Engineering Design *An Introduction*

Chapter 8

Technical Drawing

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Technical Drawings

- Multiview drawings
  - Also called three-view drawings
  - Simple objects take three views
    - Front, top, one side
- Title block
  - Identifies who did the design
  - Gives date, scale, and tolerance

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Technical Drawings (cont'd.)

- Notes on the drawing
  - Provide additional production information
- Drawing gives all necessary measurements for production
- Some parts may be fully described by a single view
  - Example: parts made from sheet stock

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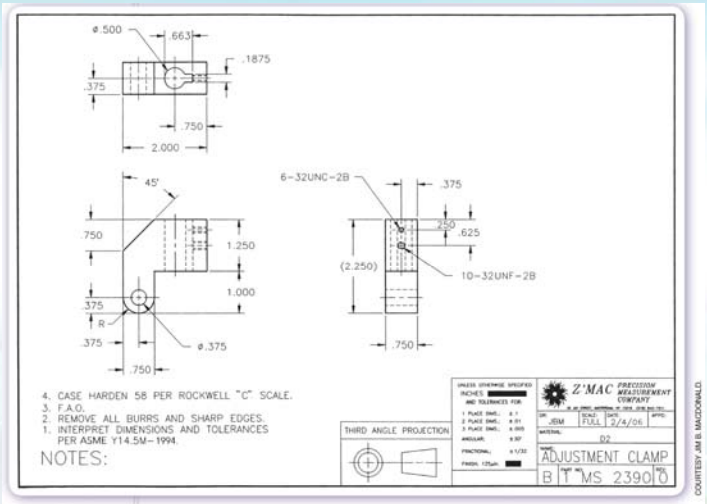

Figure 8-3: Industry drawing with three views used to describe the part.

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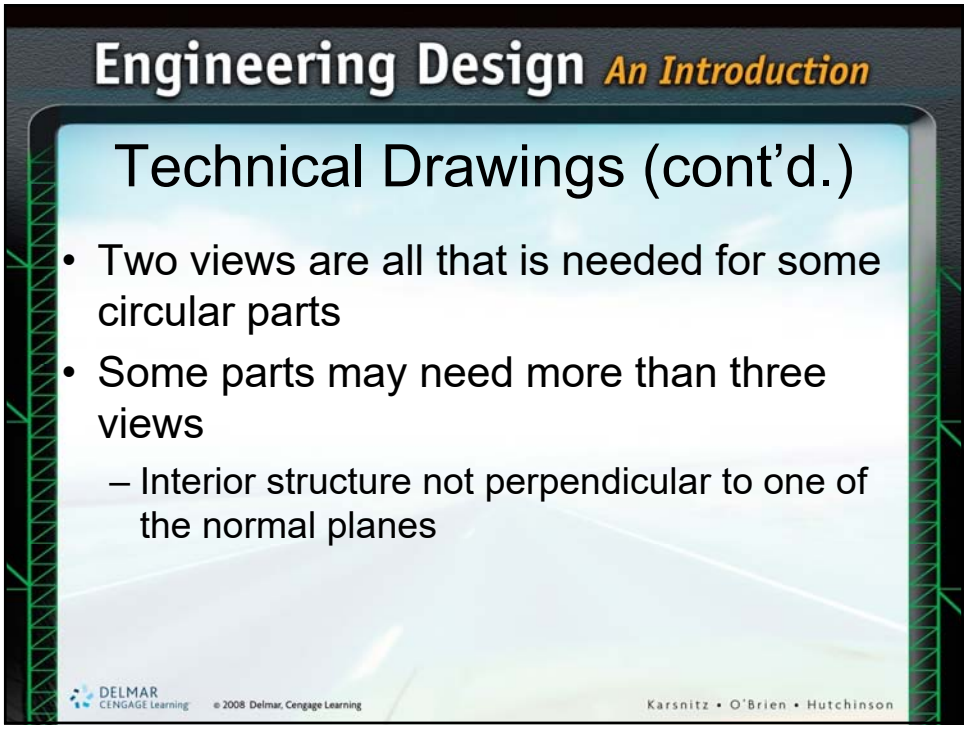
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Technical Drawings (cont'd.)
• Two views are all that is needed for some circular parts
• Some parts may need more than three views
– Interior structure not perpendicular to one of the normal planes
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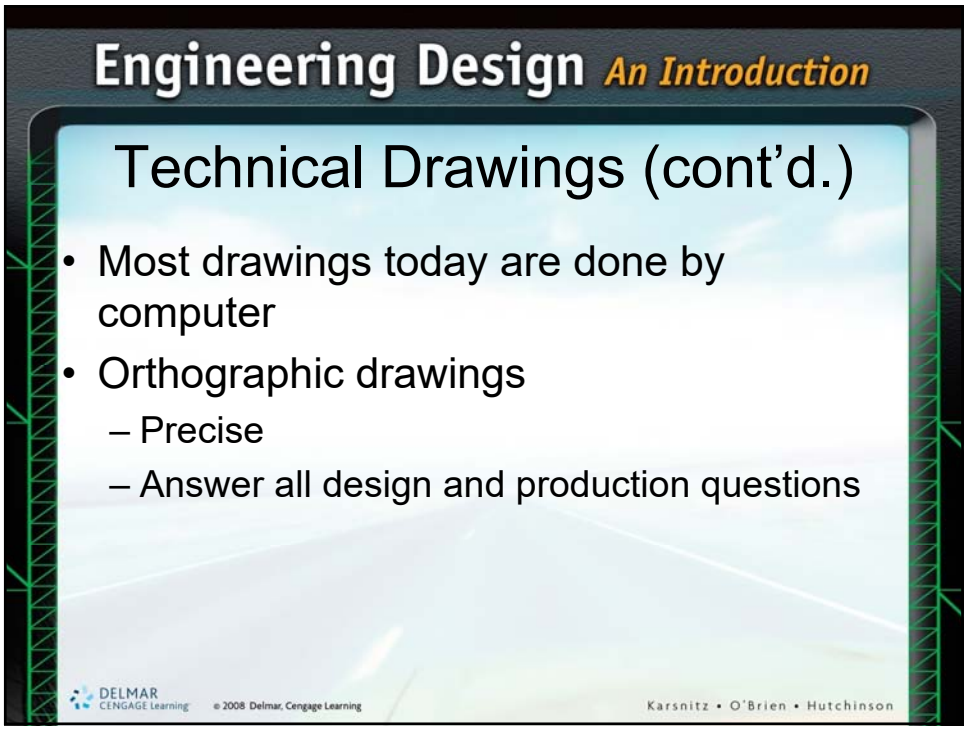
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Technical Drawings (cont'd.)
• Most drawings today are done by computer
• Orthographic drawings
– Precise
– Answer all design and production questions
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Measurement for Engineering Design

