CHAPTER 3
Orthographic projection

Plans, sections, and elevations, known as orthographic projections, are some of the most fundamental tools of representation. They are two-dimensional abstractions that convey both horizontal and vertical information. They have strong relationships to one another and the representations of such drawings can facilitate a clearer understanding of a project. The successful understanding and implementation of these skills is fundamental to communicating with different audiences, including the builder, the client, the community, and other architects.

Orthographic projections are abstract drawings that do not represent objects as we see them. Because orthographic projections lack the three-dimensional qualities of perception, they have none of the foreshortening or distortion that we see in real life.

The method and construction of orthographic projection can reinforce the design ideas of the architect. Therefore it is important to understand the basic structuring devices for these drawings to equip yourself with tools that can develop your design ideas.

By drawing a variety of orthographic representations of a building, you can isolate particular design investigations. For instance, program and circulation can be studied in plan, while stairs, double height spaces, and windows can be investigated in section.

Since it is difficult to convey a project in a single drawing, multiple drawings or orthographic sets are used to present a more complete picture.

This chapter introduces fundamental skills of orthographic projection through the work of Albrecht Dürer. Drawing techniques and line weights are discussed.
Plan, section, and elevation

A compilation of two-dimensional orthographic drawings can describe the space of a three-dimensional object. There are three drawing types that make up the collection of orthographic (90°) projections: plan, section, and elevation.

Each drawing type flattens or projects two-dimensional information onto a corresponding picture plane. They can be referred to as sections, since the basic manner in which all orthographic drawings are constructed is the same; a plan, for example, is a horizontal section. Orthographic drawings are cuts through space, whether horizontal or vertical, and whether directly through an object or just outside of the object. They are not perspectival; it is best to imagine that you are able to look directly at each component part of the object, thus eliminating the perspectival aspects of the object.

**Plan**

A plan is a horizontal cut through an object, building, or space, typically directed down. Imagine the cut as a plane, parallel to the ground plane, intersecting a building or object. The cut is drawn using appropriate line weights, but is always rendered as the darkest element in the drawing. There are a number of types of plan drawings.

**Cut lines**

Plans and sections are essentially the same. They are cuts taken through an object. The elements that are cut through are rendered as the darkest line weight in the drawing. This typically corresponds to an HB or B lead.

**Floor plan**

The floor plan is a means to convey architectural space. It is a horizontal cut through a building, typically at 4 ft (1.2 m) above floor level. The cut-height convention is set so that you generally include doors and windows in the plan cut and elements such as counters, and half walls not cut through are shown from above for spatial clarity. This convention is not absolute. It is important to learn how to draw plans that clearly show the nature of the space. For example, if a clerestory window at 7 ft (2.1 m) is important to the idea, then include it in the plan by moving the cut plane to cross through that area. Floor materials can be depicted in the architectural floor plan. Scales include ⅛, ⅜, ¼, and ⅜ in.

**Roof plan**

A roof plan is a horizontal cut above a building mass looking directly down onto the roof. Shadows are often constructed on a roof plan drawing to demonstrate the mass of the building relative to the space around it and to distinguish it from the context. Scale: ⅛ in or smaller.
**Site plans**

A site plan can be drawn from above all of the buildings including the new design and the surrounding context, or can include the first floor plan to demonstrate the relationship between the interior and exterior spaces. Shadows are often constructed on these drawings. Your building intervention does not need to be centered on the page. Page composition will be discussed in Unit 16. Scale: typically uses engineering scales 1 in = 20 ft or 1 in = 40 ft.

**Figure-ground plan**

A figure-ground plan usually depicts an entire neighborhood, district, or city. It is used by architects and urban designers to describe the building patterns. It is an abstraction of building and space. Typically, buildings are rendered as black poche and non buildings or spaces are white. These maps are useful for analytic and pattern studies.

