Three Dimensional (3D)

Having the dimensions of height, width, and depth.

Thumbnail Sketch

A preliminary visual of a possible idea for a design. Most thumbnail sketches are not full-size and have little detail. They are intended to quickly explore possible alternative designs.

Two Dimensional (2D)

Having the dimensions of height and width, height and depth, or width and depth only.

Two-Point Perspective

A realistic way of drawing objects in three dimensions using a horizon line, a key edge, and two vanishing points.

Vanishing Point

A point in space, usually located on the horizon, where parallel edges of an object appear to converge.

Views

Views is shorthand for multiview projection, which is a system used to view an object. The six mutually perpendicular directions any object may be viewed are top, front, right-side, rear, left-side, and bottom. Top, front, and right-side views are also referred to as the three regular views because they are the three views most frequently used.

Visualize

To imagine the visual form of an object or situation that one cannot see.
Width

The measurement or extent of something from side to side.
Sketching Practice

“One picture is worth a thousand words.”
Pictorial Sketches

• Show shape of object

• Show height, width, and depth

• Common types:
  – Isometric
  – Perspective
Isometric Sketch

- Width and depth lines are drawn at 30° from the horizon line.
- One view shows height, width, and depth.
3D Sketching Techniques

Isometric Grid Paper
Thumbnail Isometric Sketch

Copy and label this cube on your isometric axis.
Isometric Thumbnail Sketch

- Additive and Subtractive 3D sketch
- Follow the steps in your activity to complete this drawing on the isometric graph paper.
Perspective

• Perspective is a way to draw that shows a view of the object in the most realistic way.

• Vanishing points are used to guide the lines in the object to the horizon line or the horizontal line you see at your line of sight.
One-Point Perspective

• All lines in the depth project to one point (the vanishing point).
• The location of the vanishing point is based on your line of sight.
• Copy this one-point perspective sketch onto your activity. Label the front, top, and right side.

Vanishing Point (VP)
Two-Point Perspective

- In two-point perspective, the width lines converge on one vanishing point (VP1), and the depth lines converge on the other vanishing point (VP2).
- Copy this two-point perspective onto your activity sheet. Label the top, front, and side.
Orthographic
(Multiview Drawings)
Orthographic (Multiview) Sketching

- An orthographic sketch is used to show true size and shape.
- Each view is adjacent to the other as if unfolded from a 3D shape.
- Notice the top view is directly above the front with the right side view directly to the right of the front.
Orthographic (Multiview) Sketching

- Copy this orthographic sketch onto your activity sheet. Label the top, front, and right side.
- Don’t forget the hidden lines.
Orthographic – View Selection

Characteristics for selecting the front view

- Best shape & details
- Longest dimensions
- Fewest hidden lines
- Most natural position

Which view do you think should be the front?

1  2  3  4  5
Precedence of Lines

• Object lines exist over hidden and center lines.
• Hidden lines exist over center lines.
Sketching Techniques
Purposes of Sketching

- Think through a design
- Convey your ideas
- Uses lines and symbols to describe a design
Common Uses of Sketching

- Brainstorm
- Communicate
- Document Measurements
Advantages of Sketching

- Convenient
- Inexpensive
Sketching Techniques

Lines

Vertical Line

Horizontal Line

Inclined Line

Rise

Run
Sketching Techniques

Sketching a Line

1)  

2)  

3)
Sketching Techniques

Sketching a Circle

1) Set up the diameter

2) Square in the diameter

3) Sketch diagonals
Sketching Techniques

Sketching a Circle

4) Identify triangle centers

5) Sketch arcs
Alphabet of Lines
Alphabet of Lines

Construction Line
Alphabet of Lines

Object Line
Alphabet of Lines

Hidden Line
Alphabet of Lines

Center Line
Image Resources

Introduction

There are many different kinds of languages. You know English. You may have heard people speak other languages, such as Spanish, French, Korean or Italian. There is another language used to communicate that is not orally spoken. Sign language uses gestures and hand symbols.

