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## Glossary

NOTE: Underlined terms appear elsewhere in the Glossary.

**3-View Drawings.** A series of plan views that illustrate the overall form of a subject. Such “primary” views often show the subject’s height, width, and depth. This may be all that is needed to adequately describe many subjects.

See also First-Angle Projection, Multi-View Drawing, Orthographic Projection, Third-Angle Projection.

**Adjacent View.** A view that is located to the side of, directly above, or directly beneath another view.

**Arc.** A portion of the circumference of a circle.

**Arrowheads.** Directional marks in the shape of the tip of an arrow, used either to indicate the distance between two points on a dimensioned working drawing or as a pointer to specify a particular object in a drawing.

**Auxiliary Plane of Projection.** A special plane arranged so as to be parallel with a non-principal plane or surface in order to project an auxiliary view. When any plane or surface on an object is not parallel to a principal plane of projection, it is a non-principal plane and will therefore not appear true size in the corresponding plan views. An auxiliary plane of projection is set up in order to create a true-size view of such a non-principal surface.

**Auxiliary View.** A true-size view of a non-principal plane or surface projected from an auxiliary plane of projection. When any plane or surface on an object is not parallel to a principal plane of projection, it cannot be depicted as true size in the corresponding normal (i.e. principal) plan views. Such a plane or surface can only be depicted true size by creating an auxiliary view.

**Axes of Motion.** The three dimensions about which motion can occur. Labeling for each axis often depends on the context or subject. For objects such as vehicles, the three dimensions may be described as *longitudinal* (fore-aft), *lateral* (side to side) and *vertical* (up-down). Longitudinal and lateral motions often correspond with the “x” and “y” axes of a two-dimensional plane. In this case, the “z” axis represents the third or vertical dimension. See also Geometric Center.

**Axes of Rotation.** The three dimensions about which an object can rotate. Labeling for each axis often depends on the context or subject. For aircraft, the three axes are *pitch* (rotating upward or downward about the lateral axis), *roll* (rotating or “banking” left or right about the longitudinal axis) and *yaw* (turning or “pointing” to the left or right about the vertical axis). See also Geometric Center.

**Axis of Rotation.** One of the three dimensions about which an object can rotate. See Axes of Rotation.

**Axis of Symmetry.** The “dividing line” or centerline about which an object is symmetrical. Features on either side of the axis of symmetry will be a mirror image of each other.

**Bézier Curves.** (Pronounced “BEZ-ee-ay”) A curved line created by a computer illustration program. The formula for calculating such curves was pioneered by Pierre Bézier, a noted French engineer, scientist, and teacher. These drawing objects are nearly universal to all computer illustration programs, though some applications may refer to them as “paths.” CAD programs may use a completely different approach behind the scenes when creating curved lines. See also Spline.

**Bitmap Image.** A digital image created from individual dots called pixels. When an image is scanned, the computer divides it into tiny little regions. The number of regions recorded depends on the resolution of the scan. Both

the color and the light/dark value of each region are individually recorded and stored as pixels. These values are then assembled to create a digital image file. Because of the large amount of information being stored, the file size of bitmap images can be quite large. As a result, they can take up a lot of disk space. See also Vector-Based Art.

**Blueprints.** Drawings created to precisely and accurately describe the construction of an object. Presentation plans depict a subject from multiple angles or views. Floor plans and elevations describe buildings and other structures. Design drawings depict objects ranging from furniture and cabinetry to crafts and consumer products. Modelers create plans in order to build their projects. All these drawings are blueprints.

**Body Plan.** A special plan view that consolidates many different cross section outlines into a single view. Naval architects use body plans to describe the complex curves of boat and ship hulls. By consolidating all the cross section outlines together, the result is a clean and compact representation of the cross section for the entire hull. See also Dividing Line.

**Bored.** Drilled partially or all the way through. Example: A hole can be bored through an object, or a hole can be bored in an object.

**Bulkhead.** The dividing line between watertight compartments on a ship, or a transverse frame member inside an aircraft fuselage. On boats and ships, frame stations mark the points along the hull where either a bulkhead or a transverse frame is positioned. On aircraft, frame stations mark the points along the fuselage where bulkheads are positioned. The structural frame is then “skinned” to form the shape of the hull or fuselage.

**CAD.** An acronym meaning “Computer-aided design.”

**Centerline(s).** A “dividing line” defining the location of a cutting plane that precisely divides an object in half. For symmetrical objects, the centerline is the axis of symmetry. In such cases, features on either side of this line will be a mirror image of each other.

**Central Angle.** The angle between the two lines that make up a pie-shaped *sector* of a circle. If you imagine a pizza in the shape of a circle, a sector would be a single slice. The straight edges of the slice would be two radial lines drawn from the center of the circle to the outside edge or circumference. The central angle would then be the angle between these two radial lines.

**Chordal Distance.** An approximation of the distance between two points along the edge or circumference of a circle. Since the precise measurement of such distances requires utilizing mathematical formulas for the length of an arc, measuring the chordal distance is quicker and easier because it can be accomplished graphically. The chordal distance is simply the length of a straight line connecting two points along the edge of a circle. In contrast, the true distance along the circumference is the *arc length* between the same two points.

**Clearance.** A gap created between two parts to streamline assembly and fitting. Because the proper fit of most parts requires some degree of tolerance, plans should ideally take this into account. In many cases, it is possible to draw parts in the computer much more precisely than they can be built. Creating “buffer” space around such parts provides some “wobble room” to allow for a proper fit. In general, a margin of at least 0.01 inch or even more is often a good idea. Machine-cut parts may require less clearance, while parts cut by hand often require more clearance. See Tolerance.

