements digitally at full scale. Scaled imported images of the top and sides of the model can also assist in its digital construction. Refer to the previous Rhino sections for information regarding file setup and best practices.

Digital to Physical

Often, you will need to produce quick physical models to test ideas that you have been drawing or modeling digitally. There will be times when you can 3D print or laser cut such models, but sometimes it can be faster or more productive to make these models by hand.

This can be done productively in a number of ways by printing drawings and using them a paper templates to cut your modeling material, such as bristol paper, chipboard, or foam. Another quick way of incorporating drawings into your models is to use an acetone transfer technique.

Acetone Transfer

Acetone is the main ingredient in many nail polish removers and can be found in the paint section of a hardware store. It can be used to transfer ink and give the illusion of a drawing or image having been printed directly on a variety of materials. It is a quick way of getting accurate dimensions and geometries onto a surface to then cut, fold, or glue to. A common technique is to transfer a plan drawing onto a sheet of material, cut along the lines to create floor plates, and glue vertical walls where walls are seen in the plan.
To acetone transfer a drawing:

1. Print a mirrored version of your drawing on a laser printer. The type of printer and ink matter. Drawings from a typical plotter will not work.
2. Prepare your material to transfer onto. Chipboard, museum board, basswood, Rockite, and plaster surfaces will all receive an acetone transfer well. Overly glossy surfaces such as shiny plastics usually will not work (although frosted or sanded plastic will).
3. Flip your printed drawing upside down and carefully position it on your model material. The printed side of the paper will be pressed against your model. Tape a few edges of the print down so that it is held in place.
4. Using a cotton ball, paper towel, or rag, apply a small amount of acetone to the back of the paper. It will quickly become saturated so you can see the image through the paper.
5. Using the back of a spoon or other smooth hard object, apply pressure and rub the paper against your model material. Rub the entire area of the drawing and make sure that the paper does not shift.
6. Remove and discard the paper. The ink from your printed drawing should now be attached to your model material.

Acetone is a chemical that gives off fumes. Use it in a well ventilated space and wear gloves if you are will be doing a lot of acetone transferring.

Importing: From 2D to 3D

Analog Drawing to Rhinoceros

Sometimes you may want to scan a sketch or analog drawing and then draw over it in AutoCAD or Rhino. This workflow is also effective for bringing satellite imagery into AutoCAD to trace elements for site plans or to study precedent projects by importing original drawings for analysis. You can easily bring scanned drawings or other image files into Rhinoceros. To keep scaling as accurate as possible, include a scale bar on your drawings or know the exact dimension of a specific element in your drawings, such as a door or stair width.

Open Reference Files in Rhinoceros

You can bring .jpeg, .png, and other image files into your Rhinoceros file. To do so you can simply drag the saved image file from the finder window into your .3dm file. Once you drag it in, you will be prompted by an 'Image Options' menu. Specify 'Picture' and click 'OK.' Click into Top view and specify the image extents.

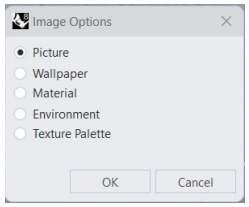


Image Options Prompt.

You can also bring in image files using the *Picture* command:

1. Type the *Picture* command and press *Enter*.
2. Click once in your Rhino file to choose where to place your image, and again to determine its size, which can be adjusted later. Your image will now be an object in your Rhino file.

Scaling

You can use the *Scale* command to accurately size your image based on a particular line, shape, or other object length in the image:

1. Type the *Scale* command and press *Enter*.
2. Select your image to scale and press *Enter*.
3. For 'Base point,' click one end of the reference length in your image.
4. For 'Scale factor or first reference length,' click the other end of your reference length in your image.
5. For 'Second reference point,' you can either click again to set a distance manually, or type in the actual dimension of your reference length and press *enter*. Your image will be accurately scaled. You can now build a model on top of it.

Since it is advantageous to work at full scale in Rhino, use the actual or real world dimension to scale your drawing, not the dimension of the drawing or model. For example, if you draw a 1/16”=1'-0" scale drawing of a square that is 16’x16’ in reality, you would use 16’ as your known distance, not the 1” length of the square’s side on your paper.

Once confident in the scale of the base image, you may next begin “roughing out” your drawing, first with construction lines as guides. Save your imported image onto its own layer, giving you the ability to lock it in place or turn it on or off as needed while drafting.

Analog Drawing to AutoCAD

Open Reference Files in AutoCAD You can bring .jpeg, .png, .pdf, and other files into your AutoCAD drawing. To do so:

1. Type the *Attach* command and press *enter*.
2. A 'Select reference file' dialog box will appear. Choose your file to open and click 'Open.'
3. A 'Attach image' dialog box will appear. 'Scale' and 'Insertion point' should both be set to 'Specify on screen by default. Click 'OK.'
4. Click once in your model space to choose where to place your image, and again to determine its size, which can be adjusted later.

Scaling

You can use the *scale* command to accurately size your image based on a particular line, shape, or other object length in the image:

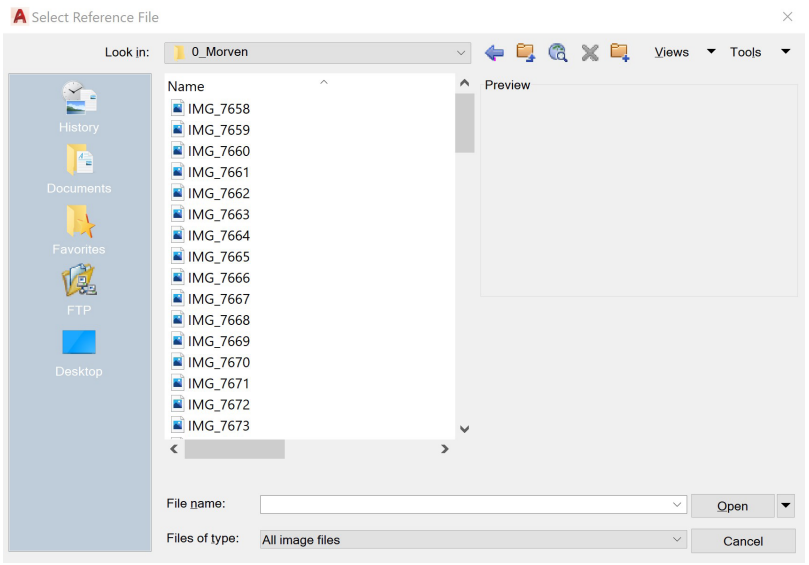
1. Type the *scale* command and press *enter*.
2. Select your image to scale and press *enter*.
3. To 'Specify base point,' click one end of your reference length.
4. The command prompt will ask you to 'Specify scale factor.' Instead, click 'Reference.'
5. Click the start and end points of your reference length in your image and press *enter*.
6. Type in the actual dimension of your reference length and press *enter*. Your image will be accurately scaled. You can now draft on top of it.

AutoCAD to Rhinoceros

This workflow might be helpful if you have drawn a plan in AutoCAD and now want to test how it works in 3D, or make renderings for a project.

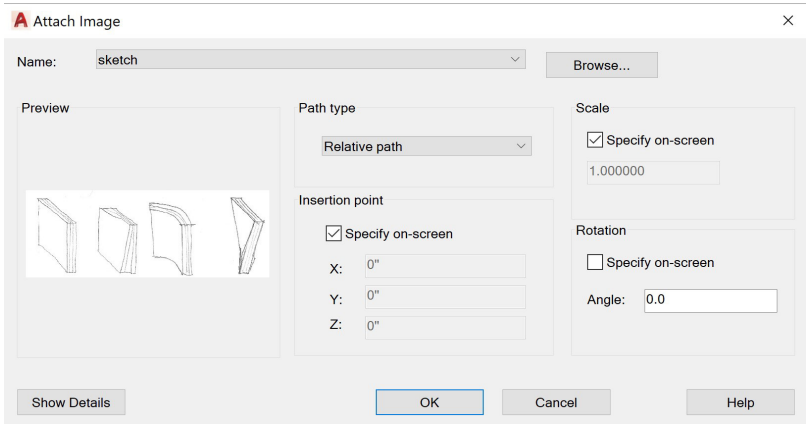
.dwg files

AutoCAD is a powerful tool for drafting and developing drawings. Rhino is a powerful tool for 3D



Select reference files

modeling. When used together, you can take models



Attach image.

developed in Rhino and turn them into architectural drawings in AutoCAD. Conversely, you can also take drawings from AutoCAD and turn them into 3D models in Rhino.

This process is quite straightforward, given that both programs can read and generate .dwg files, which contain vector graphics — your linework.

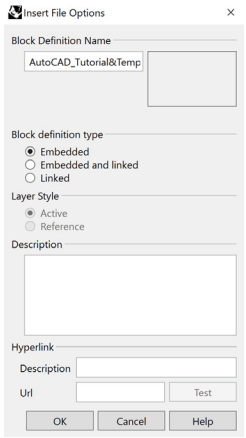
Vector graphics are mathematically defined, meaning each point, line, and shape can be infinitely scaled and not lose quality or resolution.

Opening .dwg files in Rhino

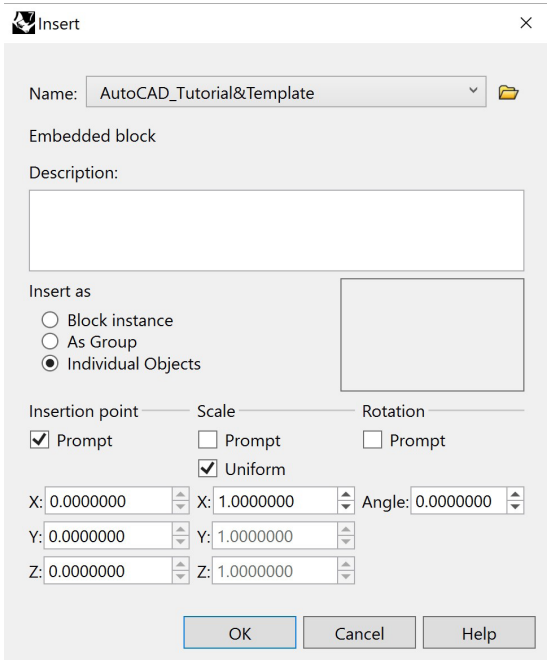
The default AutoCAD file type is .dwg, which can be opened in Rhino. You do not need to do anything specific when saving your AutoCAD file to open it in Rhino:

1. In Rhino, type the *Insert* command and press *Enter*.
2. An 'Insert' dialog box will appear. Click the folder icon on the upper right and select your .dwg file to open. You should not need to change anything in the 'Insert file options' box that appears, so just click 'OK.'
- Under 'Insert as,' check either 'As group' or 'Individual objects.'
- Under 'Insertion point,' check 'Prompt.'
- Make sure that 'Scale' x, y, and z values are set to 1.0. If your AutoCAD and Rhino files are both set to inches, this will import your drawing at the correct scale.
- Click 'OK.'
3. Click on the screen wherever you would like to place your file.

You can now start using 2D to 3D commands such as *Extrude* to begin creating a 3D model from your linework. Plans can be extruded upward, and sections can be positioned vertically using *Rotate3d* before extruding.



Insert file options.



Insert options.

Exporting: From 3D to 2D

Rhinoceros to AutoCAD

You will often develop a 3D model in Rhino and then need to produce drawings of your design. There are a few strategies you can use to expedite the process of getting your drawing started, before further developing and detailing it in AutoCAD.

Make2d

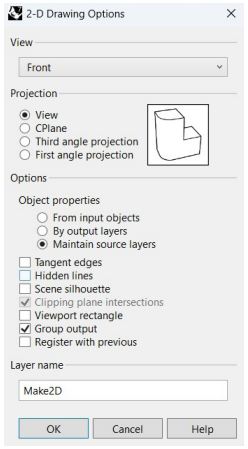
When working from a Rhino model, basic linework can be generated with the *make2d* command:

1. In Rhino, highlight your entire model (remember objects on locked layers will not be selected).
2. Type the command *make2d* and press enter.
3. A dialog box — '2-D Drawing Options' — will appear with many options for your linework.

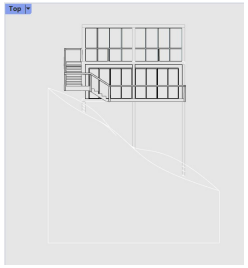
- Under 'view' there is a drop down menu where you can select which Rhino viewport you are making 2D.
- Checking 'Maintain source layers' means your linework will maintain the layer organization of your 3D model, which will carry over to AutoCAD and make it much easier to work with your drawing.
- Checking 'Hidden lines' will generate linework from objects hidden behind others in the view.

Working in a front view to generate linework for an elevation.

Select every object needed for linework.



Make2d options.



Make2d linework in top view.

Linkedin Learning: Make2D

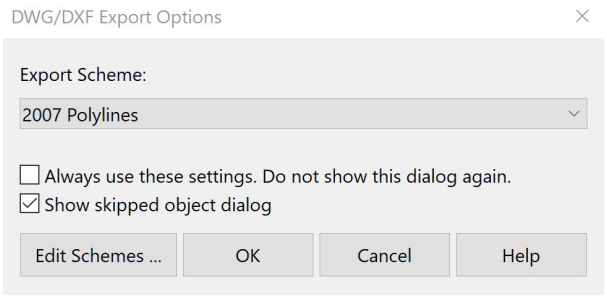
- These lines will be assigned to separate hidden lines layers that can be easily turned off if not needed.
- Checking 'Scene silhouette' will generate linework on a separate layer that outlines the outermost edges of objects you are drawing. This can also be done manually and with more control after you have 2D linework using the *curveboolean* command.
- Checking 'Group output' will automatically group your linework, which can later be undone with the *ungroup* command.
- Click 'OK' to execute the command.

4. The 2D linework will appear in the top view near the origin point. It is important to move your linework as soon as you generate it, because all *make2d* linework will be deposited to the same location in your Rhino file. You will now have basic linework for your drawing, ready to take into AutoCAD.

Exporting

Once you have generated 2D linework from your model, make sure it is flat on the horizontal drawing plane in Rhino. Errant 3D information may create issues with snaps in AutoCAD. To bring your linework into AutoCAD:

1. Select your linework.
2. Go to *File>Export Selected...* A dialog box will appear for you to name and choose where to save your file. Under 'Save as type:,' select 'AutoCAD Drawing File (*.dwg).' Click 'save.'
3. A 'DWG/DXF Export Options' dialog box will appear. When bringing drawings to AutoCAD, you will usually want to select '2007 Polylines' and click 'OK.' Your file will be saved.



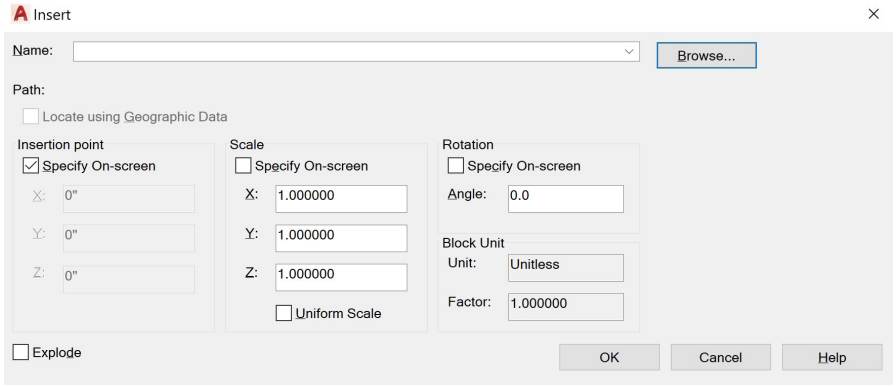
DWG/DXF export options.