The figure-ground plan was derived from the traditional Roman city survey map of 1748 created by Giambattista Nolli (b. 1692 d. 1756). Nolli constructed his plan of Rome by rendering buildings in dark gray poche and non buildings or space in white, with the exception that enclosed public spaces such as churches and piazzas were rendered in white. These interior spaces of churches, piazzas, and enclosed public spaces were intended to be continuous with the space of the public realm. Colin Rowe (b. 1920 d. 1999) and Fred Koetter (b. 1938) pioneered the use of the figure ground map in analyzing the city in their book, *Collage City*.
Section

A section is a vertical cut through an object, building, or space. Sections describe vertical relationships and help define the spatial characteristic of the building. A scaled figure shown in section clarifies the height relationships in the spaces. Imagine the cut as a plane, perpendicular to the ground plane, intersecting a building or object. As in the plan, the information that is cut is rendered using appropriate line weights, but is always rendered as the darkest element in the drawing. There are a number of types of section drawings.

Wall section

A wall section of a building depicts detailed construction systems and material choices. Scales: 1/4, 3/8, 3/4, or as large as can fit on the page.

Street section

A street section depicts the section through a building and includes the space of the street and buildings directly adjacent to or across the street from the building. Scale: 1/4 or larger.

Building sections

A building section depicts the spaces inside and directly outside of a building. The scalar relationship between these different spaces is visible in a section. Scales: 1/8, 3/16, 1/2, 3/8.
Elevation
An elevation is a vertical section cut outside of an object, looking back at its face. Imagine the cut as a plane, perpendicular to the ground, that does not intersect with the building or object. The ground outside of the object should be rendered as a cut line. The object or building itself is not cut through; all of the lines related to the building are elevation lines. Elevation lines vary with distance from the projected picture plane. Elements farther away are lighter than those that are closer. Scales: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$.

Continuity of section cut
Architectural drawings highlight space as defined by the walls, ceilings, and floor. Its representation is manifest in the continuous cut. These drawing types do not distinguish between materials, and therefore all elements cut in section are continuous with one another with one exception. The variation from this rule occurs when cutting through glass or some other transparent or translucent material. Glass is never rendered as a dark, cut element. If so, it would appear as a solid wall—contradicting its transparent nature. It is rendered as if it were in elevation, even when cut through. Typically, construction sections depict the building systems employed to construct the wall, ceiling and floor, and are meant to convey material and construction information to the contractor.

Combination of section and elevation
Aligning the section and elevation drawings allows one to see the transition between materials and spaces on the interior and exterior.

Building elevation
A building elevation gives an impression of how one face of the building will look from the outside. The building can be considered in isolation or in context.

Combination of plan and elevation
The plan provides a sense of space and movement in this bathhouse design while the complementary elevation exposes the material quality and characteristics of those spaces.
Creating a section
Sections represent continuous vertical cuts through an object or space. The appropriate use of line weights in a section determines its legibility and can reinforce intention.

- Column cuts
Cutting a section through a column (middle image) deceptively depicts two separate spaces with a wall between. Always cut a section in front of the column (never through it) and render the column using elevation line weights.

There are a number of techniques for constructing orthographic projections and for distinguishing cut elements in plans and sections from non-cut elements. One method uses line weights, the second uses a coloring technique called poche, and the third uses rendering techniques.

Poche comes from the French word *pocher*, "to make a rough sketch." It is typically understood to be the solid elements in a building rendered in solid black. This method, when constructing orthographic drawings by hand, is often much more time-consuming than using proper line weights. Therefore it is better to use the line weight technique when constructing these drawings. The third method uses rendering of interior spaces to distinguish between the white space of the cut area.

- Continuous section line
The white of the page is brought into the section by extending the ground line to the edges of the paper. Crop the page away from the section line so there is enough space for the section to indicate pertinent ground information. Section lines should be drawn with the darkest line weights in the composition.

- Section base
The white of the page is separated from the white of the section cut through the creation of a section box. The thickness of the base should be determined by the design intent. Section lines should be the darkest line weights. The base completes the section graphically so that it has an object-like gestalt.

- Poche section
The clarity of the drawing is achieved by rendering the section with black. This poche technique does not use line weights for the section cut. Use proper line weights for the other non-section elements in the drawing to convey depth.