**CMYK.** An acronym that means “Cyan, Yellow, Magenta and Black.” CMYK represents what is known as a “color space” and is the format used by printing presses and color printers to create color images using four different colors of ink. In contrast, RGB (“red, green, blue”) is the method both televisions and computers use to display images on screen. Digital image files that will be printed on any sort of printer should be scanned and saved in CMYK format. This stores more information, however, and therefore takes up more computer memory than color scans saved in RGB format. CMYK images may also take longer to scan. See also Bitmap Image, Grayscale, Monochrome.

- CNC.** An acronym that means “Computer Numeric Control.” A CNC device is a machine that is controlled by a computer. These machines may operate in two dimensions or three dimensions to cut or shape parts out of wood, metal, or plastic. Such a device moves by means of stepper motors that are actuated by a computer-controlled interface.
- Conical Helix.** A coil formed by wrapping a sloping line around a cone. This type of helix appears as a *spiral* when viewed from directly above. See [Helix](#).
- Constant Cross Section.** Having a [cross section](#) that does not change in either size or shape along the entire length of the object. Examples of shapes that have a constant cross section include solid rods, tubes, and pieces of pipe. An object with a constant cross section can be extruded. See also [Extruding](#).
- Construction Lines.** Temporary lines sketched on a drawing to aid in constructing views of objects. Such lines often extend from one view to another to help locate points and/or features in multiple views at the same time. Since these lines must be removed to produce a clean, final drawing, it is best to place them on a separate [layer](#) when using a computer drawing program. It is also very helpful to use a very light color for construction lines. See also [Tint](#).
- Conventional Revolution.** The practice of [revolving](#) a [symmetrical](#) object or feature until it appears [true length](#) in a particular view. For the draftsman, it may be considered poor practice to draw a true representation of certain symmetrical features in a plan view when they are not [parallel](#) to that view. The reason is simply that such objects cannot be measured when they do not appear true size in a view. While revolving such features allows them to be measured, the view in question will no longer be a true representation of what the object really looks like. As a result, this convention is somewhat subjective and may cause confusion. See also [Revolution](#), [Revolved](#), [Revolving](#).
- Cross Section.** A [section view](#) created by passing a [cutting plane](#) through an object. The cutting plane is typically parallel to the [frontal plane of projection](#), though section views may also be created at any location necessary to describe the structure of an object. See also [Section](#).
- Cube.** A six-sided, three-dimensional shape where each side is a square.
- Custom Guides.** Custom lines or objects in a computer illustration program that have been moved to or otherwise added to the Guides [layer](#). Standard [Guides](#) can only be horizontal or vertical lines. Creating a Custom Guide permits the use of angled lines (such as a [miter line](#)) or other objects that have all the properties of a standard Guide, including [Snap](#). See [Guides](#).
- Cutting Plane.** A [plane](#) that “slices through” an object at a particular location. By plotting the [intersection](#) of the plane and the object, a [cross section outline](#) can be drawn at that location. The cutting plane is represented by a straight line in a view when the [edge](#) of the plane is parallel to that view. See also [Edge View](#).
- Cylinder.** An object with a circular [cross section](#) such as a round rod, tube or piece of pipe.
- Decimal Inches.** A unit of measurement whereby an inch is divided into tenths rather than sixteenths. 1/2 inch would therefore be 5/10 of a decimal inch. Decimal inches are a convenient measuring system when you need to use a calculator to find measurements. In contrast, fractions must be converted into a decimal equivalent before punching the numbers into a calculator.
- Degrees.** The basic unit of measurement for angles. A circle is divided into 360 degrees. An alternative to the degree is a unit known as a [radian](#). The radian is often used in mathematical formulas for calculating the length of an arc, in trigonometry, and for certain values pertaining to circles. As a result, it may sometimes be necessary to convert from degrees to radians and vice versa when using these formulas. See also [Radians](#).
- Derived.** Deduced or calculated from available information. As an example, if you know the overall length of an object and also the length from one end to a certain feature, you can derive the measurement for the distance between the same feature and the opposite end of the object.