When you use symbols or formulas in mathematics or science class, you are using still another form of communication. These symbols and formulas describe, generalize and communicate technological ideas.

Lines of varying style and thickness are used in specific ways to develop and communicate graphic messages about an object's geometry. Imagine if all the lines had the same style, thickness, weight, and consistency. Understanding line types and when to use them will help your sketches look cleaner and more professional.

Equipment

- GTT notebook
- Pencil
- Eraser

Procedure

Complete this activity as your teacher discusses the Sketching Techniques presentation.

1. What is the purpose of sketching?

2. What are some common uses of sketching?

3. What are the advantages of sketching?
4. On the graph below, practice sketching some lines and circles using the steps provided in the presentation.

5. Label the line types shown below:
   a. 
   b. 
   c. 
   d. 
6. Label the line types shown in the drawing below:

a. 

b. 

c. 

d. 

e. 

f. 

g. 

Conclusion

1. Why is it important that you learn how to sketch?

2. Why is it important to use the proper line types?
Activity 1.4.2 Sketching Practice

Introduction

Pictorial drawings show the shape of an object viewed by the human eye. Pictorial sketches are sketches that show height, width, and depth all in one view. Common types of pictorial drawings are isometric and perspective.

An isometric sketch shows an object in which the width and depth are projected at 30 degree angles from the horizontal axis. The height, width, and depth values are all at the same scale. A technique that you can use when making an isometric sketch is to use isometric grid paper. This helps with determining the correct angle for your sketch.

Perspective is a way to draw that shows a view of the object in the most realistic way. Vanishing points are used to guide the lines in the object to the horizon line or the horizontal line that you see at your line of sight. In a one-point perspective, all lines in the depth project to one point (the vanishing point). For example, when you look down a long, straight train track, it appears that the track eventually narrows until it vanishes. In a two-point perspective, the width lines converge on one vanishing point, and the depth lines converge on the other vanishing point. Think of standing at the corner of a city block; the buildings vanish in both directions.

Pictorial sketches help engineers explain ideas and communicate to the customer what the final part will look like. Unfortunately, pictorial drawings have some disadvantages. Foreshortened views and distorted features do not allow for accurate prototyping. In order for parts to be accurately depicted, you typically need views that directly portray each surface. In order to obtain these straight line views, we have a type of drawing called orthographic projection, also known as multiview drawing. Orthographic projection is a way to project a view based on a line of sight that is perpendicular to that view. Orthographic drawings are said to show true size and shape.

Look at your GTT notebook. How many sides does it have? That's right, six. The top and bottom are similar, the right and left are similar, and the front and back are similar. In orthographic projection we typically draw only 3 views: the front, top, and right side. We use hidden lines to represent features that are on the surfaces that are not visible in the view we are sketching.

Let's practice some sketching. Remember the more you practice, the better you will become. Always sketch with a pencil and make sure that you have a good eraser nearby.

Equipment
Procedure

In this activity you will create a portfolio of sketches and drawings that will enable you to learn and understand the terminology and different methods of sketching. These skills will allow you to better communicate your ideas. Follow along as your teacher discusses the Sketching Practice presentation.

1. Describe a pictorial sketch.

2. Practice pictorial sketching with the two objects that your teacher provides. Remember to use a pencil and sketch lightly. Darken your final image.

3. Create an isometric sketch of a cube using the isometric graph paper below. Pay close attention to which lines are vertical and which lines are parallel. Label the sketch.
4. Follow the steps below to create an isometric sketch using the additive and subtractive method to create a 3D picture.

Start with the Isometric axis.

Add vertical lines from the corners so that your isometric axis now looks like this. Try to keep your lines parallel to the center line.

Add lines for width parallel to the width axis.

Finish the cube with lines for depth that are parallel to the lines for the depth axis.

To add a shape using the Additive Method, cut away the back...
corner by using the lines that are parallel to the width and depth axis. Be sure to connect the lines and keep them parallel.