- Sky section
This section inverts the poche drawing by rendering the sky as a tone or color. The sky recesses and "punches" the drawing forward. Additional details in the drawing focus attention on the only element not rendered: the section cut. Consider this as a method of white poche.
Line types
There are a number of different line types that can be employed to aid in the clarity of a drawing. Graphite line types often correspond to specific line weights. Lines that represent cut objects are the darkest, while lines for objects that are further away from the cut plane are lighter. Space can be portrayed and emphasized with the proper use of line weights in orthographic drawings. Elements that are above the cut plane and not seen in the projected drawing should be drawn with dashed elevation lines.

Cut lines: section lines both in plan and section—B or HB; these are the darkest elements in the orthographic drawing.

Profile lines: lines that define the edges between an object or plane and open space—HB (often used in axonometric or perspective drawings).

Elevation lines: lines that define edges that are further away from the cut line in both plan and section—H or 2H. These elevation lines can also vary in weight, depending on the distance away from the cut plane. Because lighter lines recede in the view, objects further away are drawn lighter than those closer to the cut plane. This variation in line weight helps to convey depth in an otherwise flat drawing. These are middle-range lines, but never reach the lightest line weight, the construction line.

Hidden lines: dashed lines that depict objects or planes that are technically not visible in the drawing—H or 2H. The spacing of the dashes and the length of the dashes should be consistent. Elements in front of the section can also be rendered with hidden lines. In plans, hidden lines are used to show objects above the cut line. This is extremely helpful when roof canopies, ceiling changes, or open spaces to upper floors must be understood relative to the plan below them.

Start drawing with three line weights: HB for cuts, H for elevation, and 4H for construction lines. As you improve, increase the number of line weights. As you develop your drawing skills, you may use at a minimum four line weights distinguishing between different elevation lines based on distance: those that are closer are darker, while those further away are lighter. The darker elevation lines never reach the level of section lines.

Scale considerations
Another factor to consider in determining the proper lead weights for a drawing is the scale of the drawing. For instance, a section line at a smaller scale might be drawn with H and a lot of pressure. This same line, when drawn at a larger scale, might be drawn with an HB lead. You must make a conscious decision about how to convey information to edit at the different scales. Each weight should be distinctive.

Conveying information
When representing buildings, architects use scales to reduce the size of the building so that it fits conveniently on paper. U.S. architects use engineering and architectural scales. Both scales are based on the inch and convert a series of inch increments to equivalent foot dimensions at true scale. When drawing, you will use a variety of scales to show different types of information. Large scale plans, like ¼, show construction materials, while smaller scale plans, like 1/₈, emphasize the architectural space. See Unit 4 for more on scales.

Typical scales
Typical architectural scales include:

- ½ in = 1 ft, ¼ in = 1 ft, and ⅛ in = 1 ft.

When sections are drawn larger than the plans, they might be drawn in the scale range of:

- ⅛ in = 1 ft to ⅛ in = 1 ft.

The larger increments found on the architectural scale are used for detail drawings:

- 1½ in = 1 ft and 3 in = 1 ft.

The engineering scale is used for site plans, roof plans, and overall building massing. Typical scales used are:

- 1 in = 50 ft, 1 in = 100 ft, and 1 in = 200 ft.
Assignment: 11

Chair section

Find a chair that interests you. You will draft this chair freehand, without using a straightedge. Draw a multitude of plan, section, and elevation views of your chair onto a single sheet of paper. The drawing does not have to be to a certain scale, but must maintain scale and proportion between the parts that make up the chair. Work on your hand-eye coordination as you draft across the entire page. Cut a series of plans of your chair at varying heights. For example, make several horizontal “slices” at different heights: 1 ft, 2 ft, and 3 ft (0.3, 0.5, and 1 m). Align the plans vertically with the section or elevation using construction lines to maintain similar proportions across the page. Use light construction lines (4H) to draw similar elements in each plan. Take at least two sections through the chair, one at the midpoint and one off-center, and construct at least three elevation views. On a typical chair, only three elevations are needed instead of four since the side elevations would be mirror images of one another. The drawings should be constructed from one another, meaning that composition is foremost in your mind when drawing these projections. By drawing construction lines you can maintain consistency between drawings. Remember that plans, sections, and elevations all have relationships to one another and that construction lines between the drawings can help align them. Information can be transferred between the drawings without the need to re-measure. Proper line weights will be critical for a clear understanding of the drawing.