4. There are two options to open this file in AutoCAD:

- Double click the file or start a new file in AutoCAD and type the command 'open.' From here, a window will open stating that this is a foreign .dwg file. Click 'Continue opening DWG file.' Your file will now be opened in AutoCAD.
- Alternatively, you can insert this new linework into an existing AutoCAD file, so that you can continue to work with any existing layers and lineweights. Type the *insert* command and press *enter*. An 'Insert' dialog box will appear. Click 'Browse...' and select your file to open.
- Check 'Insertion point>Specify on-screen.' Under 'Scale,' make sure x, y, and z are all set to 1.0. If your Rhino and AutoCAD files are both set to inches, your drawing will automatically import at the correct scale. Click 'OK' and then click a location in your AutoCAD model space to place your new linework.

Notes

It is important to remember that the *Make2d* workflow from Rhino does not produce a finished drawing, but rather basic linework with which you can construct a drawing. This linework will usually require a bit of work to clean up inconsistencies before assigning it lineweight through your layers and then continuing to develop it as a 2D drawing.



AutoCAD insert options.

When modeling in Rhino, you often do not need to worry about modeling every single detail. Bringing basic model linework into AutoCAD is a great way to draw in details that would be overly complicated and time consuming to model in 3D. Also, the more complicated a Rhino model is, the more clean up required once you have exported to AutoCAD.

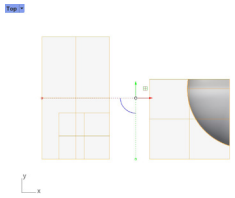
Techniques: Axonometrics in Rhinoceros

Making an Axonometric (Plan Oblique) View
Rhino has built in isometric views that can be set by clicking on the name of any viewport and selecting *Set View>Isometric*. If you want to make a plan oblique axonometric, there are a few easy steps to follow:

1. Your model will be distorted within Rhino through this process. You should either save another copy of your file or duplicate your models within Rhino using the *Copy* command before proceeding.

2. Select the model(s) you want an axon of and select them in the Top viewport.

3. To streamline the process, you can copy-paste one of the macro commands below directly into the Command Prompt in Rhino. Each command will make an axon rotated at the underlined number. You can also change this number to any angle you like for future use. For now, try the 30 or 60 lines below:



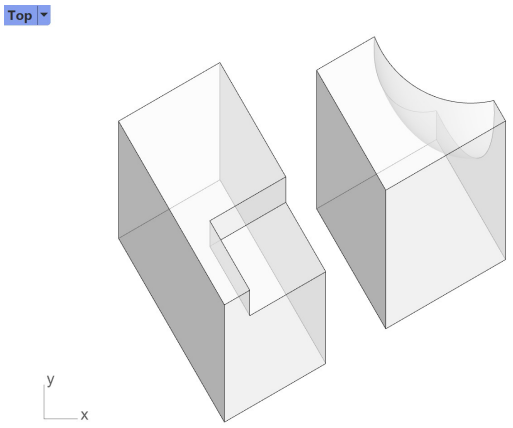
Select objects in the top viewport.

! _Select _Pause _SetActiveViewport Top _ Rotate 0 45 _SetActiveViewport Right _Shear w0 w0,0,1 -45 _SetActiveViewport Top _Zoom _All _Extents

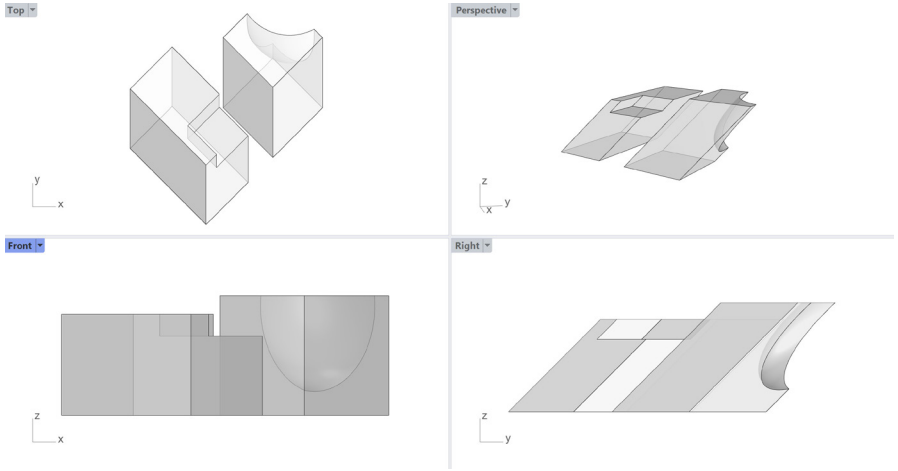
! _Select _Pause _SetActiveViewport Top _ Rotate 0 30 _SetActiveViewport Right _Shear w0 w0,0,1 -45 _SetActiveViewport Top _Zoom _All _Extents

! _Select _Pause _SetActiveViewport Top _ Rotate 0 60 _SetActiveViewport Right _Shear w0 w0,0,1 -45 _SetActiveViewport Top _Zoom _All _Extents

4. When you paste the command into Rhino, your model will be rotated and sheared to create an axon view in the Top viewport. If your model leaves the viewport, it will still be selected, so you can use the Zoom command to zoom to selected objects and locate it. The model will be distorted in other viewports – this is why it is important to copy your model before starting this process.



Resulting plan oblique axonometric view.



Model is manually sheared to create an axon view.

Making an Axonometric View Manually

Axonometric views can also be made manually in Rhino with a few manipulations to a model. Again, it is important to save a copy of your model before starting this process, as it will distort your model.

1. To make a 45 degree axon, start with top and right viewports visible.

2. Rotate your model in an increment of 45 degrees. Depending on the view you are trying to capture, other degrees of rotation can be used.

3. Working in your right viewport, highlight your model and type the command 'shear.'

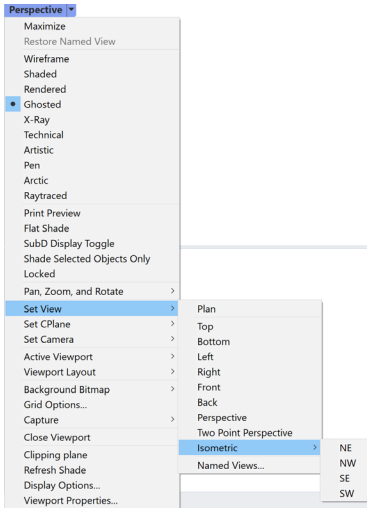
4. Click the bottom, left corner of your model as the base point.

5. Click above your model anywhere, keeping the shear line completely vertical.

6. Type '-45' in the command bar and press 'enter.'

7. Your model in a 45 degree axonometric view will be visible in the top viewport.

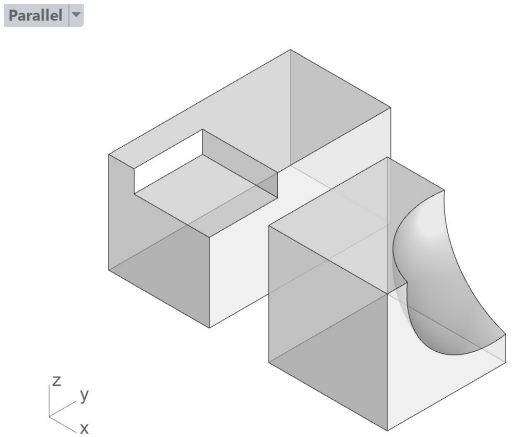
Viewport>
Set View>
Isometric



Isometric View

Isometric views are built into Rhino. To set an isometric view, click the viewport name at the top left of any viewport and select *Set View>Isometric*, then select one of the preset isometric views based on cardinal directions (NE, NW, SE, or SW).

The viewport with now be set to an isometric view with parallel projection. If you rotate the view, it will maintain parallel projection but will rotate around as with a perspective view.



Resulting isometric view.

Editing and Publishing

Adobe Creative Could

The Adobe Creative Cloud is a collection of software applications used to create graphics, edit photographs and videos, develop websites and apps, and more. Several Adobe programs are widely used in architecture school and in other design fields and professions. The Creative Cloud can be purchased at a discounted rate through Cavalier Computers through the QR code below. This section will introduce three commonly used Adobe programs: Photoshop, Illustrator, and InDesign.

Photoshop, Illustrator, and InDesign work hand in hand with the drawings, renderings, and other outputs explained in the Production Manual. Learning when to use each software begins by understanding the differences between Raster Images (Photoshop), Vector Graphics (Illustrator) and Publishing processes(InDesign). Each of these softwares has excellent translational capabilities with other drafting/digital software and analog production methods. This makes it easy to integrate into current workflows and adapt to future ones as well.

UVA Cavalier Computers: Purchasing Adobe Creative Cloud

Key Terms

Photoshop	A powerful photo editing and raster graphics software developed by Adobe
Illustrator	a vector graphics software developed by Adobe, used to edit in vector files exported from Rhino, AutoCAD, and other softwares
InDesign	a publication software developed by Adobe, used to create plot layouts, portfolios, books, and more
raster	an image made from pixels, can be scaled down and not lose quality but loses quality and becomes pixelated when scaled up
vector	a mathematically defined image format, meaning each point, line, and geometry can be infinitely scaled and not lose quality or resolution
workspace	the combination of panels, toolbars, and windows available on screen
panels	small, docked windows that contain controls, options, and settings

Photoshop

Why Photoshop?
Photoshop is a very powerful and versatile program for editing, manipulating, and creating images. Photoshop is one of many programs within Adobe Creative Cloud, a subscription service that can be obtained for a discounted rate through UVA Cavalier Computers. Once you have a Creative Cloud subscription, you will need to download and install Photoshop, which is available for both Windows and MacOS. Photoshop should function nearly identically on both systems, but there may be some variation in where tools are located. This document will show examples in the Windows version of Photoshop.

This Chapter Introduces:

Getting Started and Workspace Navigation
Photoshop Essentials Workspace Example
Layers
Tools
Image Adjustments
Transform
Saving
LinkedIn Learning supplemental material

Opening Images
Images can be easily opened in Photoshop by either dragging into the program window, or under *File>Open....*

Workspace Navigation
A Hand tool for panning and a Zoom tool can be found in the left toolbar, but it is faster to use a mouse and keystrokes below:

Scroll up/down: *mouse wheel*
Scroll left/right: *ctrl+mouse wheel*
Zoom: *alt+mouse wheel*
ctrl++ (zoom in)
ctrl+- (zoom out)

File settings
Image>Image Size... opens a dialog box where you can edit the width and height of your image in various units (pixels, inches, etc.) as well as change the image resolution. The small chain link icon maintains image proportions. These options can be helpful to check if you have an image that has an unexpectedly large file size. Since Photoshop is primarily a raster program, and images that you reduce in size and then enlarge again later will suffer from a loss in quality. It is a good idea to keep an unedited version of your images in case you need to edit them differently in the future.

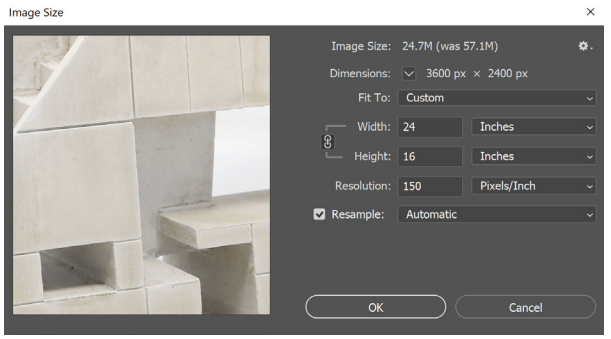
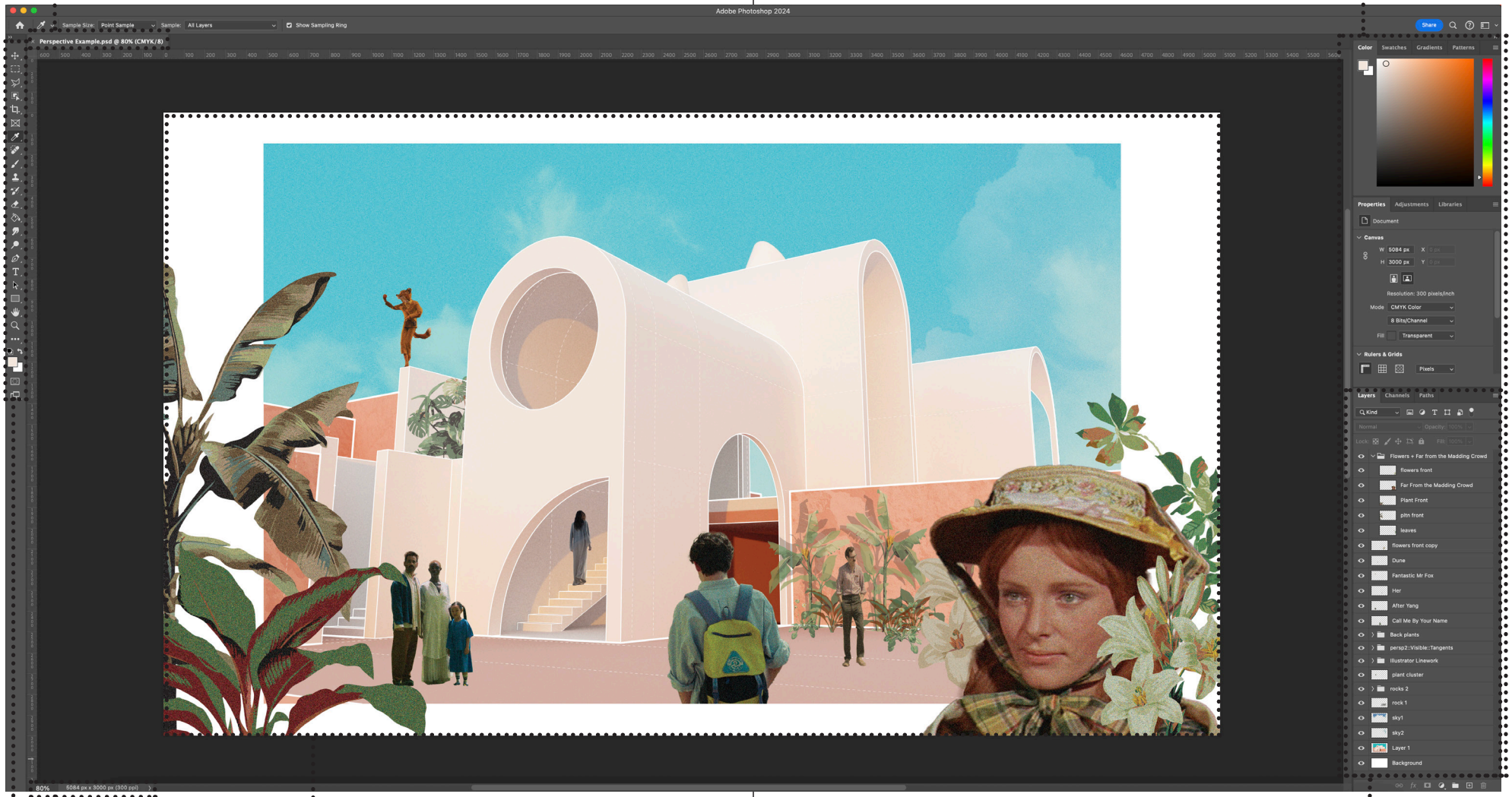
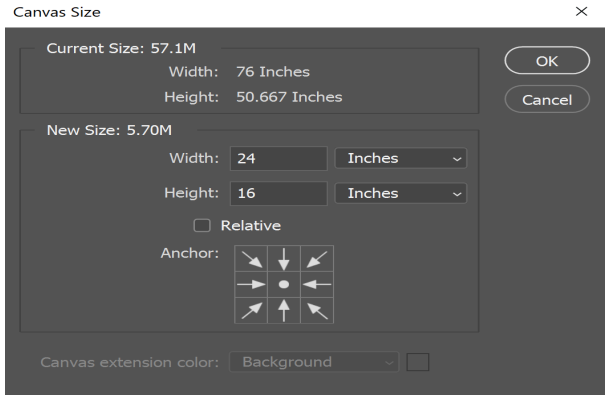


Image size.