Add three lines to the cut away that are parallel to the height axis. The length should be not more than ¼ inch. Finish off the addition of the new shape by completing the width and height of the top of the new shape. Remember to keep the lines parallel with the respective axis.

To remove a shape from an object using the Subtractive Method, draw two vertical lines and a line parallel to both the width and depth axis as shown on the drawing below.

Add lines on the top surface to complete the area that will be removed. Be careful to keep your lines parallel and the same length.

Erase the front corner.
lines, those that come together in a point in the section to be removed.

Add the isometric axis to the inside of the area cut away. Your final figure should look like the one below.

5. Describe a perspective drawing.
6. Create a one-point perspective in the space below. Extend light lines to the vanishing point.

Vanishing Point

7. Create a two-point perspective in the space below. Extend light lines to the vanishing points.

Vanishing Point

8. Describe an orthographic (multiview) sketch.
9. Draw the orthographic sketch using the graph paper below. Line up the views so that the top view is directly above the front view and the side view is directly to the right of the front view. Label the views.

10. What factors should you consider when deciding which side of an object is the front?

11. What is meant by precedence of lines?

Conclusion
1. Your teacher will provide you with an object to sketch as well as isometric and orthographic graph paper.
   a. Draw this object as an isometric drawing and an orthographic (multi-view) drawing.
b. Title each sketch and label the views of the orthographic drawing. Be sure that your orthographic drawing is properly oriented.

2. What determines the best type of sketch or drawing to complete when you want to communicate your idea about a solution to a technical problem?
Activity 1.4.3 Language of Sketching

Introduction

An important skill that you should learn while taking Design and Modeling is the skill of sketching. This language is quick, easy, and "worth a thousand words." I know some of you say, "My drawings look awful!" If you stay with some of the techniques shown, all of you will be successful in quickly and effectively placing your ideas down on a sheet of paper for all to understand.

Thumbnail Sketch: This is a quick way to get an idea onto a sheet of paper. A sketch is usually small but drawn in proportion. The relationship of height to width should be shown in the thumbnail sketch. It is recommended that you use the pencil very lightly and darken when the drawing is in its final stage. A thumbnail sketch must be as detailed as necessary to convey your idea.

Perspective Drawing: Perspective drawings are pictorial representations of objects because they look like a photograph. Perspective drawings appear as the eye sees the object. Geometrically, an ordinary photograph is a perspective. While perspective is of major importance to the architect, industrial designer, or illustrator, the engineer at one time or another is certain to be concerned with pictorial representations of objects.
One-point Perspective: In a one-point perspective, an object is situated with one face parallel to the plane of projection; only one vanishing point is required.

Two-point Perspective: In this type of perspective drawing, the object is situated at an angle with the picture plane but with vertical edges parallel to the picture plane. Two vanishing points are required due to the turning of the object from the picture plane; the result is a two-point perspective. This is the most common type of perspective drawing.

Orthographic Drawing (commonly referred to as multi-view drawing): A photograph or a perspective drawing shows an object as it appears to the observer, but not as it truly is. Such a picture cannot describe the object fully, no matter from which direction it is viewed. It is said that a perspective drawing doesn't show TS&S (i.e., true size and shape). What is needed in industry is a complete and accurate description of the shape and size of an object that in the end will be made by the Project Lead The Way, Inc.

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manufacturer. In order to provide information clearly and accurately, a number of views must be systematically arranged so that anyone in the world can understand. Using Universal Language Drawing practices with many views to describe an object accurately and clearly is called Multi-view Drawing or Orthographic Drawing.

You will learn to look at objects in Design and Modeling in a way that “normal humans” do not. When you look at an object as a human, you see three different dimensions (width, height, depth) all at once (like a perspective drawing). In an orthographic drawing, you will look at the object in three different ways. You will look at the front view and observe two dimensions — height and width; the top view shows width and depth; and, finally, the right side view shows height and depth. You must also keep in mind that this is a Universal Language; therefore, the positioning of the views is standard. The front view is placed in the lower left, the top view is placed directly above the front view, and the right side view is placed to the right of the front view.