- Systems of units
  - British imperial system used throughout North America
  - Metric system (SI) became universal worldwide system

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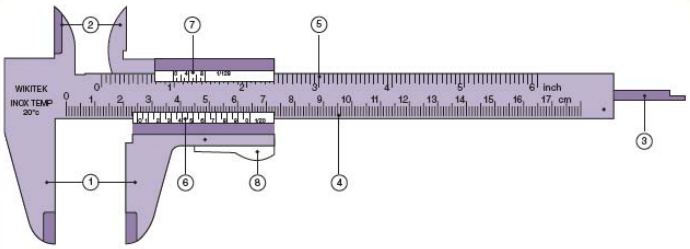

1. **Outside jaws:** used to measure the width or outside diameter of an object
2. **Inside jaws:** used to measure internal width or diameter of an object
3. **Depth probe:** used to measure depths of an object, hole, or channel
4. **Main scale:** metric scale marked in cm (large divisions) and mm (small divisions)
5. **Main scale:** Imperial scale marked in inches (large divisions) and fractions (small divisions)
6. **Metric Vernier** gives interpolated measurements to 1/10 mm or better
7. **Imperial Vernier** gives interpolated measurements in fractions of an inch
8. **Retainer:** locks the slide or movable part of the caliper so that measurements can be read off the work piece

Figure 8-11: *Reading a vernier caliper.*

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Architectural Scale

- Used for direct measurement and scaling

Figure 8-12: Architectural scale.

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Measurement: The Real World of Variability

- Variation
  - Measure of the extent to which the dimension can be expected to vary in magnitude
- All dimensions have variability
- Example: box through a hole

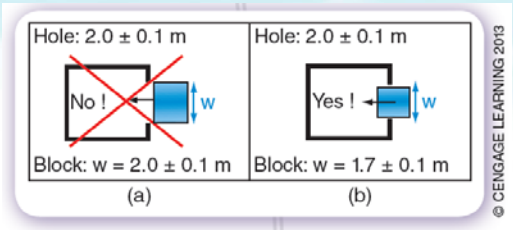

Figure 8-14: A "box-through-a-hole" example illustrates the need to accurately define variability to achieve successful designs. Unless the variances in both the hole and box are correctly accounted for, the box will not fit through the hole, resulting in failure.

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Accuracy and Precision

- Accuracy
  - Degree of conformity of a measured or calculated value to its actual value
- Precision
  - Degree to which several measurements or calculations show the same result
  - Also known as repeatability or reproducibility

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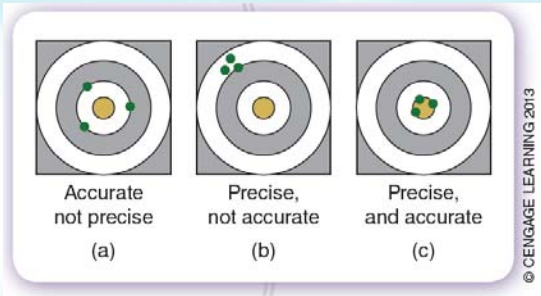

Figure 8-16: Graphical bull's-eye, examples of measurements that are (a) accurate, (b) precise, and (c) both accurate and precise.