Default Photoshop 'Essentials' Workspace.

The default Photoshop workspace is called 'Essentials' and contains most or all of the tools you will most commonly use. If you are missing a certain tool or menu item in your workspace, it can likely be turned on via the Window dropdown menu at the top of the screen.

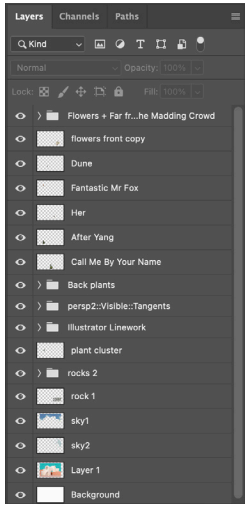


Canvas size.

Image>Canvas Size... will open a similar dialog box to edit the width and height of the Photoshop canvas. This will essentially change the bounds of the frame that your image exists within and will not affect the size of the original image.

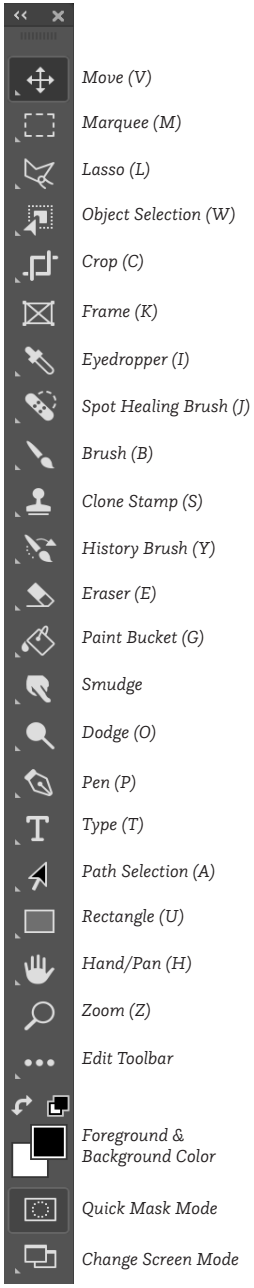
Layers

Like many other design programs, Photoshop uses a layer system to control the various properties of groups of objects. The Layers menu is found in the tools to the right side of the screen. When opening a JPEG image, you will find a single layer in your file named "background." Click the lock icon next to the layer name to unlock it and make it editable – you will see the lock disappear and the layer name change to "Layer 0." Also in the Layers menu are options to change the opacity, fill, and mode of the layer, and you can edit the layer name by double-clicking on its text. *Double-clicking* on the layer thumbnail will open the Layer Style dialog box, which contains a series of various style effects including stroke, glow, shadow, etc. To the left of the layer thumbnail is an eye icon that will toggle the visibility of the layer.



Layers panel.

When working with a file that has multiple objects, it is good practice to organize and name layers accordingly. You can also create groups to further keep your file in order.



Tool Icons

Tool Icons

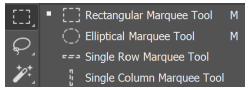
Many of the toolbar icons along the left side of the screen will show small thumbnail videos of their various effects when you mouse over the icon. This also produces a "Learn how" button that will open a simple set of instructions explaining the use of the tool, which can be very helpful. A small arrow symbol to the lower right of a tool icon means other related options are available and can be accessed by *right-clicking* or *left-clicking* and holding on the icon.

Selecting Tools

When making targeted adjustments to your image in Photoshop, it is often helpful to select specific regions of your image to manipulate.

Marquee (M)

The Marquee selection tools allow the quick selection of rectangular or elliptical regions within your image.



Marquee tools.

Lasso (L)

The Lasso tools allow for the more manual selection of regions in the image. The Lasso tool is completely freehand with your cursor, the Polygonal Lasso tool allows the creation of a series of polygon corners with a series of mouse clicks, and the Magnetic Lasso tool will automatically snap to nearby edges within the image.

Lasso tools.

Object Selection/ Quick Selection/ Magic Wand (W)
The Object Selection tool recognizes people, skies, water, and other items in an image. When hovering the mouse above the image, the object will be highlighted in pink. The Quick Selection tool recognizes edges along an image. The Magic Wand tool allows for the targeted selection of specific colors or tones in the image. The tolerance or range of the selection can be adjusted, as well as if the selection is a single contiguous region, or all applicable regions across the image.

When using each of these tools, the degree of 'feather' (measured in pixels) can be adjusted in the top toolbar. This will adjust the crispness or blur of the edge of your selection. Selected regions will be visible with a dashed line edge. *Right-clicking* on a selected region while a selection tool is active will pull up a drop down menu allowing you to move or copy the selection to a new Photoshop layer ('Layer Via Copy' or 'Layer Via Cut'). Selections can be quickly deselected with *ctrl+D*.

Crop (C)
As the name implies, the Crop tool allows you to crop your image, which will also change the size of the canvas. Clicking and dragging the corners and edges of the crop box will resize it. Holding shift while dragging will lock the box proportions. You can also input a specific ratio or dimension at the top of the screen.

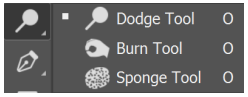
Another tool within the Crop icon is the Perspective Crop tool, which will allow you to crop and correct perspective in one step. Correcting perspective can also be done with the transform tools discussed below.

Quick Selection and Magic Wand tools.

Object Selection tool identifies woman.

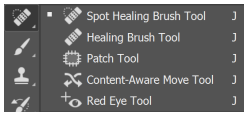
Quick Selection tool recognizes the edges of the opening.

Magic Wand recognizes the blue background of the base image



Dodge, Burn and Sponge tools.

Richer colors and contrast created with Dodge, Burn and Sponge tools



Healing Brush tools.

Touchup Tools
Dodge/Burn/Sponge
The Dodge, Burn, and Sponge tools are brush tools that can be used to make targeted adjustments to specific regions of your image.

Dodge will lighten the image, and you can use the tool menu adjustments along the top of the screen to change the size of the brush, the range of tones to effect (highlights, mid-tones, shadows), and the exposure level. For most fine-tuning adjustments, a very low exposure level (5% or lower) is recommended.
Burn works the same way as Dodge but will darken instead of lighten.
Sponge works in a similar manner to Dodge and Burn but can be used to either increase saturation or to desaturate specific regions of the image.

Spot Healing Brush
The Spot Healing Brush can be used to paint over undesirable smudges or marks in the image and will remove them by automatically detecting neighboring parts of the image to predict the colors, tones, and textures that should fill in where the marks are removed. Choose a brush size that closely matches the size of the marks to remove, but make sure that you paint over them entirely.

Healing Brush
The Healing Brush works in a similar manner to the Spot Healing Brush, but instead of automatically predicting how to fill the region in, it allows you to control and select how this is done. Once you have the Healing Brush tool selected, use *alt+left-click* to select a point in you image. This will be the starting point in your image that will be used to paint over other parts of the image. This is particularly useful for correcting distortions along straight edges in your photos, and other fine details.

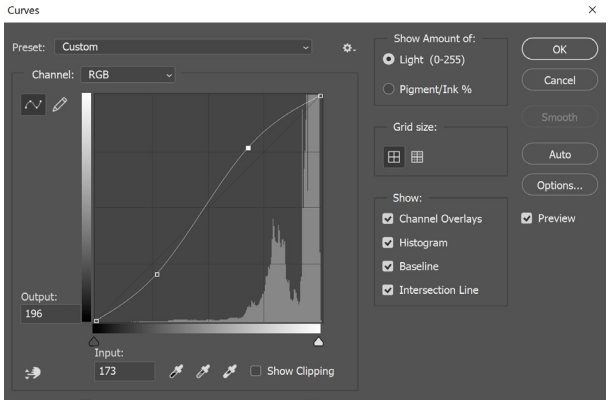
Clone Stamp
Clone Stamp works in a nearly identical manner to the Healing Brush, but also allows you to adjust the opacity of the corrections you are making.

Clone Stamp tools.

Image Adjustments
If editing a single image or a layer within a Photoshop file, you can make significant ___ changes using the multiple Adjustments features. They can be found on the Top Menu Bar, under *Image*.

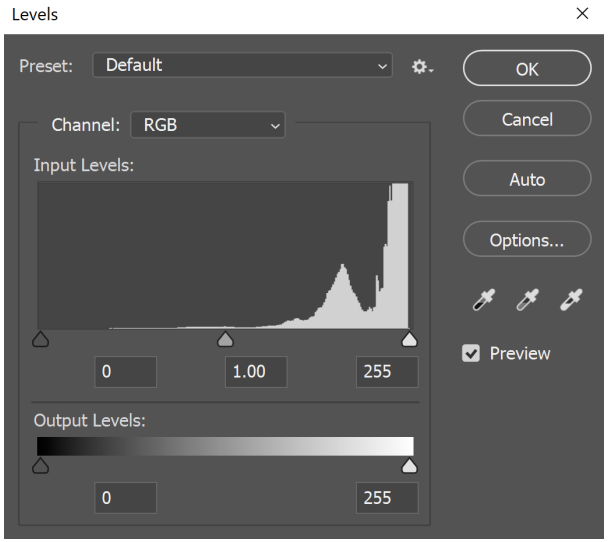
Brightness/Contrast
Image>Adjustments>Brightness/Contrast will bring up a dialog box with two sliders to adjust the brightness and contrast in your image. The 'Preview' check box will toggle the display of your image between the original and adjusted versions. The 'Auto' button will automatically adjust both sliders based on the tones and brightness of the image. You can try this as a starting point, but typically you will want to make these adjustments manually to more carefully control the final image.

Curves (ctrl + M)
Image>Adjustments>Curves... Here you can edit both the brightness and contrast of the image in a very controlled way. This is done by manipulating the curved line over the visible graph. Additional control points can be created to adjust the curve by clicking on the curve. Each end of the curve will control the lighter and darker tones in the image. If you want to increase the contrast in your image, pulling the left side of the curve down and the right side up will make the darks darker and the lights lighter. If you want to make the image brighter or darker overall, you can adjust the middle parts of the curve up or down, respectively.



Curves dialog box.

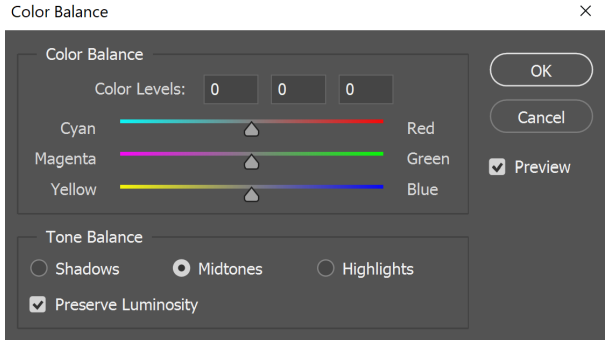
Levels (ctrl + L)
Image>Adjustments>Levels... Controls the range and distribution of input and output levels. The input levels graph has a slider bar below that allows for several adjustments. Manipulating the left end of the slider will make the dark parts of the image darker, while the right end of the slider will make the light parts of the image lighter. Shifting the center of the slider to the right or left will adjust the brightness of the middle tones in the image. Similarly, adjusting the output levels slider will change the brightness of the lighter and darker tones in the image.



Levels dialog box.

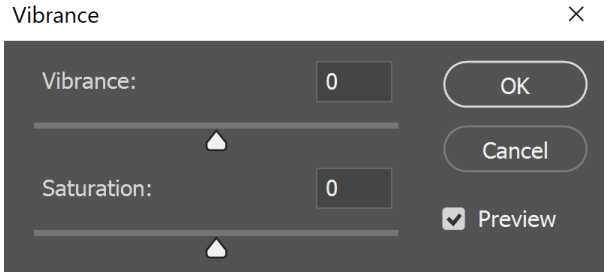
Experiment with both Curves and Levels to determine what method you prefer for editing your images. In general, Curves is helpful for fine tuning middle tones and adjusting contrast in a very controlled way, while Levels is helpful for adjusting the brightest and darkest parts of the image, as well as overall brightness.

Color Balance (ctrl + B)
Image>Adjustments>Color Balance... Adjusts the color tones in an image. Adjusting the three sliders will shift the various color tones (cyan-red, magenta-green, and yellow-blue). The top and bottom sliders in particular will be helpful in correcting warmer or cooler tones in your image that may be a result of the type of lighting or bulbs you are using in your model photography. These adjustments are made specifically to the shadows, mid-tones, or highlights in the image, and these modes can be selected using the three buttons under 'Tone Balance.' Often you will want to try adjusting the sliders in each of these three modes to achieve the overall corrections you are looking for



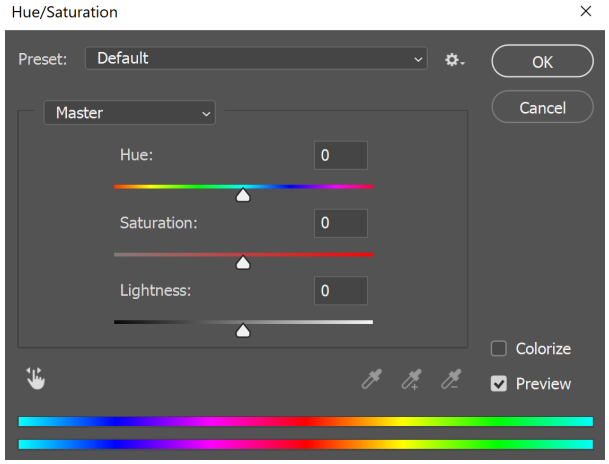
Color Balance dialog box.

Vibrance
Image>Adjustments>Vibrance... will bring up the Vibrance dialog box. This allows for another degree of control over the vibrancy and saturation across either the whole image or the currently selected region. This is also helpful to easily correct for overly warm or cool tones in images.



Vibrance dialog box.

Hue/Saturation (ctrl + U)
Image>Adjustments>Hue/Saturation... (or ctrl+U) will bring up the Hue/Saturation dialog box. This can be used to adjust the degree of saturation in the image and the overall color hue. More targeted color adjustments can be made to specific color tones by selecting one of these (reds, yellows, greens, etc.) from the 'master' drop down list.



Hue/Saturation dialog box.