Construct your drawings on a sheet of large paper, 18 x 24 in (457 x 610 mm) and use the entire page.

1 Use a 4H lead to create a series of construction lines to establish the boundaries of the chair. Determine the chair’s width proportion to its overall height. Continue to establish these proportions for all of the required orthographic projections. Complete this step before adding detail and line weights.

2 Use an H lead to begin to darken the elements that are seen in elevation. The construction lines remain the lightest line weight on the page and should, at this point, begin to fade naturally as other, darker, lines appear to become more dominant.

3 Use an HB lead to begin to darken in the elements that are cut in section. Section cuts are continuous and shall not be left open-ended. Make crisp dark lines with a sharp lead. The light construction lines should remain on the drawing.

Ortho construction

- When constructing an orthographic drawing it is helpful to pause midway and review your drawing abstractly.
- Ask yourself: “How legible are the lines from some distance away?” While drawing, you are too close to your paper, physically, to make this assessment. Move at least 3–4 ft (0.9–1.2 m) away from the drawing and assess the line quality.
- It is useful to pin your work up on a wall, step back 3 ft (0.9 m), and assess.
- When drafting, you should always use your lead holder. The lead in the lead holder maintains a much sharper point than the sketching pencils or even a mechanical pencil. In addition, you have greater control over the type of line you create with the lead holder.

▲ Compositional alignments
By aligning plans, sections, and elevations on a single sheet of paper, dimensional information can be transferred without the need for remeasuring.
Manual and digital two-dimensional representations have similar evaluation methods based on the clarity of the line weight. Therefore the practical difference between the two is negligible.

Digital technology has had a great effect on office organization. The use of digital technology has enabled a more transparent integration, organization, and management of the drawing set by larger groups of people. Digital programs have revolutionized the iterative process for large-scale projects, enabling architects to draw, modify, and communicate orthographic information with ease.

It is necessary to eventually become familiar with digital applications since they are common in architecture offices. They are best mastered in a similar manner as hand drawing: the more you practice, the better and more efficient you will get.

However, even with the available software and technologies it is important that you learn to draw by hand. There is an immediate cognitive and physical connection between thinking and your drawing implement (pen or pencil) that has yet to be captured by the computer. This translation of information from mind to page is improving every year.

In digital technology, the mouse is the interface to the flat image transmitted through to the screen. There is a second interface between the brain and the graphic, or the method of getting the image onto a page. Drawing by hand facilitates a direct connection between cognitive thinking and the transfer of ideas to paper. There is an immediate result of the line being drawn on paper to a scale that is not present in the digital realm. The limitation of the screen requires you constantly to zoom in and out of an image without a real understanding of the ramifications of doing so.

Orthographic digital images are typically constructed at one-to-one scale, floating in space. The output from the computer is typically modified to a scale for feasibility with printers and paper sizes. Though the construction of images on the computer are considered one to one, the screen becomes the modulating factor that limits the size of the view available to the user. You can zoom in and out on an image, but the limitation of the screen remains.

Digital capabilities
Sophisticated drawings can be constructed using a number of digital programs. Which program to learn is often a product of your work or academic environment. If you can understand the framework of how any one of these programs functions, you should feel comfortable moving from one to another. The graphic rules that apply to manual drafting also apply to digital drafting.
Composite representations

Orthographic drawings have simple graphic relationships to one another, making construction between the drawing types easy. Consider the collective composition of these drawings on a page. When additional drawing types are introduced, establish a hierarchy to emphasize the main ideas of the project.

Construction
Orthographic drawings have dimensional similarities when constructed at the same scale, which can contribute to ease of constructability. That is, when drawn at the same scale, plans, sections, and elevations can be derived from each other. They inform each other—sections and elevations share height information, and plans and sections share location data. For example, a plan can be used to construct a complementary series of plans, sections, or elevations. Construction lines can be extended from elements on one plan that remain consistent on a second plan; or construction lines can be extended to an elevation drawing. One thing to make sure of is the appropriate orientation of the drawings relative to one another.

Page composition
The arrangement of drawings on a page can facilitate the construction of additional orthographic drawings. For instance, the section can be constructed from both the plan and the elevation, using the 45-degree angle for translation of information.