Isometric Drawing: An isometric drawing is often used for quick sketching to explain an idea quickly. It does not show how we actually see an object. The objects are drawn at an angle so that you can see three sides at once. All parallel lines are drawn in parallel, with no vanishing points, so that lengths do not diminish in the distance. Diagonal lines representing horizontal edges are drawn 30° from a horizontal base line.
Matching: Place the letter of the correct sketch in front of the term that describes that type of sketch or drawing.

_____ Thumbnail Sketch

A.  

_____ One-Point Perspective

B.  

_____ Two-Point Perspective

C.  

_____ Orthographic Drawing

D.  

_____ Isometric Drawing

E.  

Conclusion

1. Have you used any of these methods to sketch in other classes? If so, which ones and in which class?

2. Which method(s) do you think we will use the most in Design and Modeling?
Activity 1.4.4 Orthographic Projection

Introduction

Did you know that when an invention is sent to the patent office, the patent office must verify that your invention is truly new and unique from other products? In order to do this, the patent office requires explanatory drawings with your application. A simple invention may only require one drawing. More complicated objects or products require orthographic drawings (commonly referred to as multi-view drawings) so that every feature of the invention listed is shown. This is to enable anyone with the appropriate skills to be able to build your invention and test it.

Whether you plan to invent something or whether you are just interested in learning how to make something, a drawing helps you figure out the different parts and how those parts go together. Orthographic drawings enable the reader of the drawings to understand how each part fits and how the final product should look from all views.

Orthographic projection is used to show an object in true size or scale on a flat piece of paper. When we look at an object, we see three dimensions (height, width, depth) all at once. In an orthographic drawing, you will be looking at the object from three different planes. When you look at the front, only two dimensions—height and width—appear. From the top, the two dimensions are width and depth, and from the right side, the height and depth are the dimensions.

Equipment

- GTT notebook
- Pencil
- Colored pencils
- Straight edge
- Isometric graph paper
- Orthographic graph paper
- Wooden blocks—7 cubes, 1 cube with hole, 2 triangles, 1 half round, and 1 cylinder
- Sugar cubes, plastic linking cubes, and other shapes to form various objects for students to draw

Procedure

Orthographic Projection Activity 1:
Match the isometric view with the corresponding orthographic view.

1. _______________
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Orthographic Projection Activity 2:
In this part of the activity, you will draw the same block four ways. In each drawing the block is turned to a different position.

1. Use colored pencils to color the top view of each block red, the front view of each block green, and the right side view of each block blue.

2. In each position shown, draw the top, front, and right side views of the block, making sure that the front view is in the bottom left quadrant of the graph paper, the top view is directly above the front view, and the side view is directly to the right.

3. The dimensions of the block are given in Figure 1 and are to be used for all of the drawings of the block.

4. Each small square represents one inch.

5. Notice that the placement of the block in a drawing may fit in the drawing space better than in other views. You will also notice that each drawing may have a different number of hidden lines. Hidden lines are dashed lines used to represent an edge that cannot be seen from a particular view.
Orthographic Projection Activity 3:
In this part of the activity, you will build an object using a combination of the following shapes – 7 cubes, 1 cube with hole, 2 triangles, 1 half round, and 1 cylinder. You will follow the provided drawings. Finally, you will create your own object using the shapes provided.

1. Use the blocks provided to create an object. You will follow the provided drawings. The drawings are orthographic projections, so your model must correctly match each view.

6. After building each object, have your teacher or another classmate check your work.
Orthographic Projection Activity 4:
Draw a challenge of your own on the graph paper below. Give your challenge to your teacher or another group to solve.