Rulers & Guides

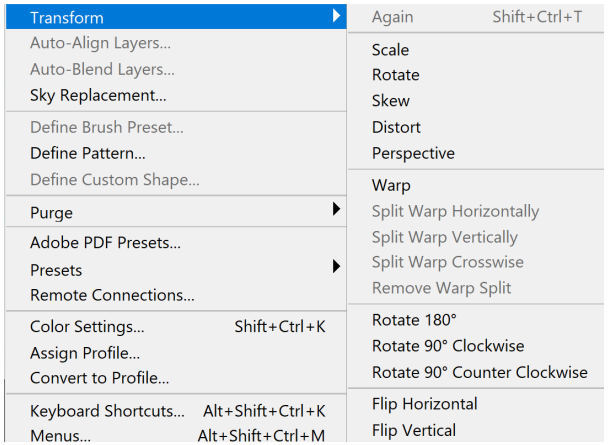
When straightening or adjusting your image, it is often helpful to have some orthogonal guides over the image. This can be easily done using rulers and guides. *View>Rulers (or ctrl+R)* will turn on rulers along the top and left side edges of your work-space. The units of the rulers can be changed by *right-clicking* on them. *Left-clicking and dragging* on either the top or left ruler will create either a horizontal or vertical guide over your image, re-spectively. Once created, these guides can be moved by *left-clicking and dragging* them, and can be either locked or deleted through *View>Lock Guides* or *View>Clear Guides*.

Transform

Photoshop has a series of transform tools that allow you to easily scale, rotate, stretch, and otherwise distort your image. These can be found under *Edit>Transform.*

Free Transform can also be activated with *ctrl+T* and can be used to resize and rotate your image. *Holding shift* while performing these operations will toggle between various snaps and settings, such as maintaining the original image proportions and snapping to orthogonal angles.

Other transform tools allow you to distort the image in specific ways, which can be helpful to correct and straighten the perspective in an image. The perspective and skew transformations are helpful in this regard, and the warp transformation can help adjust for arcing of straight edges due to lens distortion. It is easy to overly distort your image using these transformations, so use guides to help you target and align edges.



Edit> Transform.

Saving

When saving your work in Photoshop, pay attention to the file type you are saving. Saving a Photoshop (.psd) file will save all of your layers and Photoshop settings so that you can continue editing your file where you left off. Saving a JPEG (.jpg) file will flatten all of your layers and leave you with just an image, meaning the ability to edit individual layers will be lost. Saving as a .jpg means the file size will be much smaller, and that the file can be opened and inserted into a variety of other programs, while a .psd file can only be opened in Photoshop or placed into InDesign.

It is recommended to save a .psd file to preserve editing capabilities while working on your image, and to save a high quality .jpg file once you are have finished editing the image.

LinkedIn Learning: Adobe Photoshop

A Tour of the Interface

Panning and Zooming

Exploring Layer Basics

Using the Crop Tool

Marquee and Lasso Tools

Healing, Patch & Clone Stamp

Free Transform

Blend Mode Basics

Saving and Exporting

Illustrator

Why Illustrator?

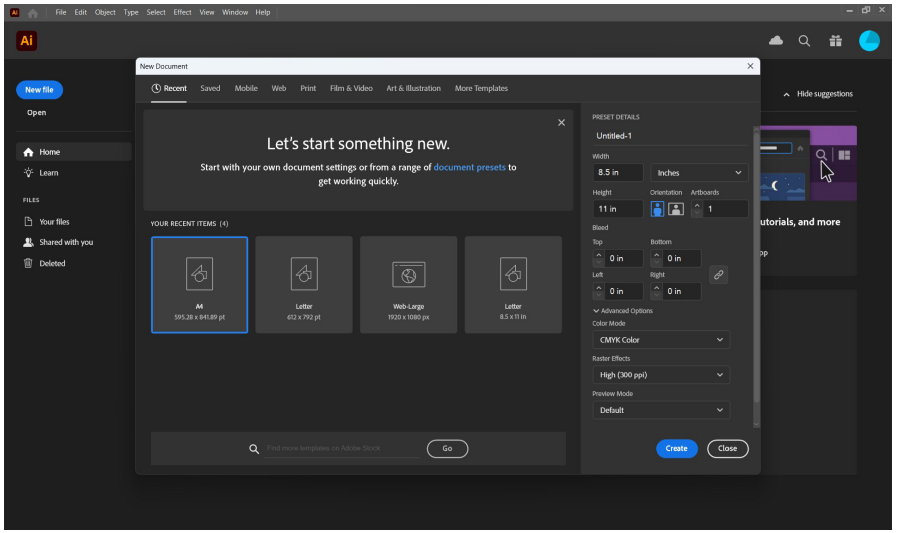
Adobe Illustrator is a vector graphics software popular with graphic designers. It is not a drafting software, so should never be used for drafting or lineweights in place of AutoCAD. However, it can edit vector files from Rhino, AutoCAD and other graphic softwares.

Getting Started

To get started with a drawing in Illustrator, open the application and click 'New File.' A window will appear that lets you select the size of the artboard you will be working with and its units. After choosing your file settings, click 'Create.' These settings can be changed later if needed.

Importing

You can import a variety of file types into Illustrator. *Linework from AutoCAD or Rhino can be imported as a .dwg or .pdf.* You can export linework directly from Rhino as an Illustrator .ai file, which will preserve all of your Rhino layers. It is important to note that Illustrator is not a drafting tool. Any linework imported into Illustrator should be



New Document window.

in a finished state. Illustrator is used for additive elements and advanced graphics, not as a precise drafting software.

Images can also be imported into Illustrator for additive graphics in nearly all file types. Notably, images being worked on in Photoshop can be imported directly as a .psd file. This creates a link between the image in Photoshop and Illustrator and changes in either program will be reflected in the other.

To import any type of file into Illustrator, use *File>-Place*.

Panning and Zooming

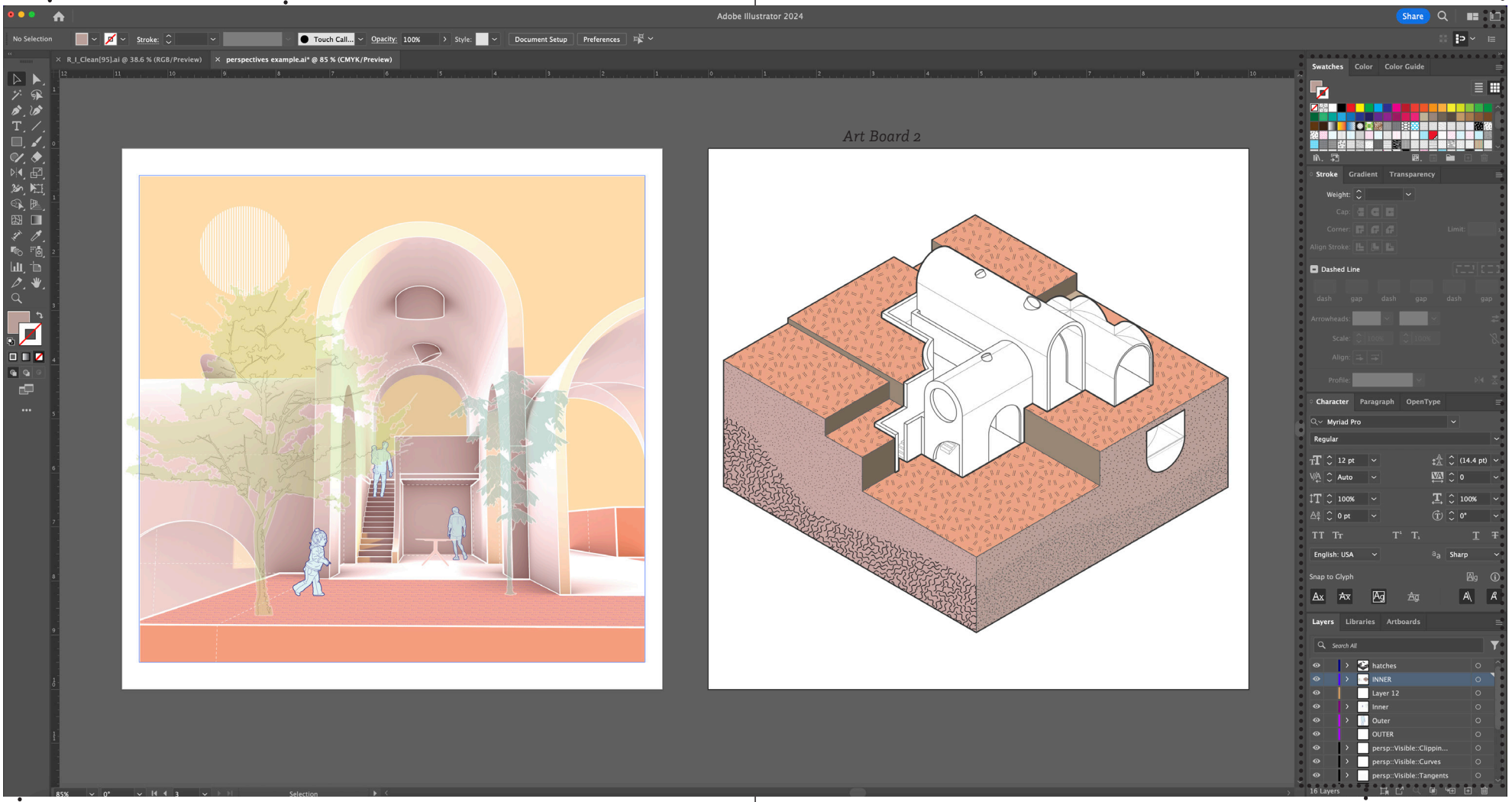
Pan by holding the *spacebar+click+drag*. You can also hit 'H' on your keyboard and use the mouse to pan in the same way.

There are several different ways to zoom into your artboard. One is to hold *ctrl++* to zoom in or *ctrl+-* to zoom out. Another way to zoom is by hitting 'Z' on your keyboard, then hold *alt+scroll* with your mouse wheel. Hitting *ctrl+0* zooms to your full artboard in frame.

Open file tabs

Current tool options

Switch workspace

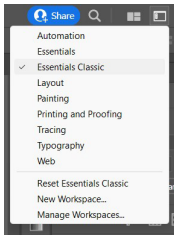


Toolbar

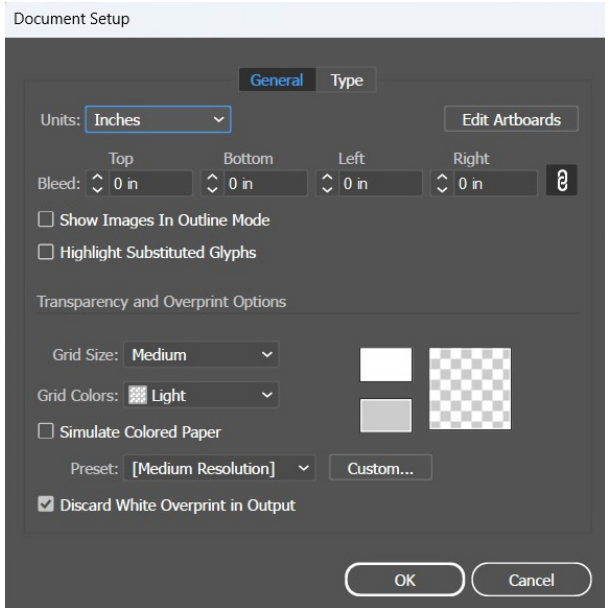
Panel options

Illustrator 'Essentials' Workspace.

The default Illustrator workspace is called 'Essentials.' You will find more useful tools in 'Essentials Classic.' This can be found by clicking the workspace menu at the top right side of your screen. If you are missing a certain tool or menu item in your workspace, it can likely be turned on via the Window drop down menu at the top of the screen.



Workspace Drop-Down

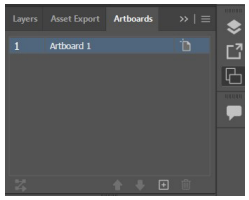


Document Setup window.

Document Set Up

Document settings can be changed once you have started a drawing in Illustrator. The document setup button can be found in the right properties panel, as well as the top banner.

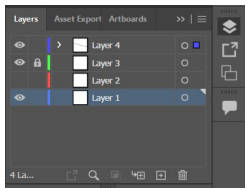
To change the size and other settings of your artboard, click 'Edit Artboards' in the document setup window, followed by 'Artboard Settings,' which will appear in the right properties panel. Here, you can also add, remove, and rearrange artboards.



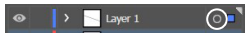
Artboards panel.

Layers

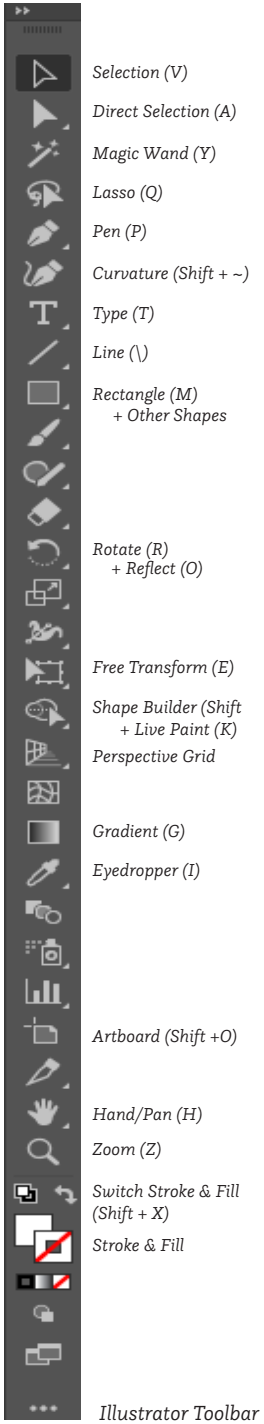
Like other programs, Illustrator organizes objects with a layer system. The layers panel is found in the panel bar on the right side of the Artboard. The layer you are working in will be highlighted in blue. To add a new layer, click the plus button at the bottom of the panel. To delete a layer, click the layer you would like to delete, the click the trash can. To rename a layer, *double-click* the layer name.



Layers panel.



Select by layer.



Illustrator Toolbar

Layers work in a stack, where the objects in the top layer appear on top of the objects in the layers below. To move a layer in the stack, *click+drag* a layer to the layer to the desired position in the stack.

Some other layer functions are found in this panel. The eye on the left edge shows what layers are visible. To turn a layer off, click the eye. To turn a layer back on, click the empty box in this column. Beside the eye is the lock. Layers that are locked cannot be edited or selected. To lock a layer, click the empty box in this column. To unlock a layer, click the lock.

Tools

Once you have started a new file and are in your preferred workspace, you can begin drawing or editing with the tools on the left side of your workspace. You can learn what a tool does by hovering over it with your cursor and click 'Learn more' to learn how to use it if you are unsure. Also, any tool that has a small, gray triangle on its button has more similar tools associated with it. You can access that list of tools by *right-clicking* the tool button.

Selecting Tools

There are several different tools and ways to select objects in Illustrator, depending on your needs. The dark gray arrow is the Selection Tool (V). This tool allows you to select any object by clicking it or *click+dragging*. You can select multiple objects by holding *shft* while clicking individual objects or by *click+dragging* over multiple objects. You can also deselect an object with *shft+click*.

The lighter arrow below is the Direct Selection tool (A) . This tool allows you to select individual anchor points within an object, path segments, or individual objects within a group.

In your layers panel, the colored square to the right

will show what layer your selection is on. You can select all objects in a layer by clicking this square.

There is also a Select option in the top banner. By clicking on this, you can access different ways to quickly select similar objects (*Select>Same*).

When opening .pdf files, you may not be able to select individual lines or objects immediately. In this case, click on the drawing then *right-click>Release Clipping Mask* until individual objects can be selected.

Transform

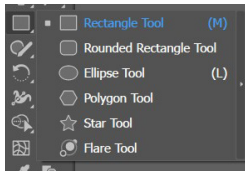
There are many ways to transform an object. One is to select an object with the Direct Selection tool. Once selected, *double-click* the Direct Selection tool in the toolbar and a window with transform options will appear. In this window, you can move or rotate an object specified amounts. You can also *right-click* a selected object and a menu with more transform options, as well as other options for modification will appear.