Before you begin drawing, understand how the page will be filled. Allow for enough white space on the page. You should err on the side of fewer drawings on a single page rather than too many.

Rendered composite drawings
This collection of rendered orthographic drawings highlights the relationships between the level changes inside of the space. The inclusion of a human figure establishes the scale of the space as well as highlights the programmatic elements in the room like the soaking tub.
**Composite drawings**

Drawings which tend to overlap one another physically are considered a single drawing made up of multiple drawing types to create a dynamic quality in the presentation. Drawings can be reorganized to emphasize design intention. Plans can be combined with sections in a way to emphasize the relationship between the cut point in the plan and the constructed section.

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**Digital advice**

Sometimes there is an overcrowding of information on digital printouts due to the fact that you can easily compile many images onto one single sheet on the computer. Recall the discussion of the role of white space in the chapter on sketching on page 41. The white of the page is just as important as the image on the page.

Use different-scaled images to allow for multiple image son a single page. Use a repeating element on the page, such as a similar-sized image box, to provide flexibility in the layout.

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**Competition board**

The most important image is the largest, centrally located on the page. The supporting orthographic, diagrammatic, and perspectival images and text wrap around this central image. All drawings were hand constructed and rendered using Photoshop. The composition was created in InDesign.
Models are abstract representations of ideas. In most architectural models, the replication of reality is not highly sought after. Building models is an essential part of the process of designing and refining architectural constructs, not just a presentation of the final iteration.

There are basically two types of models: ones that are process-oriented and explore ideas, and those that are presentation-oriented, built to demonstrate the final product. Of course, the appropriate level of craftsmanship varies relative to the purpose of the model, but by developing your model-building skills you will be able to produce good quality models efficiently for both study and presentation.

There are a number of different types of models that architects use in the process of design. The type of model depends on the need and audience. Process models include study models and massing models. Study models developed during the design process provide ways to understand, explore, and refine the realization of your design ideas. Presentation models are typically representative of a final proposal.

**Process models**

A study model is a representational tool to study architectural ideas and concepts. These models get altered, modified, or reconfigured constantly through the design process; consider them to be works in progress. Study models provide opportunities to review optional solutions and test ideas before making final decisions. They should be saved during the design process to see the physical development of the idea over time. You may want to return to an earlier idea. In addition, study models are typically smaller in scale than final presentation models.

**Model series**

Diagrammatic study models can convey different ideas about a project. Different design strategies relating to the same project are represented using a series of small-scale studies that emphasize volume, containers, overlapping continuous planes, and structure. These models are easy to construct, and visualize the ideas in a three-dimensional way.

**Modeling safety**

- When using sharp instruments, always cut away from yourself.
- When cutting materials with any knife, first score the material along a guide line, then make several passes with your knife. Attempting to cut through material with one pass can often lead to mistakes, knife dulling, and an increased risk of injury.
- Replace your blade often. It is easier to cut with a sharp knife.
- Never use anything non-metal as a cutting guide. Never use your plastic triangle, parallel edge or scale to make cuts. You will be sure to nick their plastic surfaces and ruin them.
- You will cut yourself. Be careful.

**Interior space**

When making a model it is important that your audience can see both the interior and exterior components of your design. If only showing exterior elements, then the model can typically be smaller in scale. This final presentation model for a school project demonstrates both interior and exterior design components as seen through the large transparent window.
Material thickness
Every material has a thickness that needs to be considered in the process of model building. You should carefully consider the joining of two planes, whether similar materials or not. For example, consider the corner joint in terms of what direction you want the edge of the material exposed. Do you want the joint visible from the front or side? Material dimensions will affect the assembly and should be considered when cutting complementary elements of the model. Heed the carpenter’s motto: measure twice and cut once. Accuracy in measuring and thinking out the process will help in creating a well-crafted and accurate model. Different materials may require different joint conditions. Foamcore can be mitered to meet at the corner; each piece is full length. Chipboard and basswood typically are butt-joined and require an understanding of the joint location for accurate measuring of materials.
Gluing