- Design drawings.** Blueprints created by industrial designers or craftsmen for constructing industrial or consumer products. This is a subjective label that can be applied to any number of different items. For example, an industrial designer might produce design drawings for a toy or for a bottle that contains a liquid product. A craftsman might produce design drawings in order to construct a cabinet or piece of furniture.
- Develop.** To “unfold” or “unroll” a three-dimensional object in such a way as to create flat patterns that can then be used to construct it from sheet material. See also Developments, Unfold, Unroll.
- Developments.** Flat patterns that, when assembled, will yield a three-dimensional object. See Develop.
- Diameter.** The distance across a circle, measured from the widest point on either side. The diameter can be accurately measured by passing a straight line through the exact center of the circle and extending either end of the line until it meets the edges of the circle.
- Dimension Lines.** Lines used to indicate the start and end points of measurements noted in a dimensioned drawing (i.e. working drawings). To conform to convention, dimension lines should be positioned so as not to cause confusion or clutter in a drawing and should have arrowheads at both ends.
- Dimension Numbers.** Numbers placed over the center of dimension lines to denote the values of the measurements being specified.
- Dimensioned.** Having key dimensions specified/labeled using dimension lines, dimension numbers, and extension lines.
- Dimensioning.** The process of marking key dimensions on a drawing using dimension lines, dimension numbers, and extension lines.
- Dividing Line.** A line added to a top or side plan view to mark the location of the widest point along the hull of a ship or fuselage of an airplane. All cross section profiles forward of this point will appear in the front plan view while all cross section profiles aft of this point will appear in the rear plan view. The dividing line also helps in the creation of a body plan. See also Body Plan.
- Dodecahedron.** A three-dimensional geometric shape having 12 faces where each face is in the shape of a five-sided pentagon.
- Drafting.** The process of creating mechanical drawings of an object in such a way that measurements can be accurately extracted and/or interpreted from them.
- Edge View.** A view that depicts a plane or surface on an object as an edge. The edge of the plane or surface will appear as a straight line in any such view.
- Elevations.** Side, front, and/or rear plan views of a building or other structure. An elevation is any view that shows the vertical portions of the building/structure rather than the horizontal layout. See also Floor Plan.
- English.** A traditional system of measurement using inches, pounds, and gallons that is standard in the United States of America. Also known as “US Customary Units,” English measurements, sometimes called “Imperial” measurements, are also standard in Great Britain. Note, however, that some measurements have slightly different values between US/English and British/Imperial standards. In stark contrast, the Metric system (called “Système International d’Unités” or “SI”) is a decimal-based system of measurement using meters, kilograms, and liters.
- Extension Lines.** Lines that extend from points on a feature or object to either end of a dimension line. Extension lines are used to indicate the start and end points of measurements in a dimensioned drawing. They help keep the drawing clear by allowing the dimension labels to be placed away from the object while still clearly indicating the exact start and end points of the measurement in question. See also Dimension Lines, Dimension Numbers, Dimensioned, Dimensioning.
- Extruding.** The process of creating a three-dimensional object using a two-dimensional pattern by adding height to the two-dimensional shape or outline. Extruding is commonly used in the manufacture of products that have

a constant cross section. It is also a technique for making 3D computer models of simple objects. All that is needed to build such a shape is a drawing of the outline to be extruded, making this a very easy and fast technique for three-dimensional construction.

**First-Angle Projection.** Standard for arranging multi-view drawings practiced in Europe and the International community. This system places the top view at the center of the drawing with the front view above and the left side view to the right of the front view. A completely different arrangement called third-angle projection is practiced in the United States, Canada and Great Britain.

**Floor Plans.** Top plan view of a building or other structure looking downward. A floor plan shows the horizontal layout of the building/structure whereas elevations depict the vertical portions.

**Focal Plane.** A surface onto which light is focused in order to create a clear image either by exposing film inside a camera or recording information in digital format using a charge-coupled-device (“CCD”). The focal plane is parallel with the body of the camera. Due to the properties of optics, light focused through the lens of the camera creates an upside-down image on the focal plane.

**Fold Line.** The line along which two sides of an imaginary glass box surrounding a subject meet. Orthographic projection works by “unfolding” such an imaginary box and arranging all the sides on a single plane represented by a sheet of paper. The fold line becomes very important when creating a primary auxiliary view because the draftsman will measure distances from the object to the fold line in order to create a true-size representation of the object in the auxiliary view.

**Foreshortened.** Not appearing true length or true size. Both lines and planes/surfaces can appear foreshortened in an orthographic plan view when they are not parallel to the principal plane of projection upon which the view was derived. See also True Length, True Size.

**Frame Station.** A location along the hull of a boat or ship – or along the fuselage of an aircraft – where a structural framing member is located. On boats and ships, frame stations mark points along the hull where either bulkheads or transverse frames are positioned. (On aircraft, all transverse frames are called bulkheads.) The structural frame is then “skinned” to form the shape of the hull or fuselage.

**Frontal Plane.** One of the three principal planes of projection that yields the front and rear plan views. Since both views are parallel to one another, the plane of projection that yields the front plan view is parallel to the plane of projection that yields the rear plan view. As a result, these planes of projection can be combined into a single plane known as the frontal plane.

**Frustum of a Cone.** A cone that is missing part of the top. The top outline of the frustum of a cone is parallel with the outline of the bottom. When a cone has been trimmed such that these top and bottom outlines are non-parallel, it is known as a truncated cone instead.

**Frustum of a Pyramid.** A pyramid that is missing part of the top. The top surface of the frustum of a pyramid is parallel with the bottom. If the pyramid is trimmed such that the top and bottom surfaces are non-parallel, it is known as a truncated pyramid instead.

**Geometric Center.** The precise center point of an object where the lateral, longitudinal, and vertical axes come together. Since some objects can rotate or move about a point other than the geometric center, this may or may not be the same point as the *center of rotation* (i.e. the point where the three axes of motion meet). See also Axes of Motion, Axes of Rotation.

**Geometric Solid.** A three-dimensional area of space enclosed by either a curved surface or a series of flat surfaces that are joined together at the edges (i.e. a “closed” surface). Geometric solids include cubes, cylinders, prisms, cones, pyramids, spheres, and polyhedrons (or “polyhedra”).

**Gores.** A portion of the development of a sphere. A gore is also known as a lune. Since a sphere has compound

curves, it cannot be precisely developed. The process of creating gores or lunes permits the surface of a sphere to be approximated as a series of flat patterns. This process is commonly used to create globes from printed paper parts.