To scale an object evenly, use the scale tool or type 'S.' You can also scale an object by selecting it, then *click+dragging* from a control point. To evenly scale an object on all sides, hold *shft+click+drag*.

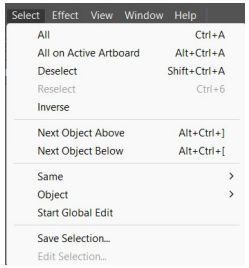
Live Paint

A common use for Illustrator is to add and edit hatches and fills in your drawings, since AutoCAD can struggle with complex hatch graphics.

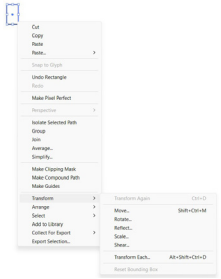
Hatches can be created using the Live Paint Bucket tool found in the toolbar or by the keyboard shortcut 'K.' Selected linework and objects can be converted into a live paint group that can then be populated with various hatches or fills.



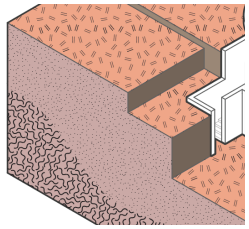
Toolbar drop down menu.



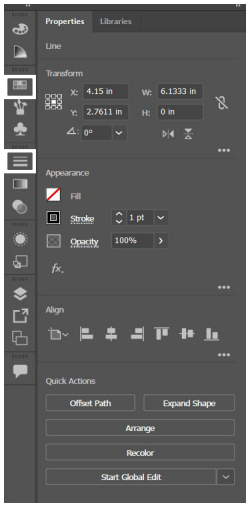
Selection menu.



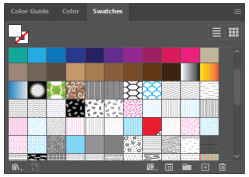
Transform drop down options.



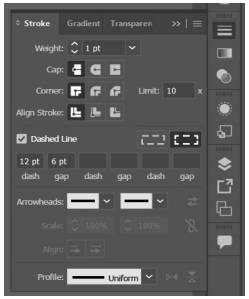
Color Fills and Hatches done with Live Paint.



Panels.



Swatches panel.



Stroke panel.

Panels

Panels appear by default on the right side of your workspace. They are used to modify and monitor what you are working on.

The Properties panel is very useful in editing your work and changes to reflect what you have selected. If nothing is selected, the Properties panel shows Artboard properties, which can easily be changed in this panel. When you select an object in your drawing, the Properties panel changes to reflect what you have selected. There are basic transform and appearance tools that can be used from this panel for the selected object. While an object is selected, color properties can be changed through the color panels and linetypes can be customized through the Stroke panel.

Here you will also find panels for Artboards, layers, exporting, gradients, and more.

If any panels disappear, they can be found in the Window tab on the top banner which lists other panels that can be added to your workspace. You can also reset your panels and tools by clicking the workspace button and selecting 'reset.'

Exporting

There are several ways to export your work out of Illustrator. You can use the workflow: *File>Export>Export As...* and an export window will appear where you can chose from various file types and an output destination for your file. You can also use *File>Save As...* and save your work under a specific file type.

If you are working with multiple Artboards and only want to export one, or export as individual

Asset Export is a good option. To do this, highlight a drawing, then *right-click>collect for export>a single asset*. This takes you to the Asset Export panel. There are many functions of this panel, but for this specific use, you will click the 'Export for Screens' icon button, which is located beside the Export button. This will open an export window. Click 'Artboards' at the top of the window. From here, you can name your Artboards and chose the type of file to export to, along with customizable file sizes.

LinkedIn Learning: Adobe Illustrator

Illustrator Keyboard Shortcuts

Panning and Zooming

Using Layers

Selecting Objects

Using Specific Transform Tools

Panels

Color Modes

Stroke Attributes

Exporting Files

Walk through

InDesign

Why InDesign?

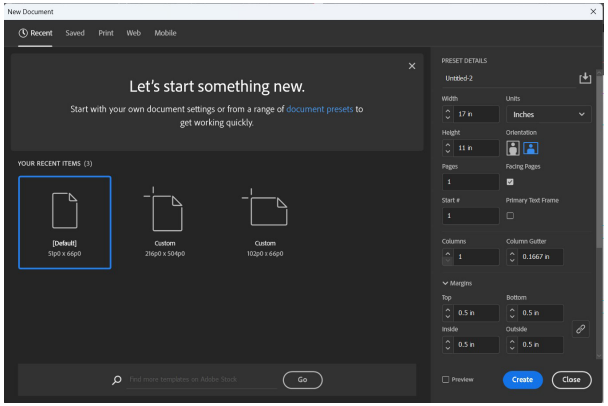
InDesign is a versatile software used for designing layouts and organizing images and information on a page or pages. It excels in designing plot layouts, organizing presentations, and creating portfolios, books, and other documents that include a variety of text and visuals.

Getting Started

After opening InDesign, you will land on the home-page, much like Illustrator and Photoshop, where you will find some preset layouts and page sizes. You can select from these options or can customize your own size, units, pages, margins, etc. Most of these options can be adjusted after the document is created. After setting these options, click 'Create.'

Document Navigation

Panning can be done in the same way as Illustrator and Photoshop: while the direct selection tool is in use, press *space bar+click and drag* to pan. The mouse wheel will scroll up and down through your pages, as with any website. You can jump to specific pages in your document by *double-clicking* on a page in the 'pages' panel.



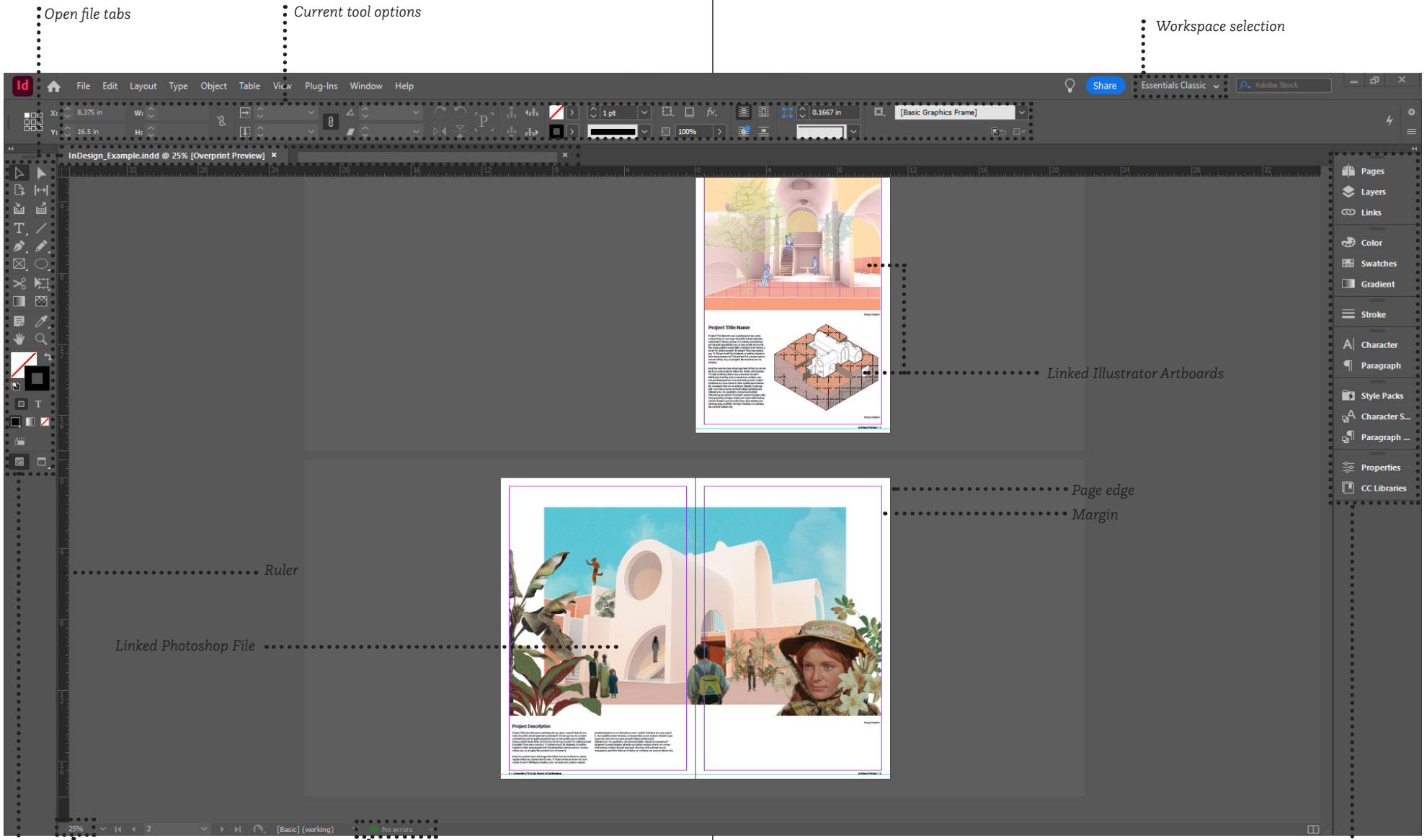
New Document options.

Zooming is also done in a similar way to other Adobe programs. Use *ctrl++* to zoom in and *ctrl+-* to zoom out.

Layers

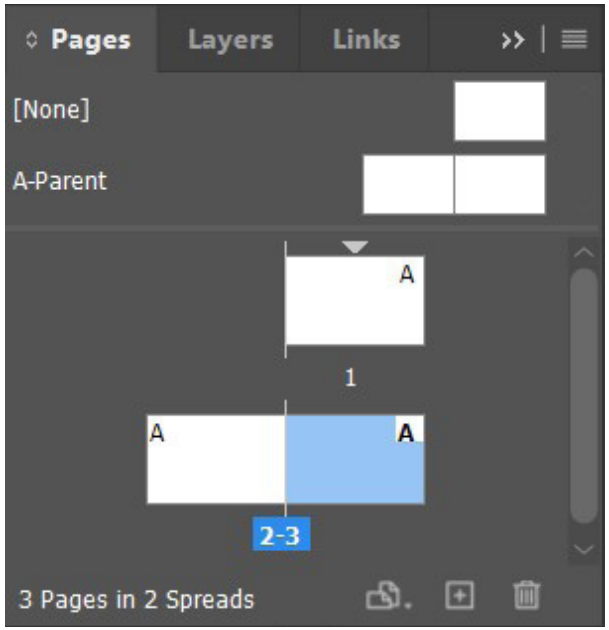
The layers panel in InDesign is very similar to Illustrator. Layers are less necessary than in other Adobe programs, but can still be quite useful. The layers panel is found in the panels on the right side of the screen.

The layer you are working in will be highlighted in blue. To add a new layer, click the plus button at the bottom of the panel. To delete a layer, click the layer you would like to delete, then click the trash can. To rename a layer, *double-click* the layer name. Layers work in a stack, where the objects in the top layer appear on top of the objects in the layers below. To move a layer in the stack, click and drag a layer to the layer to the desired position in the stack. Some other layer functions are found in this panel. The eye on the left edge shows what layers are visible. To turn a layer off, click the eye. To turn a layer back on, click the empty box in this column. Beside the eye is the lock. Layers that are locked cannot be edited or selected. To lock a layer, click the empty box in this column. To unlock a layer, click the lock.



InDesign 'Classic Essentials' Workspace.

The default InDesign workspace is called 'Essentials' and contains many of the tools you will most commonly use. It is recommended to change your workspace to 'Essentials Classic' or 'Advanced' Like other Adobe programs, to find missing panels, click the Window drop down menu at the top of the screen to turn individual tools on and off.



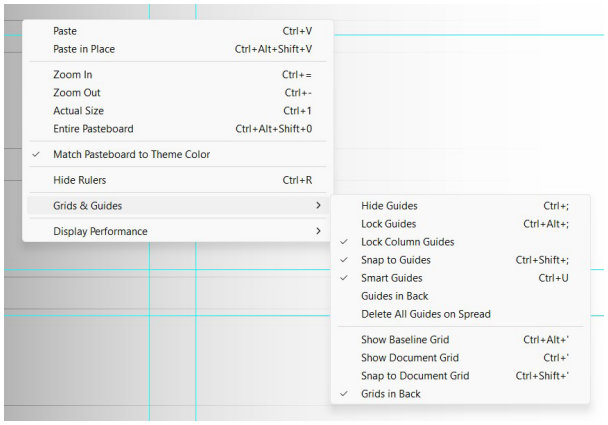
Pages panel.

Pages

When creating a document, you will begin with a window with page settings. Here, you can choose the units, dimensions, orientation, margins, number of pages, and other settings for your document. There is also an option for facing pages with a check box. If the box is checked, your document will have spreads as in a book with a spine. If unchecked, you will have an individual pages that do not face each other.

The Pages panel organizes all pages in order, with sets of two pages, called spreads. There are a few other important functions located in the Pages panel, including Parent pages at the top.

A-Parent can be accessed by *double-clicking* either of the pages in the row for spreads or the singular page if not working with facing pages. The pages in this row are called the 'Parent Pages.' This is where master grids can be made as well as footers, page numbers, or any other object or text that will be applied to all pages in a document. The setting made on the left page will be applied to all even pages. The



Grids & Guides options.

settings made on the right page will be applied to all odd number pages. By default, the first page is considered a cover page and is not placed in a spread. If you are not working with facing pages, the parent page will be applied to all pages.

In the Pages panel, pages can be added and deleted by clicking either the 'Plus" button or 'Trash Can' button. You can move directly to a page by *double-clicking* on it. You can also reorder pages within the document by highlighting them and *clicking and dragging* them to a new position.

Grids and Guides

Setting up guides before starting a layout helps create consistency and order across a layout. You can create guides both on parent pages and on individual pages. Guides will be visible in InDesign and can be used to snap objects into alignment, but will not be exported or printed from your file.

To create a guide, *click and drag* from the Y ruler for a horizontal guide, or from the X ruler for a vertical guide. Guides can be further adjusted once created. After creating a guide, select it with the direct selection tool. Once selected, its settings will appear in the upper toolbar, where you can type specific dimension for precise positioning. If you *right-click* on a selected guide, a drop down will appear with options to lock, hide, or delete guides.

Tools

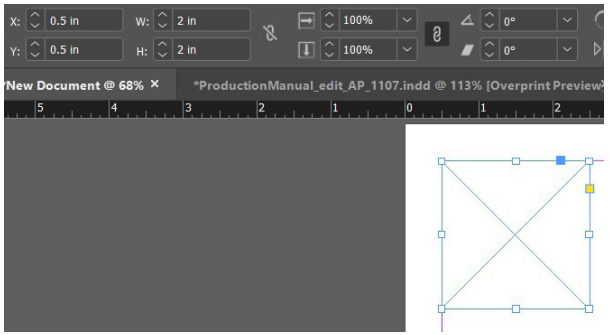
There are many tools in InDesign that work in the same way as tools in Illustrator. A few of the most commonly used tools include:

- Selection tool. When in use, you can select any object in your file by clicking on it, or select multiple objects by holding *shft+clicking*. To deselect an object you have selected, hold *shft+-click* it a second time.
- The direct selection tool lets you select parts of objects to edit. For example, the direct selection tool allows you to select anchor points, text within a text frame or an image within an image frame, without selecting the frame.
- The type tool creates a text frame that can be typed within.
- The line tool creates lines, that can be edited for type, color, and lineweight.
- The rectangle frame tool is useful for setting up consistent layouts before placing images and text. It will create a blue box as a placeholder that you can later place text or an image into. Once selected, the top banner will give you options to type in a specific X and Y location for the frame, a specific size, scaling and angle options. To put text in a frame, select the type tool and click on the frame. To place an image in the frame, you will need to place a file.