White glue like Elmer’s or Sobo is commonly used in architecture studios and offices. Elmer’s is better for joining porous materials such as basswood, paper, and cardboard and Sobo is better for joining porous to non-porous materials, like plexi to basswood or metal to cardboard. It is best to use a minimal amount of glue so that clean-up at the glue joint and drying times are reduced. Place a dollop of glue on a scrap piece of chipboard and allow it to achieve a tacky quality. This provides a shorter gluing time when it is applied to materials. A small wooden dowel or your finger can be used to apply glue onto an edge surface. Drag the applicator across the edge of the material in a steady pattern. Do not apply too much glue along the edge; only a minimal amount is needed. Hold the glued materials together to allow the joint to dry. Use pressure to seal the joint. Temporary fasteners or drafting tape can be used to hold elements in place, especially when gluing complicated structures.

Sanding

When working with wood, it is critical to use a sanding block to clean up joints and material surfaces. A sanding block can be a rectangular piece of wood wrapped in sandpaper. The sanding block keeps you from rounding the edges of materials. Sand the material in the direction of the grain. By doing so, you can make joints seamless and reduce the effects of residual glue. Sanding across the grain leaves scratches. Do not sand to shorten a piece of material that is too long. You will end up rounding the edges and reducing the crisp edge of the cut. If a piece of material is too short, recut the piece and sand only to clean up the joint.

Digital modeling machines

There are a number of new digital modeling machines prevalent in architecture schools today. These include the laser cutter, starch model machine, vertical mill, metal lathe, waterjet cutter, 3-axis CNC mill, 5-axis robotic arm CNC mill, foam cutter, and plastic 3D printer. Some modeling techniques completed by hand in the past can now be constructed using these high-tech modeling tools. More complex shapes and configurations seemingly impossible by hand can now be completed by machine. A limitation of hand modeling is that the material can generally only be manipulated in one axis, so complex, multiple curvatures are near impossible to achieve. These can be formulated by machines. More tedious cuts like topographical model contours, and repeated standard elements such as trusses, can be made by these machines. Usually these new technologies can reduce human error. Just remember, though, that many of the simple tasks of model making should still be taken on by hand. In many instances, time and money are wasted on what seems to be a time-saving device—but in the end is not.
Model bases
The base is an important component of the model and should be highly considered. It establishes the site of the model and has the potential to reinforce design ideas. You should think about whether you want to minimize the base, accentuate it, or exaggerate it.

Often it is easier to construct the base first, but it may also be built in conjunction with the entire model.

Model entourage
Entourage is considered the additional accessory or supporting elements that fills in the context. This could include trees, bushes, people, and cars. Entourage is a challenging component of the model, since it oscillates between realism and representation. Trees can be represented abstractly in a number of ways: with wood dowels, twisted wire, dried baby’s breath, or wildflowers. Shying away from realistic trees allows the architecture to be the most prominent element.

Remember that the entourage is supporting information and should therefore maintain the model’s color palette and intensity. If a model is made completely out of basswood and then complemented with green trees, those green trees tend to dominate the model. Scale is also an important factor when considering the representation of entourage. Its abstraction needs to be maintained at all scales.

Assembly
The sequence of model construction is an important aspect to consider prior to starting the model. Consider the thickness of the material and account for it in the construction and assembly order. Decide on the hierarchy of joints before cutting any materials. This can also reinforce design intentions. One way to decide the hierarchy is to imagine the direction from which the model will be seen (from above, or in section, for example). Internal structures should be thought of as part of the model, even though they are unseen.

Models can be made to come apart to show several floor plans, or to reveal sections. This introduces more complexity to the construction and assembly. You need to consider the connection between elements and which elements will come apart.

Modeling tips
- You can curve basswood by wetting it and bending it around objects such as jars and tubes; or make your own mold. Use rubber bands to hold the wood in place while it is drying. Basswood can be bent both with and against the grain; however, it is easier to bend parallel to the grain. It is best to use a longer piece of wood than you need and cut it to size after bending. See the steps on the right for the method.
- Wax paper can be used as a gluing surface for complex structural members like trusses. The transparency of the wax allows you to place a drawing underneath and use it as a guide. Glue does not adhere to the wax paper, making it easy to work on. Remove the structure when it is completed.