1. Build a model with the blocks.
2. Draw the top, front, and right side views of the block on the graph paper. Remember that each small square represents one inch. Make sure you line up the views correctly.
3. When the drawing is complete, have your teacher or another classmate try to build the object from your drawing.
Conclusion

1. Orthographic drawings are used to express ideas that are more complicated. Explain the purpose of the different views and the importance of view alignment.

2. How can you check an orthographic drawing to be sure there are no missing lines?

3. How is an orthographic drawing similar to or different from an isometric drawing?
1. Dimensions should NOT be duplicated, nor should the same information be given in two different ways.
1. Dimensions should NOT be duplicated, nor should the same information be given in two different ways.
2. Dimensions should be attached to the view that best shows the *contour* of the feature to be dimensioned.
2. Dimensions should be attached to the view that best shows the *contour* of the feature to be dimensioned.
3. Whenever possible, avoid dimensioning to hidden lines.
3. Whenever possible, avoid dimensioning to hidden lines.
4. Avoid dimensioning over or through the object.
4. Avoid dimensioning over or through the object.
5. Whenever possible, locate dimensions between adjacent views.

Incorrect
5. Whenever possible, locate dimensions between adjacent views.

Notice this dimension is not between the views, but this is a better placement than dimensioning to the hidden line in the right side view.
6. In general, a circle is dimensioned by its diameter and an arc by its radius.
7. Holes are located by their centerlines, which may be extended and used as extension lines.
8. Holes should be located and sized in the view that shows the feature as a circle.

Incorrect
8. Holes should be located and sized in the view that shows the feature as a circle.
Why Dimension?

Engineers, designers, and engineering technologists need to know

- Size
  - and
- Location of all features
Dimension Completely

Width
Dimension Completely

Width

Height
Dimension Completely

Width
Heigh
 Depth

1.25
2.50
.75

.50
.50
.50

1.00

.50

1.00
Dimension Line Types

Extension Line

Leader Line

Dimension Line

Dimension Line
Your Turn to Practice

\( \frac{1}{4} \text{ in. scale or 4 squares} = 1 \text{ in.} \)
Check Your Answers
Where are the Missing Dimensions?

¼ in. scale or 4 squares = 1 in.
Here They Are
Activity 1.4.5 Dimensioning

Introduction

Dimensions are as important as the shapes that you sketch. In order to accurately reproduce a part, the manufacturer must know the proper size and the proper location for all features. This includes the overall height, width, and depth of an object, as well as the size and location of all other features.

There are dozens of rules and guidelines associated with dimensioning. You will learn how to apply just eight of these in order to make your sketches easy for anyone to understand.

Equipment

- GTT notebook
- Pencil
- Eraser
- Straight edge

Procedure

In this activity you will begin by following along as your teacher presents information on dimensioning. Then you will apply your knowledge of dimensioning to identify missing dimensions on orthographic drawings. Last, you will practice sketching and dimensioning in orthographic from an isometric sketch. Make sure to follow the dimensioning guidelines.

1. Why is it necessary to dimension a sketch?

2. What dimensions are needed to fully describe a sketch?

3. When using ¼ in. graph paper, each square equals ¼ in. or .25 in. How many squares are in:
   - 1 in. = ________ squares
   - 2 in. = ________ squares
   - 2 ¼ in. = ________ squares
   - 1 ¼ in. = ________ squares
4. Now convert number of squares to a linear measurement. Again, each square equals ¼ in. or .25 in.
   - 7 squares = __________ inches
   - 12 squares = __________ inches
   - 3 squares = __________ inches
   - 9 squares = __________ inches

5. Dimension the following sketch.
   Each square on the graph equals ¼ in.
Dimensions must fully describe an object so that someone else can reproduce it. Fill in the missing dimensions on the sketch below. Each square on the graph represents ¼ in. Be careful not to over-dimension. Each feature should be dimensioned for size and location only once.

7. Follow along as your teacher discusses the presentation on dimensioning guidelines. List the rules or guidelines below.