Toolbar.

Placing Files

InDesign works with placed files that are referenced from their stored locations. This means InDesign can preview and work with many files at once without slowing down. Placing files in an InDesign document is the same process as placing in an Illustrator document. After clicking *File>Place (ctrl+D)*, select the image file you would like to place. You will then click to drop it on your page. You can move it by clicking it and dragging it. You can also place



Placing an image in a frame.

images directly into a rectangle frame by selecting the pre-positioned frame before placing the image. Once an image is placed in a document, there are several different way the image and the frame can be adjusted.

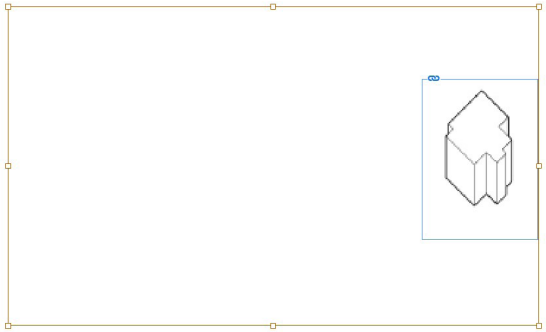
Linking Files

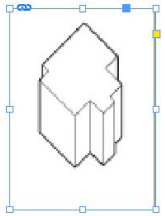
All files that are placed in InDesign are references linked to files stored elsewhere. By default, they will look pixelated in InDesign. It is important to keep files organized and in a specified location while working with them in InDesign. If files are moved, the link will be lost and InDesign will not be able to export the image at full quality.

The Links Panel holds all of the information on the links inside an InDesign document. If files are moved, it will show an error in the panel. Images can be relinked by *double-clicking* the error button and updating the new file location. Files can also be updated to new or different files in this way.

Editing Linked Files

InDesign also has the ability to link to working files from Photoshop and Illustrator. The files can be placed in their .psd or .ai formats and then quickly accessed through a feature called 'Edit Original,' which also works with .jpgs and other file types. By *alt+double-clicking* on an image, it will open the file in its original program. You can also *right-click* on a link in the Links panel and select 'Edit with.'These edits will be automatically reflected in InDesign once the original file is saved and closed.



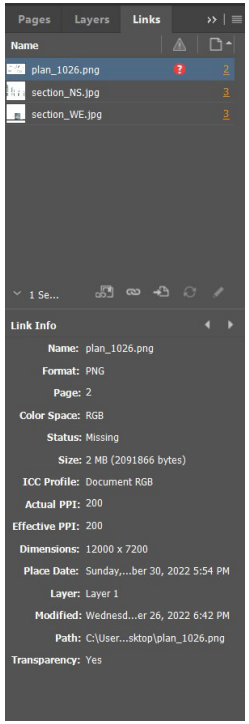


Above: Image frame selected; Left: Image selected inside frame.

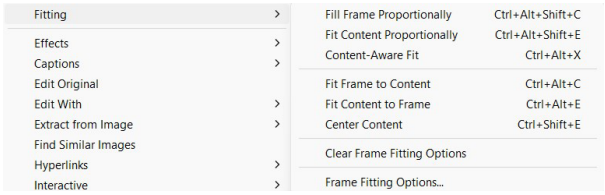
Formatting Images

There are several different methods of formatting an image once it is placed into your file. If placed into a frame, you can right-click the *Image>Fitting* and choose an option to fit the image within the frame. Images placed without being placed into a frame will be inserted with an automatic frame around the extents. This will show in blue. This frame size can be adjusted manually by selecting the image frame and dragging its edges to their desired location. The image within the frame can also be adjusted manually by *double-clicking* inside the frame. This will highlight the frame in orange. Once highlighted, you can move the image position by clicking the frame and dragging it, or by using the arrow keys. You can resize it in the same way as the image frame. This is a quick way to effectively crop images within your layout, without needing to edit the original image.

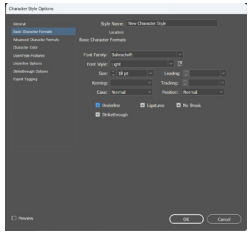
When resizing an image frame (blue outline), holding *shift* will maintain image proportions. Holding *alt* will resize the image on all sides from its center point. Holding *ctrl* before *click+dragging* will resize the image and the frame simultaneously.



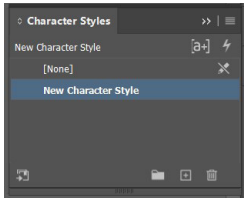
Links panel.



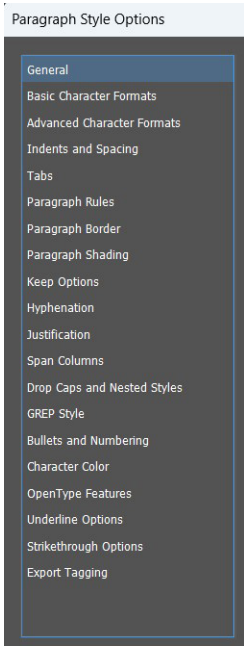
Fitting options.



Character Styles Panel.



Character styles options.



Paragraph style options.

Text

Text can be added with the Type tool and is a great way to annotate drawings with consistent sizes and styles. When the Type tool is in use, the properties panel will have many options for editing your text style: font, size, vertical and horizontal spacing, color, and more. Additional font styles can be downloaded for free by opening the Creative Cloud application in a separate window and navigating to 'Adobe fonts.'

Character and Paragraph Styles

Setting Character and Paragraph Styles allow you to easily set and change different text and font settings throughout an entire document with only a few clicks.

A character style is a set of formatting elements that can be applied to text. To create character styles:

1. In the top banner, click *Type>Character Styles.*
2. Click the 'plus' button to create a new style.
3. Once you have created a new character style, *double-click* it in the character panel to open up its editing options. Here you can set basic and advanced options for your character style.
4. To apply this style to more text in your document, highlight the desired text, *right-click* on the style in the character style panel and select 'Apply.'

Paragraph styles work in a similar way to character styles but contain formatting for both characters and paragraphs. To create a paragraph style:

1. In the top banner, click *Type>Paragraph Styles.*
2. Click the 'plus button' to create a new style. Similarly to character styles, *double-click* your new paragraph to edit it. This will open

a window similar to the character styles, but with many more options. Paragraph styles are applied the same way as character styles.

Views

In the View drop down menu in the top banner, there are many different options for viewing your pages. 'Screen Mode' changes the way your workspace appears behind your pages. 'Display Performance' Changes the quality of images on your pages. Note that 'High Quality Display' can make InDesign run much slower once a lot of images are in your file.

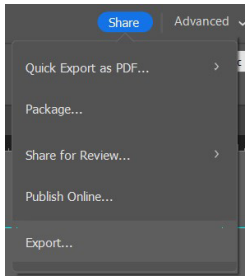
Toggling 'Overprint Preview' *(ctrl+alt+shft+Y)* will preview your placed files at full resolution. Pressing *W* will toggle on and off all blue frames and guides. *Ctrl++* and *ctrl+-* can be used to zoom in and out at any time.

Saving

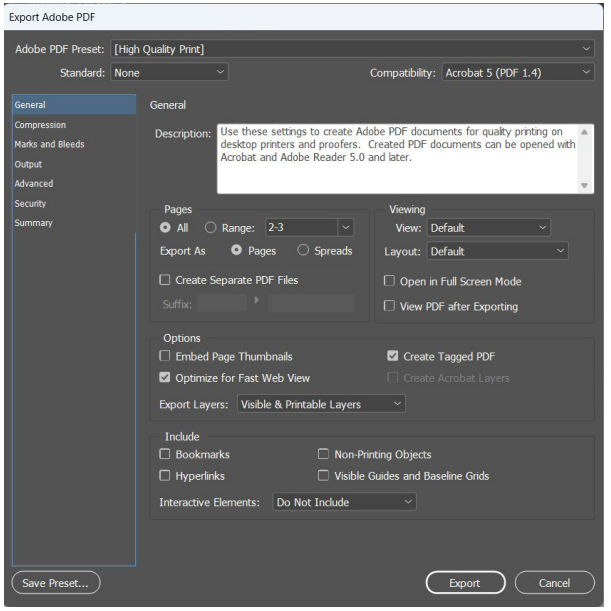
Similar to Photoshop, when you save a file in InDesign, it creates and saves a working file, in this case a .indd file. This is important to maintain editing capabilities and other layout and guide options within your file. This file will need to be either exported to a PDF or other file type for printing or presentation, or packaged with links in order to be shared with collaborators or used on another computer.

Preflight

Before exporting a file, check the 'Preflight' button at the bottom of the screen. A green or red dot will indicate any errors in your file. Clicking on the arrow and selecting 'Preflight Panel' (*ctrl+alt+shft+F*) will open a dialog box that lists any errors in your document, including broken or missing links and overset text (text that extends beyond its frame).



Share drop down menu.



Export adobe PDF window.

Exporting

Exporting can be done seamlessly through the 'Share' button in the top banner. 'Quick Export as a PDF' will give you three preset options for file size.

More options can be found under *File>Export...*, which will open a dialog box that gives you custom control over how your document is exported. Here, you can choose to export specific pages, export the file as individual pages or as joined spreads change image resolution, and edit many other options.

The most common file to export from InDesign is a PDF, which can then be shared, viewed or presented on screen, or sent to a printer or plotter.

Packaging

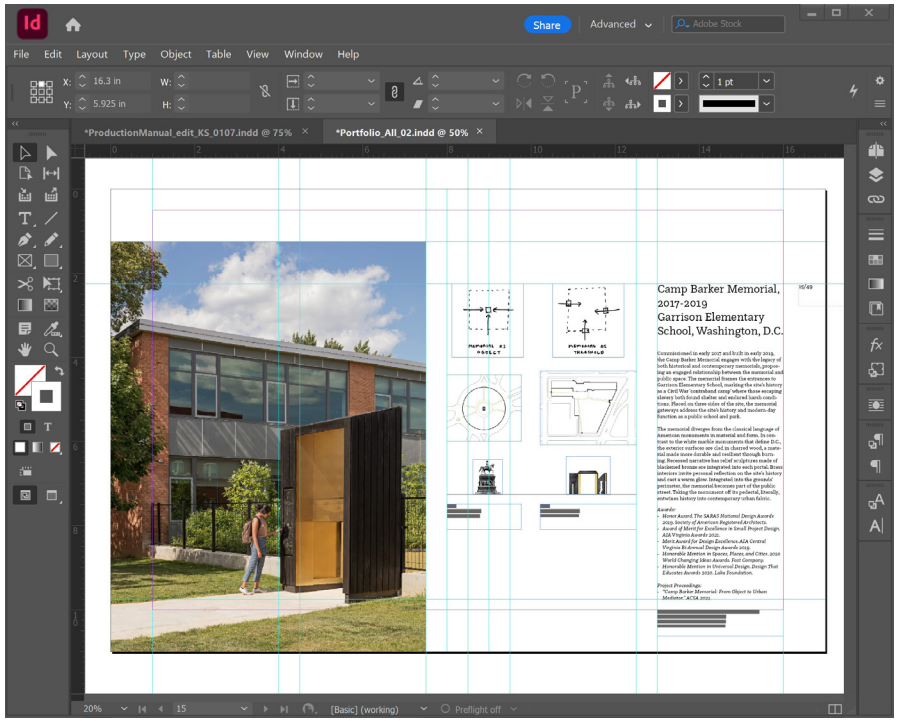
Packaging is necessary if you plan to share or edit an InDesign file elsewhere, as it will bundle all linked files and information with the saved .indd file. You can package a file from the 'Share' button or *File>Package... (ctrl+alt+shft+P)*.

Packaging a file creates a folder for your project, which includes a .indd file, a .idml file (editable by older versions of InDesign), a .pdf, all linked files,

and all linked fonts. This is crucial for sharing a working file or for opening your file on another computer. Without the linked graphics and fonts, InDesign will not be able to display or export your file from a new location properly. It is also a great practice to package any file once you are done and store the folder in the cloud in case you lose files over time, so that you can edit your file or access linked files in the future. This can be beneficial while making a portfolio or other documents you

Name	Status	Date modified	Type	Size
Document fonts	✓	10/31/2022 8:33 AM	File folder	
Links	✓	10/31/2022 8:33 AM	File folder	
Package_Example	✓	10/31/2022 8:33 AM	InDesign Markup ...	46 KB
Package_Example	✓	10/31/2022 8:33 AM	InDesign Document	1,096 KB
Package_Example	↻	10/31/2022 8:33 AM	Adobe Acrobat D...	18 KB

Packaged file output.



Example InDesign portfolio spread.

LinkedIn Learning: Adobe InDesign

Creating and Applying Parent Page

Guides and Measurements

InDesign Keyboard Shortcuts

Options When Placing Images

Using the Links Panel

Adding Text Frames

Paragraph Styles

Exporting a PDF

Packaging and Preflight for Output

Documenting

Why Document your Work?
It is critical to consistently document your work, capturing each phase of a design. As part of a working method, documentation of sketches and study models may help you move between 2D and 3D, analog and digital as you iterate through design development.

Maintaining high quality images of your process and final work is also important for submitting documentation of your coursework and ensuring that you have a record for future use in your personal portfolio, website, etc.

File Management
The development of a good digital workflow begins with a clear, organized, and uncomplicated file structure.

While working, save your files regularly and use the 'Save As' function to create a new file when making significant changes so you have a back up available if needed.

You will find that different offices and/or project teams will use different naming conventions to organize their work. Consistently following these conventions makes it possible to effectively coordinate and collaborate on shared projects.

The following text outlines a strategy for organizing your digital files from the beginning of a design project. Be consistent in implementing the organizational system you choose to adopt for your personal use.

Suggested File Naming and Folder Structure

File naming:
Date (YYYYMMDD)_File name_Version#.file extension

EX. 20240702_test_collage_v1.psd

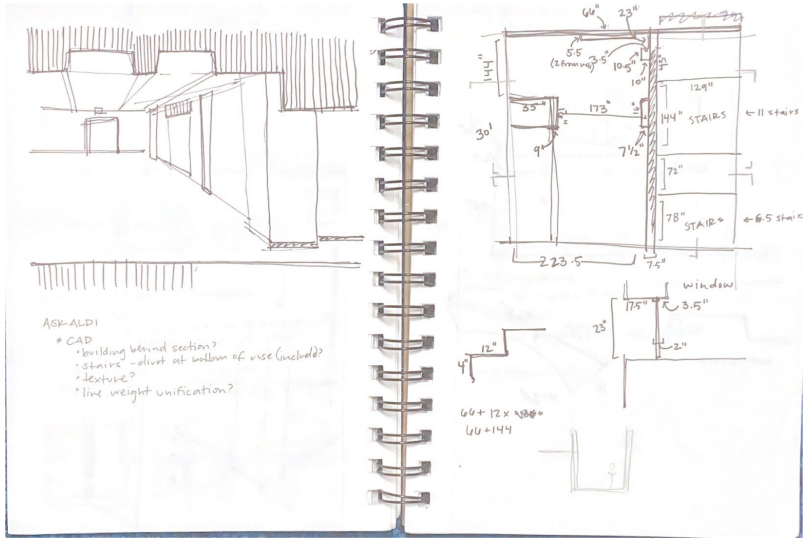
Folder Structure
01_Admin (subfolders if needed with names of types of docs) place for studio briefs, non-design specific documents like schedules, etc.