1. Soak the basswood in water until the material is completely saturated—about 30 minutes.
2. Slowly bend the basswood around an object whose diameter is similar to the bend you wish to achieve. Start at one end and work your way around.
3. If you try to curve it at once, the basswood will most likely break and splinter. Use rubber bands to hold the wood in place while it dries.

The curved basswood
Dürer saw art as the combination of talent, intellect, and mathematics under a humanistic approach. He understood the need for disseminating his work and used the printing press to aid him in this endeavor. To this end he wrote and published a treatise on mathematics titled *Underweysung der Messung* or *Treatise on Measurement*. This treatise was, in fact, only the second work on any type of mathematics to be published in German.

The treatise gives instructions to the reader on how to “construct” (draw with mathematical precision) lines, curves, polygons, and solids. In addition to abstract geometry lessons, Dürer gives practical examples of the uses of the theorems, such as drawing in perspective and shading solids. He also shows how the design of typefaces should be mathematically rigorous, based on “scientific” rules of proportion and geometrical construction.

The Roman letter was based on geometric principles and rules. It is this clarity and rationale that defined it as an elegant type. Dürer used similar geometric principles to construct the capitals of a Roman alphabet, providing detailed instructions for each letter and including images of both the geometric processes and the finished examples.

In addition, Dürer constructed a second alphabet, the *Fraktur* alphabet, using geometric shapes like the square and triangle. The *Fraktur* alphabet was a typeface used in German-language publication. The letters are not in alphabetical order because Dürer built his alphabet incrementally. Essentially, all letters are variations on the letter “I” and so he began with this letter, adding tails or other features as needed to produce the rest of the alphabet.

Upon his death in 1528 Dürer left a legacy of more than 70 paintings, 100 engravings, 250 woodcuts, 1,000 drawings, and three printed books on geometry, fortification, and the theory of human proportions.

**Dürer letter**
Dürer’s alphabet uses a simple geometric proportioning system for all letter constructions, eliminating the need to measure. All construction lines can be determined through geometric means.

**Artist at work**
Dürer understood the relationship between perspective construction and space. He conveyed that understanding in many of his drawings and etchings.
Making orthographic drawings

“Geometry, without which no one can either be or become an absolute artist.”
Albrecht Dürer

Brief
You are asked to construct a full set of orthographic drawings of one of the letters from Albrecht Dürer’s geometric Roman alphabet. Each Dürer letter is based on a specific geometry and proportion. It is imperative that you communicate that precision and proportion in the construction of the letter. Precision is necessary to achieve the accurate proportional relationships described in the Dürer instructions. Read the instructions carefully, rereading as many times as needed, since the language Dürer uses is antiquated. Reconstruct the letter following his instructions; you should not have to measure anything. Use the proportioning system to construct the drawings. The orthographic drawing set will be constructed using your parallel edge, triangles, compass, and lead holder. Construct the elevation, following Dürer’s instructions, inside of a 4-in (100-mm) square. You can then use this drawing to construct a full set of orthographic drawings. You should imagine the letter as a 4-in (100-mm) extruded volume, perpendicular to the surface of your elevation drawing. In other words, if your original elevation is considered in the x and y direction, the extrusion should be considered in the z direction.

Composition
You will need to compose the set of drawings onto a single sheet of 24 x 24 in (610 x 610 mm) paper. It is important that the relationship of your plans, sections, and elevations be apparent in this composition. Therefore leave all construction lines on the drawing.

These lines should be clear and legible on the final drawing within 12 in (30.5 cm) of the surface and from a distance of 3 ft (1 m) they should disappear altogether. Depending on hand pressure, the construction lines should be drawn with a 4H lead. Cut lines should be made using HB. Compositonally, you could think of the different drawings as an unfolded box. In constructing a new set of orthographic drawings for the first time, it is often wise to practice on a material that is less precious than vellum. A preliminary set of drawings can be constructed on trace for practice while the final set can be constructed on vellum.