**Grayscale.** An image format for storing digital photographs, images, or scans that displays the image in black, white, and shades of gray but not color. One of two possible formats for storing non-color images in digital form. The other option is called Monochrome. See also Bitmap Image, CMYK, Image File, RGB.

**Guides.** Parallel lines appearing on the screen of a computer illustration program. Guides replace horizontal and vertical construction lines traditionally drawn by the draftsman on paper using a parallel rule and t-square. See also Custom Guides.

**Half Round.** One half of a cylinder, split lengthwise down the middle.

**Half Section.** A section view where one half of the object is omitted to save space. This is most often done when the object in question is perfectly symmetrical, meaning it is not necessary to draw the entire object. See Section.

**Helix.** A coil formed by wrapping a sloping line around a cylinder. A regular helix appears as a circle when viewed from directly above. See also Conical Helix.

**Hemisphere.** One half of a sphere.

**Horizontal Plane.** One of the three principal planes of projection that yields the top and bottom plan views. Since both views are parallel to one another, the plane of projection that yields the top plan view is parallel to the plane of projection that yields the bottom plan view. As a result, these planes of projection can be combined into a single plane known as the horizontal plane.

**Icosahedron.** A three-dimensional geometric shape having 20 faces where each face is in the shape of a triangle.

**Image Editing Program.** Software designed to open and modify bitmap images. These include digital photographs, scans, and other digital artwork stored as a series of pixels in an image file.

**Image File.** An assemblage of individual pixels that make up a digital image such as a scanned photograph. When an image is scanned, the computer divides it into tiny little regions and records both the color and the light/dark value of each region. These values are then assembled to create a digital image file. Because of the large amount of information being recorded, image files can take up a lot of disk space. See also CMYK, Grayscale, Monochrome, RGB.

**Inclined Line.** A line that is parallel to only one principal plane of projection. Inclined lines are non-normal lines.

**Inclined Plane.** A plane that is not parallel to any of the principal planes of projection but is perpendicular to one plane of projection. Inclined planes are non-normal planes.

**Incomplete View.** A view that is “cleaned up” to eliminate unnecessary hidden lines. Sometimes an object is so complex that including every single hidden line would produce a very “busy” and potentially confusing drawing. In this case, some of the hidden lines may be omitted in an effort to produce a cleaner drawing.

**Interpret.** To examine and analyze a photograph to understand exactly what is being depicted. Interpreting photos is a valuable skill that can help a modeler extract critical information that can be used to accurately recreate the subject.

**Intersection.** The location where two surfaces meet in three dimensions. An intersection in 3D space is defined by a three-dimensional line. This line can then be projected into any orthographic plan view. Plotting intersections accurately can be one of the most challenging aspects of model design. 3D computer modeling tools can be invaluable to this process.

**Isometric.** A “pictorial” representation of an object that depicts three-dimensional information without including any visual perspective. Measurements can be taken from an isometric view just as they can from an orthographic

plan view. Since the eye always sees visual perspective in everything, however, an isometric view may not be intuitive.

**Lateral Axis.** An axis running from one side of an object to another, defined by a line that extends through its geometric center.

**Lathing.** The process of creating a three-dimensional object that is symmetrical about an axis using a two-dimensional profile or shape. The profile is revolved around the axis of symmetry to create the three-dimensional shape. This process can be used to turn shapes from wood and other materials on a special tool called a *lathe*. A similar process can also be used in computer modeling to build three-dimensional shapes quickly and easily.

**Layer.** A plane in a computer drawing that can contain lines and other drawing objects. Also known as an “overlay.” Layers are used to organize drawings and reduce clutter. In the past, when drawings were made by hand, sheets of vellum or clear acetate were assembled to create multiple layers in a complex drawing. Today, computer programs make it possible to quickly and easily use an almost infinite assortment of different layers in order to organize a drawing.

**Leader Lines.** Thin lines that connect a note(s) about an object on a drawing to the area or feature in question; Such lines should begin next to either the first or last word in the note rather than in the middle. A leader line pointing to a feature ends in an arrowhead while a leader line pointing to a surface or area ends in a round dot. See also Dimension Lines, Dimension Numbers, Dimensioned, Dimensioning.

**Line of Sight.** An imaginary line between the eye of an observer and an object or feature. The line of sight defines a specific viewing angle or point of view on the part of the observer.

**Lofting.** The process of creating a three-dimensional shape by combining or “blending” multiple cross sections along a given path. This process is very similar to extruding, but a lofted shape can have different cross sections at points along its length whereas an extruded shape has a constant cross section.

**Longitudinal Axis.** An axis running down the length of an object, defined by a line that extends through its geometric center.

**Lune.** A portion of the development of a sphere. A lune is also known as a gore. Since a sphere has compound curves, it cannot be precisely developed. The process of creating gores or lunes, however, permits the surface of a sphere to be *approximated* as a series of flat patterns. This process is commonly used to create globes from printed paper parts.

**Mesh.** The three-dimensional surface of an object inside a 3D computer modeling program. Mesh surfaces are composed of polygons that are stitched together. In most cases, each polygon is a triangle, though they may sometimes be 4-sided quadrilaterals. A program that creates mesh objects can be thought of as making “digital clay” that a 3D modeler can “sculpt” using a number of different computer-based tools. In sharp contrast, a spline-based modeling program creates precise surfaces from curves based on mathematical formulas. Unlike mesh modeling, spline modeling is a natural extension of the 2D drafting process. See also Multigon, Bézier Curve.