02_Reference (subfolders according to subject) ex. Research Materials, Precedent Images, Site Documentation, use meaningful folder names creates a “library" of reference materials for your project

03)_Working Files (subfolders for each design iteration according to date/subject including an Archive folder for older iterations)
2D and 3D process files

04_Documentation (subfolders according to date/subject) final 2d and 3d imagery, post-processed model photography, and presentation files

At the end of each semester, archive your work to multiple long term storage locations. Using a Cloud based digital storage platform and an external hard-drive are great options.



work by Isabel Hamilton, UVA SoA ARCH 1030

Site Documentation

Why Document a Site?
Site documentation is an important part of the design process. Collecting physical, spatial and experiential information while visiting a site provides a critical understanding of the social, ecological, and material context for your design work.

Measuring a Site
To measure a site you will need a tape measure, pencil, and sketchbook to record dimensions. A camera is also helpful to record the spaces you are surveying. Be precise when measuring , and locate elements relative to one another. Take careful notes transcribing dimensions onto sketches or base drawings you may already have. Another way to measure is using parts of your body to take quick relative measurements to estimate the size of objects. Knowing the dimensions of your hands, forearms, feet, and stride length can be helpful for taking quick, approximate measurements while on site.

Sketching
Use orthographic, perspectival, and diagrammatic sketches to record spatial relationships and ephemeral qualities of your site. Annotate your sketches with observations as you draw.

Photography
Photographs of your site serve as an important references throughout your design process.

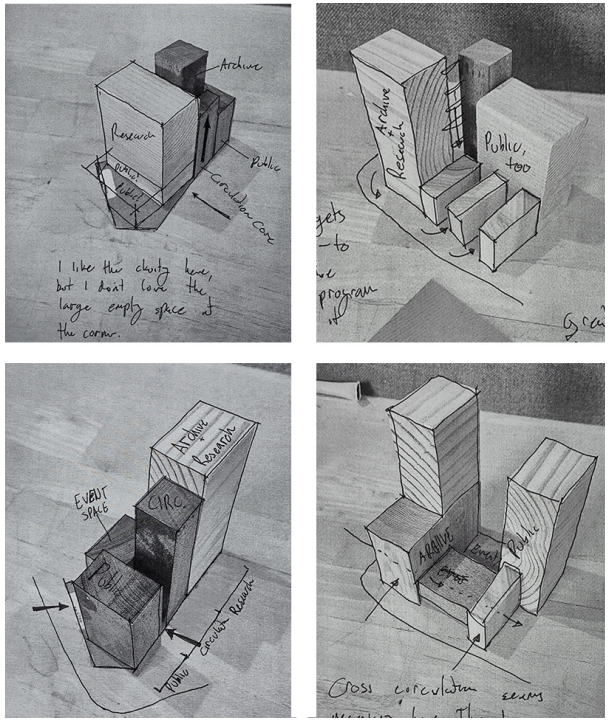
Photograph the extents of your site as well as its surrounding context. Take pictures both up close and from a distance. This is your chance to capture small details as well as changing qualities such as light, views, and the movement of human and non-human users.

Photos taken systematically can be pieced together to create collaged, panoramic views called joiners.

Site Analysis
Visiting the site is your chance to capture information that cannot be researched or observed remotely. Make observations about the site including:

- Who or what is using the site?
- What activities are occurring? How are users moving through the site?
- Are people alone or in groups?
- What landscape elements define your site? planted forms? pavement? etc?
- What materials are present?
- At what speeds are people moving?
- Where is the site seen from, and how do you approach it? What can be seen from it?
- What sensory qualities are experienced? sight, sound, smell, touch, etc?

These questions will help you to develop and understand your goals for the site and become valuable information to drive the design process.



work by Philip Edmonston, UVA SoA ARCH 3010

Documenting Physical Models

Physical models are often fragile and over time may become damaged. It's important to develop a regular practice of documenting physical models through high quality photography. Process images are helpful to explain your iterative process and design decision making in presentations and your portfolio, so all models, from rough study models through more resolved presentation models, should be photographed with the same level of care,

Camera

Use the best camera available to you to photograph your models. A good quality DSLR camera is preferred. While these can be quite expensive to purchase, the school has cameras available to borrow. Many smartphone cameras are also capable of capturing high quality photographs of your models.

work by Marisa Yamamoto, UVA SoA ARCH 1030

Regardless of the type of camera you are using, be aware of the default settings to prevent qualities such as brightness/contrast or saturation and color balance from being automatically over-corrected. You should not use any filters or other effects when taking your photos. Keeping these automatic edits to a minimum will allow you to more precisely control post-processing your images using more capable photo editing softwares.

Make sure that your camera is set to record images on the highest quality setting. Some DSLR cameras have special raw file formats (.CR2 on Canon cameras, for example) – these are unnecessary for most purposes, and the highest quality setting for .JPEG image files will be all you need.

Single surface backdrop.

Two surface backdrop.

Curved back produces no visible edge.

Two pieces produce visible edge.

Backdrop

It is important to make sure you set up a neutral backdrop so the background of your images do not distract from the model you are documenting. While a white backdrop will highlight the shadows cast by your model in an interesting way, there may be other times when you have a specific need for a backdrop of a different color. This is usually reserved for a highly specific applications.

There are a few easy strategies for setting up a clean white backdrop:

1. Single surface – Find a large sheet of thick white paper and prop it against a wall or other vertical surface so that the top of the paper is vertical and the bottom is horizontal. The paper should form a smooth radius in the middle to transition from horizontal to vertical. This is the preferred method and will ensure that there is not a visible seam or edge at this transition point. The possibility of this method will depend on the size of the model you are photographing and the size paper available to you. Large scale plotter paper can work well, but make sure that there are no visible marks on the surface of your backdrop if there is anything printed on the underside of the paper you are using.
2. Two surface – Find two large sheets of thick white paper, chipboard, or other sheet material. Place one horizontally on the ground and one vertically against a wall or other vertical surface. Make sure that the vertical sheet rests on top of the other, so that no other material is visible in the gap between the two. This method also works quite well but will leave a visible horizontal seam that may need to be removed digitally in Photoshop.

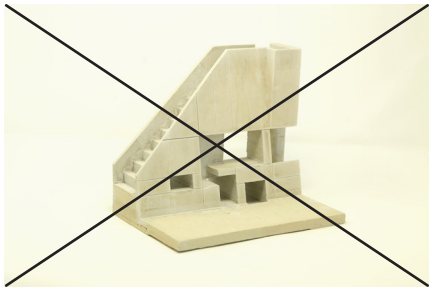
Using either method, position the model to avoid viewing edges of the backdrop.

The downside of using a white backdrop is that it may get dirty quickly, so take care to keep the backdrop surfaces as clean as possible and avoid sliding models across them or stepping on the backdrop if it is located on the floor.

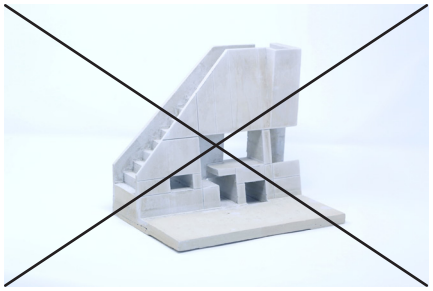
Fabric is sometimes used as a backdrop but is often much more difficult to set up properly without showing drapes or folds, so is not recommended in most applications.

Example photo box with integrated backdrop and lighting.

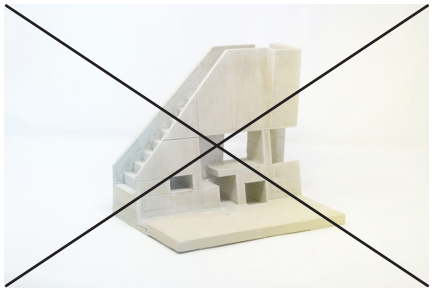
A variety of photo boxes are available on Amazon and other retailers that have some combination of integrated backdrops and lighting. These can be incredibly useful in producing professional photos, but the biggest limitation is usually size, since models will need to fit inside the photo box for documentation. The school has several photo boxes available for your use.



*Too warm.**



*Too cool.**



*Uneven color temperature.**

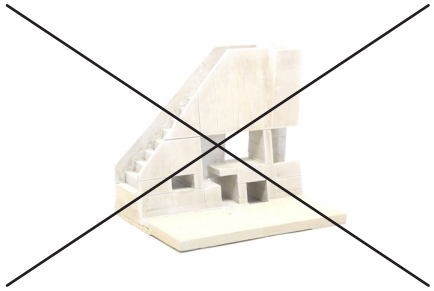
*Even neutral light.**

**Refer to digital version of the Production Manual for color images.*

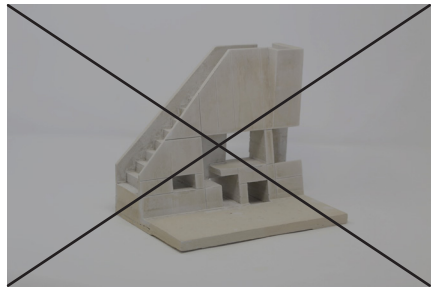
Lighting

Proper lighting is critical for good model photos. There are several considerations:

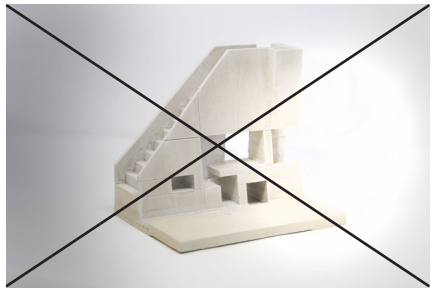
1. Color temperature – Avoid light that is overly cool (bluish) or warm (yellowish), instead aiming for neutral hued light. LED bulbs provide the highest degree of control over color temperature and are often sold with an option of color temperature options. Photographing with natural daylight is also an option and will usually be of a more neutral color temperature if not photographing too close to dawn or dusk.
2. Direction – Even, indirect lighting is important to evenly illuminate your model. Using a bright light source from farther away or using reflected light are both strategies to accomplish this. Make sure that there are no 'hot spots' on your model (specific areas that are much brighter than neighboring areas – this will often happen with more focused directional lamps, especially if they are very close to the model).



Too bright – washed out.



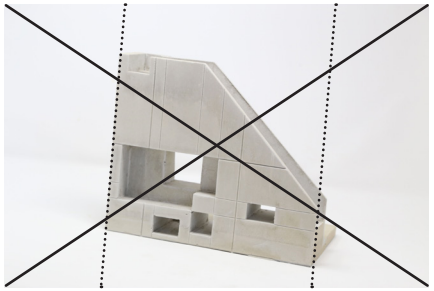
Too dim.



Uneven lighting – hot spot.

Even bright lighting.

3. Shadows – It may be a good idea to intentionally use a directional light to cast shadows within your model, and you can consider how shadows may highlight specific qualities or elements of your model. It's usually best to cast shadows with a single light source. You can experiment with multiple light sources at different angles, but this will create competing shadows cast in different directions, so is usually only done in specific applications.
4. Brightness – The brightness of your photos will be a result of both the lighting you use and the camera settings. Make sure that the photos you take are bright and well illuminated (white surfaces should look close to white, not medium or dark gray), but not so bright that parts of the image and details in the model become washed out – this is very difficult or impossible to correct when post-processing your images.



Avoid crooked photos.

Use verticals as a guide to keep photos straight.

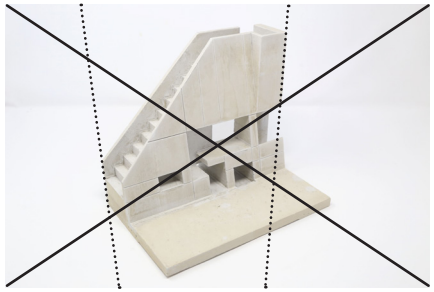
Placement

For overall shots, your model should be placed on the backdrop so that it the backdrop fills the entire frame of the camera. Avoid placing the model too far back on the backdrop, as this can cause either a ripple in the curvature of the backdrop, or shadows that are cast against the vertical surface. If you are capturing your entire model in the frame, try to preserve some white space around the object so that you have more flexibility in cropping and editing the photo in the future. For detail shots, the model should fill the entire frame.

Manual Camera Settings (advanced)

If you have a dedicated digital camera, there are a few manual settings to know about if you want to have more control over the image:

1. ISO – ISO is a value related the sensor sensitivity to light (200, 400, 800, etc.). The higher the ISO value, the brighter the image will be, but very high ISO values will often produce more grainy or noisy images.
2. Aperture – Aperture or f/stop is a value describing the size of the camera aperture that lets light in (f/5.6, f/8, f/10, etc.). A larger value will let in more light and produce brighter images. The f/stop also affects depth of field in the image – smaller values will have a smaller depth of field, meaning that objects in the foreground and background will appear more blurred, and higher values will have a larger depth of field, meaning that objects in the foreground and background will be more in focus.



Close up – more perspectival distortion.

Far away and zoomed in – less distortion.

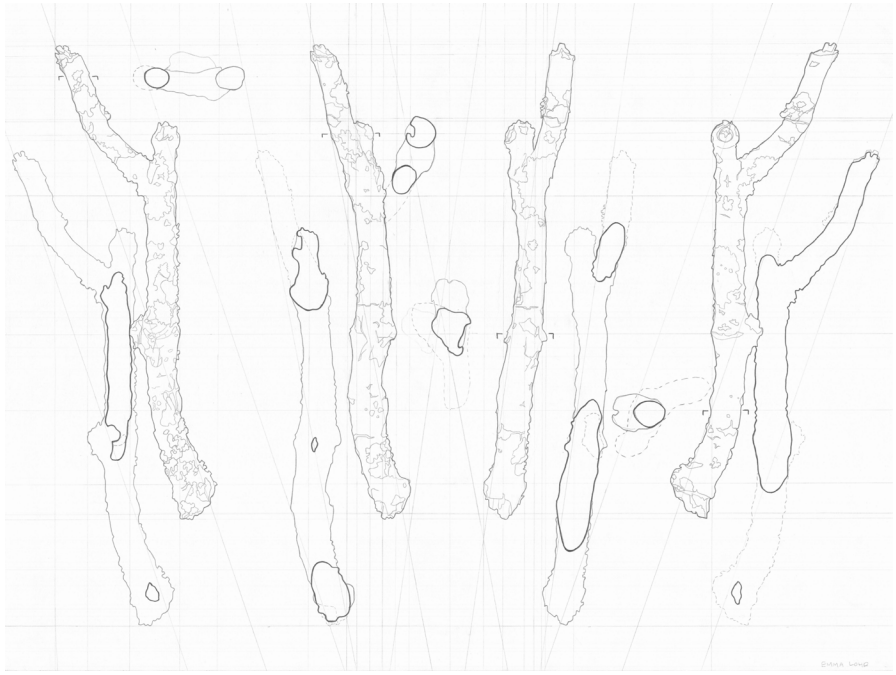
3. Exposure – Exposure or shutter speed is a duration in fractions of a second (1/200, 1/100, 1/60, etc.) describing how long the aperture is left open to allow light to enter the camera. A smaller value will produce darker images, while a larger value will produce brighter images. If the exposure time is too long, images are more likely to be more blurry and less crisp, unless a very stable tripod or camera mount is used.