- Rule 1:

- Rule 2:

- Rule 3:

- Rule 4:

- Rule 5:
8. You will create orthographic drawings of objects and dimension them from the isometric sketches in both drawings below. Make sure you place the front view in the lower left corner, the top view directly above the front view in the upper left corner, and the right side view to the right of the front view in the lower right corner. Line up your sketches both horizontally and vertically. Add all of the dimensions necessary using the scale 1 square = \( \frac{1}{4} \) in. Your dimension lines should have arrows at the end, and extension lines should not touch the object line.
Conclusion

1. What is the difference between a size dimension and a location dimension?

2. Why is it necessary for engineers, designers, and technologists to make sure that their drawings are fully dimensioned?

3. Why is the placement of your dimension important?

4. What is meant by over-dimensioning a sketch?
ACROSS

3 A method of representing three-dimensional objects on a plane having only length and breadth.
5 Lines that are thin and used to connect a specific note to a feature.
9 Is shorthand for multiview projection, which is a system used to view an object. The six mutually perpendicular directions any object may be viewed are top, front, right-side, rear, left-side, and bottom. Top, front, and right-side views are also referred to as the three regular views because they are the three views most frequently used.
11 A line that is used to indicate the axis of symmetry for a part or feature.
12 A form of pictorial drawing in which vanishing points are used to provide the depth and distortion that is seen with the human eye.
13 A proportion between two sets of dimensions used in developing accurate, larger or smaller prototypes, or models of design ideas.
17 Explanatory notes added to a drawing.
22 A realistic way of drawing objects in three dimensions using a horizon line, a key edge, and two vanishing points.
23 A point in space, usually located on the horizon, where parallel edges of an object appear to converge.
26 Having the dimensions of height and width, height and depth, or width and depth only.
27 A form of pictorial drawing in which all three drawing axes form equal angles of 120 degrees with the plane of projection.
28 A measurable extent, such as the three principal dimensions of an object of width, height, and depth.
29 Also called line width. The thickness of a line, characterized as thick or thin.
30 Thin lines that serve as guides while sketching or drawing.
31 A thin solid line perpendicular to a dimension line, indicating which feature is associated with the dimension.
32 A heavy solid line used on a drawing to represent the outline of an object.

DOWN

1 A straight line from the center to the circumference of a circle or sphere.
2 Placed directly on a feature to identify a specific size or may be connected to a feature in the form of a note.
4 A rough drawing representing the main features of an object or scene and often made as a preliminary study.
6 A straight line passing from side to side through the center of a circle or sphere.
7 A preliminary visual of a possible idea for a design. Most thumbnail sketches are not full-size and have little detail. They are intended to quickly explore possible alternative designs.
8 To imagine the visual form of an object or situation that one cannot see.
10 The measurement or extent of something from side to side.
14 Standardization of lines used on technical drawings by line weight and style.
15 The distance from front to back.
16 Thin lines capped with arrowheads, which may be broken along their length to provide space for the dimension numerals.
18 The measurement of someone or something from head to foot or from base to top.
19 A method of realistic drawing in which the part of an object closest to the viewer is a planar face, and all the lines describing sides perpendicular to that face can be extended back to converge at one point, the vanishing point.
20 Having the dimensions of height, width, and depth.
21 Dimensions that show the exact location of parts of an object.
24 A flat surface on which a straight line joining any two points would wholly lie.
25 A line type that represents an edge that is not directly visible because it is behind or beneath another surface.
Key Terms Bank:
Annotation
Centerline
Construction Line
Depth
Diameter
Dimension
Dimension Line
Extension Line
Height
Hidden Line
Isometric
Leader Line
Line Conventions
Line Weight
Location Dimension
Object Line
One-Point Perspective
Orthographic Projection
Perspective Drawing
Plane
Radius
Scale
Size Dimension
Sketch
Three Dimensional (3D)
Thumbnail Sketch
Two Dimensional (2D)
Two-Point Perspective
Views
Vanishing Point
Visualize
Width