**Metric.** A decimal-based system of measurement using meters, kilograms, and liters that is standard in Europe and the International community. Also known as “Système International d’Unités” or “SI” for short. The labels for each unit of measurement in the Metric system are based on a decimal percentage of the fundamental unit. As an example, a “centimeter” is 1/100 of a meter, while a “millimeter” is 1/1000 of a meter. In stark contrast, a more traditional system of “US Customary Units” based on the inch, pound, and gallon remain the standard in the United States of America. These English units are based on the “Imperial” units developed by Great Britain.

**Miter Line.** A line positioned 45-degrees from the horizontal that is used to transfer points between non-adjacent views. The miter line is one of the key concepts that makes orthographic projection work. Acting as an angled “mirror,” the miter line is used to “reflect” construction lines drawn from one view into another.

- Modifier Key.** A key on a computer keyboard that, when depressed, modifies the behavior of a command executed in a computer drawing program. The key must first be depressed, then the command is chosen from a menu (or a button is clicked). When the desired action is complete, the modifier key is released.
- Monochrome.** An image format for storing digital photographs, images, or scans that displays the image using only black and/ or white pixels, but not shades of gray or color. One of two possible formats for storing non-color images in digital form. The other option is called Grayscale. Monochrome format uses the least possible amount of computer memory when storing an image. See also Bitmap Image, CMYK, Image File, RGB.
- Multigon.** A two-dimensional geometric figure with three or more sides. In this book, the term “multigon” is used in place of the word “polygon” because a polygon is a special type of object used in 3D modeling that exists in three dimensions. See Polygon.
- Multi-view drawing.** The process of preparing multiple orthographic plan views of a subject using orthographic projection. In fact, multi-view drawing is often synonymous with the term “orthographic projection.” An imaginary “glass box” is said to surround the subject and views of the object are projected onto each side of the box. It is then “unfolded” so that all views are in the same plane. See also 3-View Drawings, First-Angle Projection, Third-Angle Projection.
- Non-Adjacent View.** A view that is not located to the side of, directly above, or directly beneath another view. As an example, when views are arranged according to the intuitive layout shown in this book, the side view is adjacent to the front, rear, top and bottom views because they are arranged around it (above, below, and on either side). On the other hand, the front and rear views are *not* adjacent to the top or bottom views – but *are* adjacent to the side view. When views are not adjacent, a miter line can be used to transfer points between them.
- Non-Normal Line.** Any line that is not a normal line. Non-normal lines may be either inclined or oblique.
- Non-Normal Plane.** Any plane that is not a normal plane. Non-normal planes may be either inclined or oblique.
- Normal.** A direction perpendicular to the face of a surface or plane. As an example, if a plane is a horizontal plane represented by the “x” and “y” axes, a line *normal* to this plane would be a vertical line representing the “z” axis.
- Normal Line.** A line parallel to two principal planes of projection, but perpendicular to the third.
- Normal Plane.** A plane that is parallel to two principal planes of projection at the same time.
- Normal View.** An orthographic plan view derived from one of the three principal planes of projection. All six principal plan views (top, bottom, left, right, front, rear) are normal views. On the other hand, an auxiliary view is not a normal view because it is projected from an auxiliary plane of projection not parallel with any of the principal planes of projection.
- Oblique.** (Pronounced “oh-BLEEK”) Not parallel to any normal view (as in an oblique line or oblique plane). Also, not upright, or appearing to “lean” to one side (such as an oblique cylinder, cone or prism).
- Oblique Cone.** A cone that appears to “lean” to one side. If a line is drawn from the tip of such a cone to the exact center of the circular base, it will not be perpendicular to the plane containing the base.
- Oblique Cylinder.** A cylinder that appears to “lean” to one side. The ends of such a cylinder are parallel to each other and cut at an angle so they are not perpendicular to the longitudinal axis of the cylinder.
- Oblique Line.** A non-normal line that is not parallel to any principal plan view. An oblique line appears foreshortened in all normal views.
- Oblique Parallelepiped.** (Pronounced “oh-BLEEK pair-uh-lel-uh-PIPE-id”) A six-sided, three-dimensional shape very similar to a cube but where each side is a *rhombus* rather than a square.
- Oblique Plane.** A non-normal plane that is not parallel to any principal plan view. An oblique plane appears foreshortened in all normal views.