Angles and Quantity

Take multiple photographs thoroughly representing your model. This means taking many more photos than you think is necessary and then decide on the best images to spend time post-processing.

If you are documenting a series of model iterations, it is good to photograph each from a very similar viewpoint so that they can be displayed consistently as a serial study. Except in special circumstances, photos should be straight so that the model is not angled or tilted sideways within the frame. Taking photos with the camera farther away but zoomed in will produce less severe foreshortening in the image (this should be done with a lens zoom as opposed to a digital zoom, which will produce a drop in image resolution).

Try to experiment with different perspectives and viewpoints to show various parts and qualities of the model. Try to capture straighter elevational (side) views, as well as the plan (top) view. On models with interior spaces, try placing the camera close to capture views within these spaces.



work by Emma Lohr, UVA SoA ARCH 1030

Documenting Physical Drawings
It is equally important to digitally document your drawing. This is critical for sharing and submitting your coursework as well as for use in your portfolio and elsewhere in the future.

Scanning Drawings
It is best to scan your analog drawings whenever possible. This requires a large flatbed or larger format rolling scanner. It is important to follow directions provided for properly saving images from any scanner and to keep it's surfaces clean.

You can usually control the size and the resolution of the scanned file (dpi), which ranges from below 100 up to 600 or 1200. 150dpi is usually good enough for printing, but it is a good idea to scan your drawings at 300dpi so that you have a higher resolution version if this is needed later – you can always downsize the image when post-processing,

but you cannot add resolution that is not there. Resolutions of 600dpi and higher are usually not necessary unless you are planning on significantly enlarging all or part of your drawing.

You should generally save your scans as high-quality JPEGs in either color or black and white. Make sure that the automatic corrections on the scanner do not over-adjust the brightness and wash out linework.

Photographing Drawings
If you do not have access to a large enough scanner, you can also produce high quality documentation by photographing your drawings in a similar manner to your model photography. You can do this with your drawing laying on a flat surface or pinned up on a wall. Most importantly, make sure that you have a good level of neutral color lighting spread evenly across the entire drawing surface. Avoid creating hot spots and shadows on the drawing. The same as with scanning, make sure that your drawings are not washed out due to brightness/contrast adjustments happening through your camera settings. Hold your camera is as straight and perpendicular to the drawing as possible, and steady so the image comes out sharp and not blurry.

It is likely your photographic images will require post-process editing before they are used for presentations or portfolios.

Presenting

Why Designers Present Their Work

The ability to present design work clearly and succinctly is a critical skill in architecture school and in the professional world. You will need to be able to present your work to peers, faculty and instructors, and invited critics in school, and to collaborators, consultants, and clients when working professionally.

Presentations are opportunities to convey your design process, focused on critical design decisions that impacted the outcome of your project. Sharing your process helps support your argument, justifying why certain ideas in your work are important, and how these ideas and processes led to a particular design. You will often need to present to people unfamiliar with your project, so it is vital that you convey your ideas with clarity and precision.

A presentation is also an opportunity to begin a discussion and establish the criteria with which you would like a design to be evaluated. By focusing your presentation on specific aspects of a design, you can often suggest and shape the conversation that follows.

Presentation Formats in order of Formality

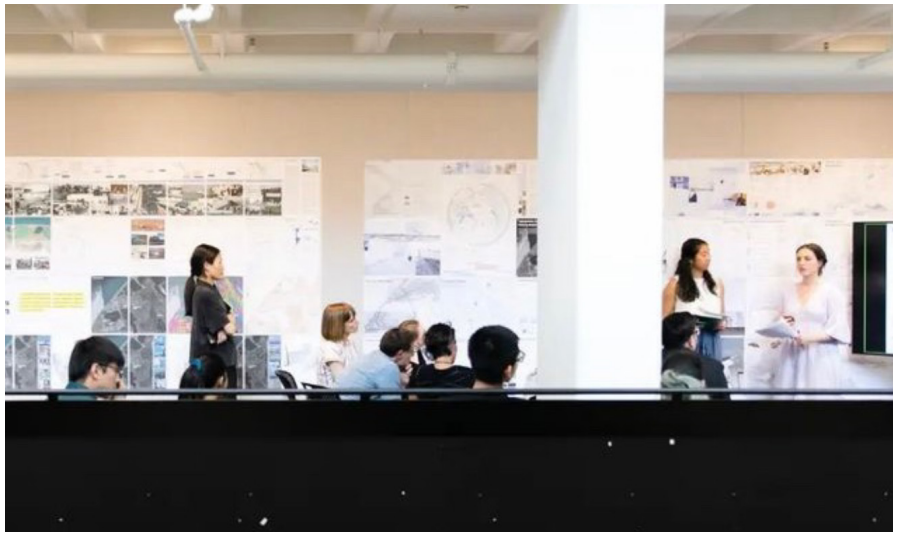
- Desk Crits- student + professor/SIA

- Pin-Ups- student + professor/SIA + peers

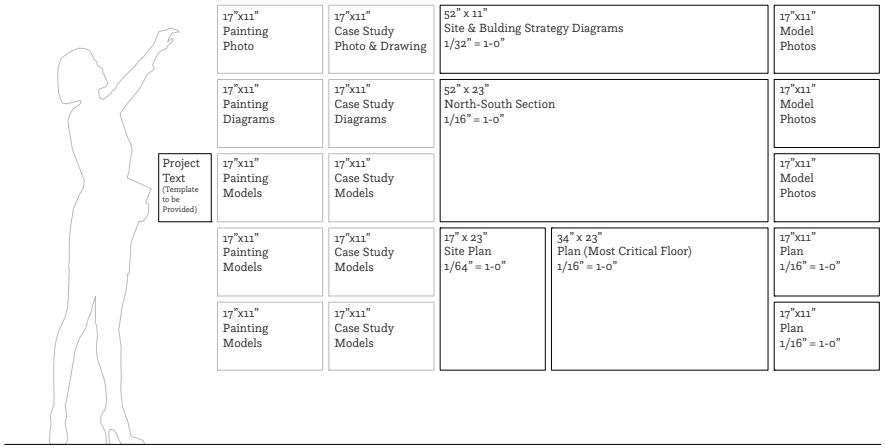
- Mid-Reviews- student + professor/SIA + peers + other faculty

- Final Reviews- student + professor/SIA + peers + other faculty + invited/external critics

Whether formal or informal, presentations are not one sided but are, in fact, a discussion. Come prepared ask questions of your instructor, critics, and peers. Reviews are not aimed at identifying weaknesses in a project, but to consider a project holistically and provide constructive criticism and suggestions to help clarify the strengths and weaknesses of a project. It is also important to always be present and attentive for the reviews of your peers, both out of respect and because feedback given on any specific project likely carries lessons that you can apply to your own work in the future.



Graduate students presenting their work in a final review image by Tom Daly



Example pin up consisting of individual drawing pages composed in a grid.

Presentation Components + Preparation

Presentations generally consist of both oral explanation and visual content (that may be shared digitally or physically), unified by a project narrative. Good preparation is key to minimizing stress and getting the most out of a presentation. Remember that clarity and hierarchy of ideas is key throughout both oral and visual presentation content.

Step 1: Project Narrative

Think of your project as an essay. What is the thesis? What is the supporting detail? Design projects are often driven by a big idea or concept that helps you make decisions as a design is developed at different scales. Being able to articulate any driving ideas, concepts, or logics governing your design is the best way to make your project clear to others.

Write a short script or bullet points of important points you need to cover when explaining your project.

Step 2: Visual Presentation

Make a list of drawings and models you need to support the main points of your project narrative. Your instructor may provide you a list to start from, but keep in mind that your project may require other types of drawings or models to best convey your ideas.

Consider how viewers will perceive your visual presentation. Composing a visual narratives requires strategic use of hierarchy, color, or sequence to most clearly explain a project's intention, process, and form.

Consider the following:

- What should your audience look at first?
- What should be viewed for the most time?
- What composition of drawings makes the most sense to present your argument?
- What connects the separate elements in your visual representation?

Digital vs. Print
In digital presentations, ordering of information over multiple slides or pages is critical.

For presentations pinned up on a wall, the composition of drawings in relation to one another is critical. Use grids and guidelines to organize and align your drawings in an orderly way. Remember that it is best to keep layouts simple and clear, so that your design is critiqued rather than the formatting of your presentation.

When presenting large plots with multiple drawings or printing multi page layouts, visual hierarchy is particularly important. Make sure that drawings don't become overly crowded are printed at a scale that can be read by a panel of critics sitting in front of your work.

Consider how your physical models will be arranged in relation to images on the wall. Smaller, lighter process models may also be pinned up on the wall along with drawings. While larger scale, detail models, and or models situated in a larger site context may sit on a podium or on the floor.

Step 3: Oral Presentation
Good verbal presentations are clear, concise, and meaningful. Practice ahead of time, especially if there is a time constraint for your presentation.

Begin your presentation with the big idea, concept, or argument, and then provide supporting information and examples of how the design supports this narrative. Good presentations do not over explain or dwell on less relevant details but should follow a similar hierarchy of detail presented in the visual representation of your work.

Undergraduate student presenting their work in a final review
image by Tom Daly

It is helpful to reference drawings and direct the audience's attention as you present. Always speak directly to a drawing. In other words, if you are describing some aspect of your project that is not illustrated somewhere in your visual presentation, you are missing a critical visual component of your work.

Know Your Audience
It is important to prepare presentation materials with your audience in mind. In more formal reviews, you can assume that faculty and invited critics will be proficient in reading and understanding architectural drawings, just as design professionals will be in the workplace. As you prepare your presentation, keep your audience in mind as you decide how much specificity to provide on various aspects of your design.

Glossary

abstraction	a composition which is not a direct reference or representation
AutoCAD	a 2D and 3D computer-aided design and drafting software developed by Autodesk
axonometric projection	a drawing that shows a 3D view of an object in which the x, y, and z axis are all drawn to scale
closed (geometry)	often a solid, can be thought of as watertight, with no open edges or missing faces. A closed line is any closed 2D shape, where the start point is touching the end point
command	terms that are used to direct drawing and editing operations in command based sofitwares like AutoCAD and Rhino
composition	the way elements in a drawing are organized and arranged on a page together or the way a series of drawings are organized and arranged together
construction lines	also referred to as guidelines or regulating lines that extend across a page used as reference points for position and dimension between multiple elements or drawings
cut plane	the supposed plane that cuts through an object to create a section or plan cut
detail	in Rhino, the view of a model or drawing within a layout
diagram	a simplified representation of a literal, functional, experiential, or metaphorical facet of a composition, can be drawn and/or modeled, 2d and/or 3d
drafting	detailed drawing representing a real-life space or object, done using certain conventions, analog or digital
elevation	a drawing of the exterior of an object viewed from the side
extrusion	a 3D object made from a base plane or curve
figure	an element which stands out, contrasting with the ground
ground	the background of a composition, contrasting with figures

ground plane a representation of the surface on which the object is placed on top or embedded

hierarchy the condition of superiority or priority of one element over another

hybridity the condition of being two things at once

Illustrator a vector graphics software developed by Adobe, used to edit in vector files exported from Rhino, AutoCAD, and other softwares

implied space space which is not totally defined, making its bounds and character open to multiple interpretations

InDesign A publication software developed by Adobe, used to create plot layouts, portfolios, books, and more

isocurve line expressing the subdivisions of a surface

iteration procedure in which repetition of a sequence of operations yields results successively closer to a desired result

layer a system of organizing objects and lineweight in digital software

layout in Rhino, where views of a model or drawing are placed at different scales to simulate a printed document(s)

linear characterized by an emphasis on line and line-like qualities

line type the style of line in a drawing (continuous, dashed, etc.), different line types represent different information

lineweight describes the thickness and darkness of a line, 'heavier' lineweights are thicker/darker and convey information closer to the cutting plane, 'lighter' lineweights are thinner/lighter and convey information further from the cutting plane

medium 1. any raw material or mode of expression used in an artistic or creative activity 2. an intermediate agency, instrument,or channel; a means; esp. a means or channel of communication or expression

model a three-dimensional representation, esp. on a small scale, of a person or thing or of a projected or existing structure; esp. one showing the component parts in accurate proportion and relative disposition

model space infinite workspace in digital drafting and modeling software

negative space compositional strategy, space on the page which is not occupied, guiding viewers' focus.

open (geometry) a solid object is open if it has missing faces, a curve is open if its end points do not connect

organizational logic compositional strategy, rules which guide or govern a form making and/or graphic design layouts

orientation the implied direction of elements in a composition or form

orthographic projection a method for drawing of a three-dimensional object accurately on a two-dimensional surface, a parallel projection in which all the projection lines are orthogonal to the projection plane and all dimensions are accurately represented to a scale without foreshortening, typically referring to primary drawing views of plan, section, and elevation

overlay layering of multiple drawings, amplifying certain characteristics of the drawn space or object

panels small, docked windows that contain controls, options and settings

paper space in AutoCAD, where the scaled version of a drawing is placed to simulate the actual piece of paper it will be printed on.

parti a simplified representation of a design objective, which abstractly shows the general goals of a project and guides decision making in the design process

Photoshop a powerful photo editing and raster graphics software developed by Adobe

plan a drawing looking down on an object from above, can be a top view or a cut plan with a horizontal cutting plane

planar relating to or in the form of a plane or surface

plot refers to both a large scale print and a command for exporting and printing drawings

poche shaded or hatched area on a drawing showing where elements have been cut through

polysurface two or more surfaces joined together, often to create a solid

raster an image made from pixels, can be scaled down and not lose quality but when scaled up lose quality/become pixelated

Rhino a 2D and 3D computer-aided design software developed by Robert McNeel & Associates

scale a way of representing large objects in a smaller size that is still measurable and accurate

section drawing of a vertical cut through an object viewed horizontally

solid a surface or polysurface that encloses a volume

spatial boundaries made up of explicit or implicit "edges", space is defined most importantly by the character of its bounds and contents

stereotomic strategy of design using massive or solid elements or systems of elements, can follow an additive or subtractive logic

surface a continuous extent having only two dimensions (length and breadth, without thickness), whether plane or curved, finite or infinite; an entity such as constitutes the boundary of a solid object or separates two adjacent portions of space

tectonic strategy of designing through the connection of multiple elements or systems of elements, often following an additive logic using planar elements

template a file with preset settings, styles and layouts

units property of measurement in a drawing or model, typically referring to digital workspaces

vector a mathematically defined image format, where each line, shape, and color can be infinitely scaled and not lose quality

viewport 1. a window that displays a drawing in AutoCAD 2. windows that show different views of a workspace in Rhino

workspace the interface made up of panels, bars and windows in an arrangement to work in any digital drafting or modeling software program

Additional Resources

UVA School of Architecture Resources
https://www.arch.virginia.edu/resources

A-School Computer Requirements
https://www.arch.virginia.edu/resources/computer-requirements

A-School Network Setup
https://www.arch.virginia.edu/resources/set-up-your-computer

A-School Classes Folders
https://www.arch.virginia.edu/resources/classes-folders

A-School Printing
https://www.arch.virginia.edu/resources/printing

A-School Virtual Workstations
https://www.arch.virginia.edu/resources/virtual-workstations

The Virtual Workstation is a tool provided by A School that gives students access to a high performance graphic computing through their own computers. The virtual workstation also has access to various softwares. It can also be useful to students working on Macs that need access to a Windows interface.

Cavalier Computers
https://www.cavaliercomputers.com/

UVA Software Gateway
https://virginia.service-now.com/its?id=software_gateway