Avoiding smears
• To avoid smearing your drawings, it is important that you draw in a manner in which your instruments do not glide repeatedly over drawn lines.
• For those who are right-handed, this means drawing from left to right, and from top to bottom on the paper; for those who are left-handed, this means drawing from right to left, and from top to bottom.
• As you complete lines, it is good to place trace over them to preserve the line integrity.

Compositional strategies
The full set of orthographic drawings should include one front elevation (the original letter), two sections and four elevation views including two side elevations, one top and one bottom view. Each drawing is to be placed in a 4 in (102 mm) square.
Making a model

Brief
Construct a three-dimensional model of the Dürer letter using chipboard material. It is good to make the model more than once. Practice models or study models allow you to test construction techniques. The study model will demonstrate problem areas. The second model often resolves the issues present in the first model. You should evaluate your model on its overall craft and accuracy.

Scale
Full scale—the model of each letter is to be considered as if it was inside a 4-in (100-mm) cube.

Study model
Final model

What you need
- 1/32 in (0.5 mm) and/or 1/16 in (1 mm) chipboard for model
- Cutting mat
- Knife and blades
- Metal straightedge
- Orthographic drawings of letter

Tip
Use internal blocking for additional support. Small triangles also help to make planes perpendicular to one another.

1. Use your straightedge to cut material. Score first, then make a series of cuts. Do not try to cut the material with one stroke.

2. Curved elements are more difficult to cut and take more time. Take it slowly, but try to maintain a continuous cut just the same as a continuous line in drawing.

3. Construction sequence is important. Recognize which pieces of material will be exposed (those facing front). This will affect the length of each piece of material.

4. Use a piece of chipboard or your finger to apply glue. You do not need a lot of glue to secure two pieces of chipboard. Too much can introduce moisture to the material and cause it to warp.

5. Be conscious of the natural joints in your material. Make them meaningful to the project. Some materials come in limited sizes so thinking about joint connections can be an important aspect to building the model.

6. Lightly sand edges that may have extra glue or were roughly cut. Sand with the grain of the material if it is visible. Don’t over-sand.
Conceptualizing an idea

**Brief**
Using the proportioning system established by the Dürer letter elevations, design a device to hold eight sketching pencils. You can store them individually or as a group. You can only work within the 4 in (100 mm) volume, and only using straight lines.

Consider the 4 in (102 mm) cubic volume that you constructed for the Dürer letter. Remove all the lines other than the construction lines. These lines represent the elements of the Dürer proportioning system. Imagine working only within the 4 in (102 mm) cube.

Your pencils do not have to be wholly contained within the 4 in (102 mm) volume. Consider the design from all six sides. Every orientation of the cube must provide a place for all eight pencils.

Remember the goal of the assignment and the definition of architecture.

**Function:** store eight pencils  
**Intention:** how do I contain the pencils?  
**Architecture:** aesthetics and compositions

What might provide you with compositional or spatial strategies?

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1. Establish the parameters of your “site.” For this assignment it is the 4-in (10-cm) cube. Study the cube before you begin designing. Use it as a way to think spatially about a concept. Consider the weight of the pencils and how that will affect what you cut.

2. Apply the Dürer proportioning system to all sides of the cube. This provides the parameters in which you can work. Think about carving into the volume as part of the design process. Consider the length of the pencil and how that will affect what you cut.

3. Begin subtracting portions of the foam. The depth of the cut is based on your notion of how the pencils will be held up. The cuts, if deep enough, will begin to affect the other faces of the volume. Consider the interface with the human hand in the design.

4. Consider all six sides of the model. Any surface could be on top. This aspect of the assignment creates the challenge. Your site is complex, even though as a volume it appears simple.

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**Concept diagrams for a school program**

- A series of overlapping boxes indicates a subtle connection between two elements: circulation (orange) and classroom units (gray). This diagram describes how these units can overlap into the hallway as instructional areas.

- Tonal variations describe overlapping spaces. An outline reinforces a more subtle relationship between spaces. Here, two classrooms are indicated by the dark outline as overlapping and sharing a middle zone between them.

- This detail diagram depicts the specific articulation of a classroom as it meets the hallway. The orange indicates the overlapping zone between classroom and hallway.

- Clusters of similar-sized boxes create a negative space between, while the subtle overlapping corners indicate a connection between these distinct elements.