- Oblique Prism.** A prism that appears to “lean” to one side. The ends of such a prism are parallel to each other and cut at an angle so they are not perpendicular to the longitudinal axis of the prism.
- Octahedron.** A three-dimensional geometric shape having 8 faces where each face is in the shape of a triangle. An octahedron can be assembled from two square-base pyramids.
- Odd Angle.** Any angle that is not commonly used in construction. Common angles include 90 degrees, 60 degrees, 45 degrees, 30 degrees, 22.5 degrees (or 1/2 of 45 degrees), and 15 degrees. Most angles chosen in construction come from this list of commonly used values, are multiples thereof, or are otherwise rounded to the nearest five degrees. Any other choice might be considered an odd angle.
- Order of Importance.** A principle used to decide which lines to show and which to omit when lines overlap in a drawing. Visible lines must always be shown and therefore have priority over all other line types. Hidden lines are next in priority, while centerlines are last.
- Orthographic Projection.** A method whereby a subject can be drawn from any angle without including the distortion caused by visual perspective. The process of preparing orthographic plan views of a subject is also known as multi-view drawing. An imaginary “glass box” is said to surround the subject and views of the object are projected onto each side of the box. It is then “unfolded” so that all views are in the same plane.
- Parallelism.** The state of being parallel, where two objects are perfectly aligned with one another and face in the same direction. If two lines are parallel, they are equidistant from one another at all times. Such lines neither converge nor diverge. Even if the lines were extended to infinity, this alignment would be maintained along their entire length.
- Partial Section.** A section view that depicts less than one half of a feature or subject. When an object is perfectly symmetrical, a half section may be used to describe its structure while taking up less space in the drawing. For some subjects that have radial symmetry (such as a wheel), even less information may be required. In such cases, a partial section may be used to describe only a pie-shaped piece of the object.
- Partial View.** A portion of a normal view. If a subject is perfectly symmetrical, it may not be necessary to describe the entire object. If space is limited, a partial view may suffice.
- Pasteboard.** The total drawing area available inside a computer illustration program. All pages or sheets that make up a drawing must fit on the pasteboard. Also known as the “virtual drawing canvas” or “canvas.” This term originates from the traditional method of creating print layouts by hand using paper and paste on a work surface such as a drawing table.
- Pixels.** A tiny region or “dot” that makes up a digital image. Unlike a television screen that has a picture made up of scan lines, images on computer monitors are broken down into individual dots called pixels. Each dot can appear white, black, a shade of gray, or any one of millions of possible colors. Because of this, all digital images must be stored as a pattern of pixels so they can be displayed on screen. When an image is scanned or “digitized,” the computer divides it into tiny little regions and records both the color and the light/dark value of each region. These values are then assembled to create a digital image file. See also Bitmap Image.
- Plan View.** An “orthographic” representation of a subject from a particular angle or point of view. Orthographic renderings are prepared in such a way that distortion caused by visual perspective is completely eliminated. An orthographic plan view can be any one of the six principal plan views (top, bottom, front, rear, left, and right) derived from the three principal planes of projection. See Orthographic Projection.
- Plane.** A perfectly flat surface. Because it is perfectly flat, a plane is actually a two-dimensional object but can be oriented in any direction in three-dimensional space.
- Plans.** Blueprints created for the purpose of building a scale model of a subject.
- Platonic Solids.** Five special types of regular polyhedrons (or “polyhedra”) where the same number of sides or

“facets” always come together at each point or vertex. These geometric figures – named after the Greek philosopher Plato – are unique because every side, angle, and edge is the same all around the object. The five Platonic Solids are the tetrahedron, cube, octahedron, dodecahedron, and icosahedron.

**Polygon.** In geometry, a two-dimensional figure with three or more sides. In 3D modeling, the polygon is the basic element that makes up a mesh surface. See Multigon.

**Polyhedron.** A three-dimensional area of space enclosed by a series of flat surfaces or “facets” that are joined together at the edges (i.e. a “closed” surface). Each face of a polyhedron is a multigon. See also Platonic Solids.

**Presentation Plans.** Blueprints that depict only the overall form of a subject, but not the structural detail needed to recreate it.

**Primary Auxiliary View.** A true-size view of a non-principal plane or surface projected from an auxiliary plane of projection. The primary auxiliary view is derived from information contained in the normal plan views via orthographic projection. In contrast, a secondary auxiliary view is derived from information contained in a primary auxiliary view.

**Principal Plan Views.** The six orthographic views projected onto the sides of an imaginary “glass box” surrounding a subject using orthographic projection. These are the top, bottom, front, rear, left, and right views. All six principal plan views are normal views.

**Principal Plane.** A normal plane.

**Principal Planes of Projection.** Three planes of projection from which the six principal plan views are derived. According to the theory of orthographic projection, an imaginary “glass box” can be placed around a subject and the six principal plan views projected onto the six sides of this box. Each side of the box is therefore a *plane of projection*. Since views on either side of the imaginary glass box are parallel to one another, the plane of projection that yields a view on one side is parallel to the plane of projection that yields the view on the opposite side. As a result, the six planes of projection can be reduced to just three principal planes of projection.

**Prism.** (Pronounced “PRIZ-uhm”) A three-dimensional shape with a base and top made from identical multigons and where the sides are either rectangles or parallelograms.

**Profile.** In a 2D drawing, a cross section outline appearing in the side plan view. A profile is created by passing a cutting plane through an object where the cutting plane is parallel with the profile plane of projection. In a spline-based 3D modeling program, a profile is a two-dimensional line, curve, or other shape used to create a three-dimensional surface using 3D tools such as extruding, lofting, sweeping, or lathing.

**Profile Plane.** One of the three principal planes of projection that yields the left and right side plan views. Since both views are parallel to one another, the plane of projection that yields the left plan view is parallel to the plane of projection that yields the right plan view. As a result, these planes of projection can be combined into a single plane known as the profile plane.

**Projected View.** An outline projected onto the side of an imaginary glass box surrounding a subject using the techniques of orthographic projection.

**Pyramid.** A three-dimensional shape where the base is a multigon and the sides are triangles that meet at a point.

**Radian.** Special unit of measurement for calculating values related to angles, circles and arc lengths. Also used in trigonometry. Technically speaking, the radian is a “dimensionless unit” which may be confusing. Many common mathematical formulas require values to be input in radians or produce results measured in radians. In this event, it is necessary to convert radians to degrees and vice versa. A straightforward formula can be used to accomplish this and many scientific calculators have a built-in function for converting between the two forms of angle measurement.

- Radius.** The distance from the exact center of a circle to the outside edge or circumference. This distance is exactly one half the diameter of the circle.
- Regular Helix.** See Helix.
- Regular Polyhedron.** One of five special types of polyhedrons (or “polyhedra”) where the same number of sides or “facets” always come together at each point or vertex. See Platonic Solids.
- Regular Pyramid.** A “right” (i.e. upright, not oblique) pyramid with a base in the shape of a regular multigon. (A regular multigon is a two-dimensional shape with three or more sides that are all identical in length.)
- Removed View.** A view created to illustrate an object, detail or feature positioned in such a location that it cannot be clearly seen in any normal view.
- Resolve.** To uncover, deduce, reconstruct or calculate based on available information, i.e. to “fill in the blank” using existing information as a guide. If the blueprinting process is imagined as being similar to solving a picture puzzle where some pieces are missing, existing information could be used to reconstruct or resolve the puzzle to find the missing pieces.
- Revolution.** The process of revolving an object or feature about an appropriate centerline until it is parallel with a normal view. The goal of revolution is to find a view of the part where it appears true length or true size and can therefore be measured. This technique is a practical alternative to the process of creating an auxiliary view. See also Conventional Revolution.
- Revolved.** Rotated about an appropriate centerline using the process of revolution. A “revolved view “is a true-size representation created by revolving an object or feature until it is parallel with a normal view. This is often a quick and easy alternative to the process of creating an auxiliary view.
- Revolving.** The process of rotating an object or feature about an appropriate centerline. See Revolution, Revolved.
- RGB.** An acronym that means “Red, Green, and Blue.” RGB represents what is known as a “color space” and is the method both televisions and computers use to display images on screen. In contrast, CMYK is the format used by printing presses and color printers to create color images using four different colors of ink. Digital image files that will only be viewed on screen or sent to others via e-mail should be scanned and saved in RGB format. (On the other hand, images that are to be printed on any sort of printer should be scanned and saved in CMYK format.) RGB images contain slightly less information and therefore takes up less computer memory than images saved in CMYK format. See also Bitmap Image, Grayscale, Monochrome.
- Right Cone.** An “upright” (i.e. not oblique) cone that does not “lean” to one side. If a line is drawn between the exact center of the circular base and the tip of a right cone, it will be normal (i.e. perpendicular) to the plane containing the base of the cone.
- Right Cylinder.** An “upright” (i.e. not oblique) cylinder that does not “lean” to one side. Both the base and the top of a right cylinder are parallel. In addition, a line drawn between the exact center of the circular base and the exact center of the circular top is normal to both surfaces.
- Right Prism.** An “upright” (i.e. not oblique) prism that does not “lean” to one side. Both the base and the top of a right prism are parallel. In addition, a line drawn between the exact center of the base and the exact center of the top is normal to both surfaces.
- Scale.** The proportional relationship or ratio of the measured size of a facsimile of an object compared to the size of the actual object.
- Secondary Auxiliary View.** A true-size view of a non-principal plane or surface derived from information contained in a primary auxiliary view via orthographic projection. In contrast, a primary auxiliary view is derived from information contained in the normal plan views. Secondary auxiliary views can be challenging to draw. As a result, employing revolution is often an easier alternative.

**Section.** A view created by passing a cutting plane through an object to “expose” the true shape of both the visible and hidden internal structures. The cutting plane is typically parallel to the frontal plane of projection, though section views may also be created at any location necessary to describe the structure of an object.

**Snap.** A feature of a computer drawing program that permits precise placement of lines and objects. When Snap is activated, the end points of a line or points that make up a multi-sided object can “snap to” or be *anchored* to points on a pre-established grid or to Guides.

**Spline.** A two-dimensional (or three-dimensional) line or curve used to build a 3D surface or object in a 3D modeling program. Not all 3D modeling programs use splines – many programs create mesh objects instead. Mesh modeling is a completely different approach and is more like “digital clay” that can be sculpted into many different shapes. In sharp contrast, a spline-based 3D modeling program creates precise surfaces from curves that are based on mathematical formulas. Because curves are the starting point for creating each 3D object, spline modeling is a natural extension of the 2D drafting process. In addition, some spline modeling programs offer incredibly powerful features such as being able to unfold or unroll certain 3D objects to create developments and/or make 2D line drawings automatically. See also Bézier Curve.

**Symmetrical.** The property whereby features or points on either side of an object are a mirror image of each other. A symmetrical object has a “dividing line” or centerline called the axis of symmetry. Points and features on either side of this axis are equidistant from the centerline.

**Template.** Any pattern that defines the outline of a part in the correct size and shape for the purposes of constructing all or part of an object. In traditional construction, templates are often cut from paper, cardboard or thin sheet stock and then traced onto the final material from which a part is to be cut. With modern computer-based tools, templates can be drawn with a computer and then used to make a part directly via computer-controlled machining such as laser-cutting or CNC milling.

**Tetrahedron.** A three-dimensional geometric shape having 4 faces where each face is an identical triangle, i.e. a three-sided triangular pyramid.

**Text Tool.** A tool in a computer drawing program that permits text to be added to a drawing.

**Third-Angle Projection.** Standard for arranging multi-view drawings practiced in the United States, Canada, and Great Britain. This system places the front view at the center of the drawing with the top view above, bottom view below, right side view to the right and left side and rear views to the left. The front view is labeled arbitrarily and is not necessarily the actual front of the object. This can cause some confusion. A completely different arrangement called first-angle projection is practiced in the Europe and the International community.

**Through Holes.** Holes bored (i.e. drilled) completely through an object.

**Tint.** A screened, muted or “washed out” color that is of lighter intensity than the color upon which it is based. For example, shades of gray are tints of the base color *black*. In the same way, a pastel blue might be considered a “tint” of bright blue. In a computer illustration program, tints can be created by specifying a percentage value of the base color, i.e. medium gray = 50% black. A very light gray can be created as a tint of 10% black. In fact, a 10% tint of an intense base color such as bright red, green, or blue yields a very light color that is ideally suited for drawing construction lines.

**Title Block.** An area in the bottom right corner of a drawing where the name of the draftsman, company, title/subject, page/sheet number, date, revision history, and any other information can be specified.

**Tolerance.** A variation in size or thickness from the expected or stated value. Some manufactured materials differ from their stated dimensions due to variations inherent in the manufacturing process. As a result, tolerance should be taken into account when designing parts that must fit together precisely. See Clearance.

**Transition.** A change in cross section over the length of a part or assembly. A transition can be used to join two parts that have dissimilar cross sections without creating an intersection between them.

- Transverse Frame.** A structural framing member that runs laterally or side-to-side. On boats and ships, both transverse frames and bulkheads are used to form the shape of the hull. (A bulkhead is actually a dividing line between watertight compartments on a ship.) On aircraft, all transverse frames are called bulkheads. These structural frame members are “skinned” to form the shape of the hull or fuselage.
- True Depth.** The depth of a bored hole measured from the surface all the way to point where the tip of the drill bit bottoms out in the hole. Most drill bits have tips that are angled at 120 degrees, creating a cone-shaped depression in the bottom of the hole. The true depth includes this depression. In contrast, the usable depth does not include this cone-shaped space at the bottom of the hole.
- True Length.** The actual length of a line or object. According to the principles of orthographic projection, a line or object can only appear true length in a normal view if it is parallel to the principal plane of projection for that view, or, in the case of an auxiliary view, if it is parallel to the auxiliary plane of projection. See also Foreshortened.
- True Size.** The actual or true dimensions of a plane or surface. According to the principles of orthographic projection, a plane can only appear true size in a normal view if it is parallel to the principal plane of projection for that view, or, in the case of an auxiliary view, if it is parallel to the auxiliary plane of projection. See also Foreshortened.
- Truncated.** Having one or both ends cut off. In some cases, a truncated shape requires that the ends be cut at an angle such as with a truncated cone or truncated pyramid. In these cases, if the shape is cut so that the trimmed face is parallel with the base, it is called a “frustum” instead.
- Truncated Cone.** A cone with the tip cut off at an angle. If the tip is cut in such a way that the trimmed top is parallel with the base of the cone, the shape is called a “frustum of a cone” instead. A paper cup is an excellent example of a frustum of a cone.
- Unfold.** To create a development for a three-dimensional object or surface composed of flat faces or “facets” (or to create a development that approximates a sphere). The object is “unfolded” into order to flatten it. See also Develop, Unroll.
- Uniform Cross Section.** Having a cross section that does not change in shape but may change in *size* along the length of the object. Objects with a uniform cross section are often easy to draw because the cross section merely needs to be *scaled* at different points along the length of the object. It may also be possible to create such an object using the lofting tool of a spline-based 3D modeling program.
- Unroll.** To create a development for a three-dimensional object or surface such as a cylinder with rounded surfaces. The object is “unrolled” into order to flatten it. See Development.
- Usable Depth.** The depth of a bored hole that includes only the cylindrical portion of the hole. Most drill bits have tips that are angled at 120 degrees, creating a cone-shaped depression in the bottom of the hole. The usable depth does not include the cone-shaped space occupied by the tip of the drill bit when it bottoms out in the hole. See also True Depth.
- Vector-Based Art.** Line drawings and other object-oriented art created with a computer in such a way that they are not composed of individual pixels. All computer drawing programs (both CAD and computer illustration programs) generate vector-based art. A vector drawing object is created by storing the start, middle and end points, as well as direction or path information and also various properties of the object such as *stroke color* and *fill value*. This permits the program to draw the object on screen dynamically when needed, meaning vector-based objects can be modified quite easily. Since the amount of information being stored is minimal, vector-based artwork can sometimes take up as little disk space as a word processing document. In stark contrast, digital images stored as pixels take up much more memory and are much more difficult to modify since each individual pixel must be changed in order to alter the appearance of the image. See also Bitmap Image.
- Vertex.** The point where two sides of a multigon meet, a point where two lines that form an angle between them converge, or the point where three or more sides of a three-dimensional object such as a geometric solid meet.

**Vertical Axis.** An axis running from the top to the bottom an object, defined by a line that extends through its geometric center.

**Vertical Plane.** An alternate term for the frontal plane of projection.

**Visual Perspective.** A natural phenomenon that allows the eye to perceive three dimensional objects. Perspective also creates dramatic visual distortion, the amount of which depends both on the size of the object and how far away it is from the viewer. The closer an object gets, the more perspective distortion increases. Orthographic projection was developed to eliminate all visual perspective from blueprints so objects in the drawings can be accurately measured.

**Working drawings.** A set of blueprints that include detailed measurements and other information needed to accurately recreate the subject. By nature, a working drawing is always a dimensioned drawing.