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Simple Rules for Variability of Measurement

- Variability typically referred to as tolerance
- When using a physical measuring device:
  - Take a fraction of the smallest viewable dimension as the variability
- When using a commercial instrument:
  - Use the published accuracy

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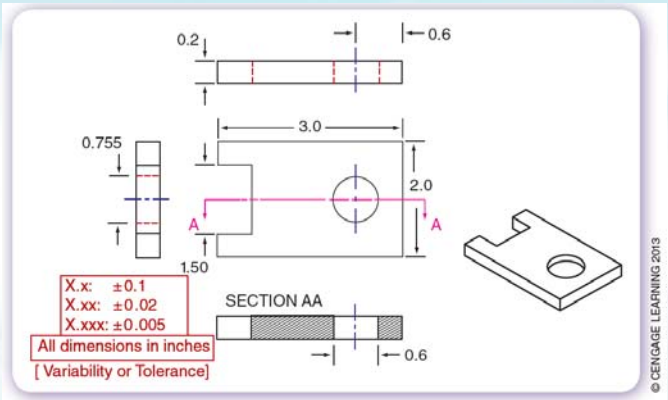

Figure 8-17: Design drawing showing expected definitions of variability for all dimensions. For drawings, "variability" is often referred to as "tolerance."

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Who Uses Technical Drawings?

- Those who will make or check a component
  - Tool designer
  - Quality control person

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Technical Drawings and the Consumer

- Assembly drawing
  - Shows main components
  - Annotations guide assembly process

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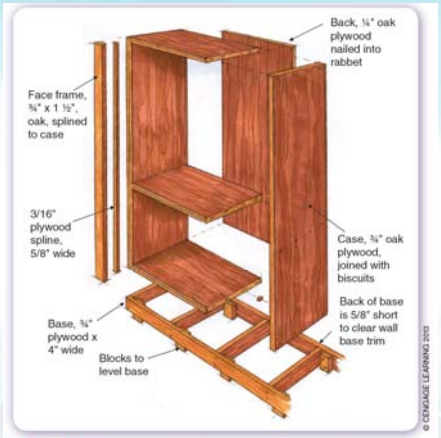

Figure 8-24: An example of a technical drawing that is used to describe the main details of a project. This particular drawing is hand-drawn and is "exploded" to show the construction and assembly details. The drawing also contains annotations that provide additional information.

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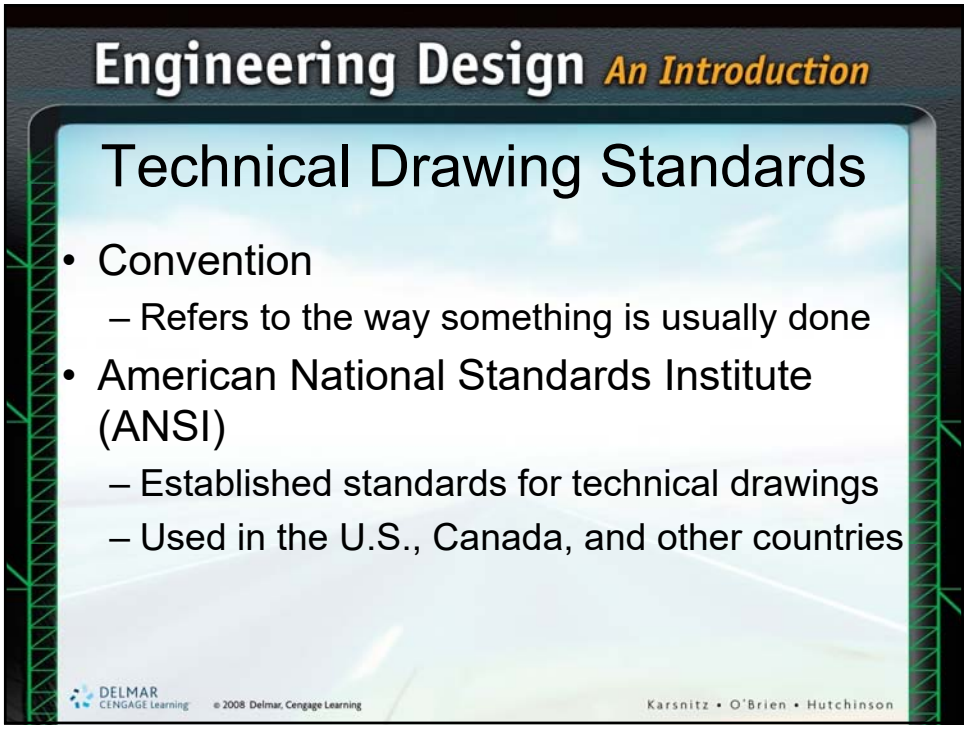
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Technical Drawing Standards
• Convention
– Refers to the way something is usually done
• American National Standards Institute (ANSI)
– Established standards for technical drawings
– Used in the U.S., Canada, and other countries
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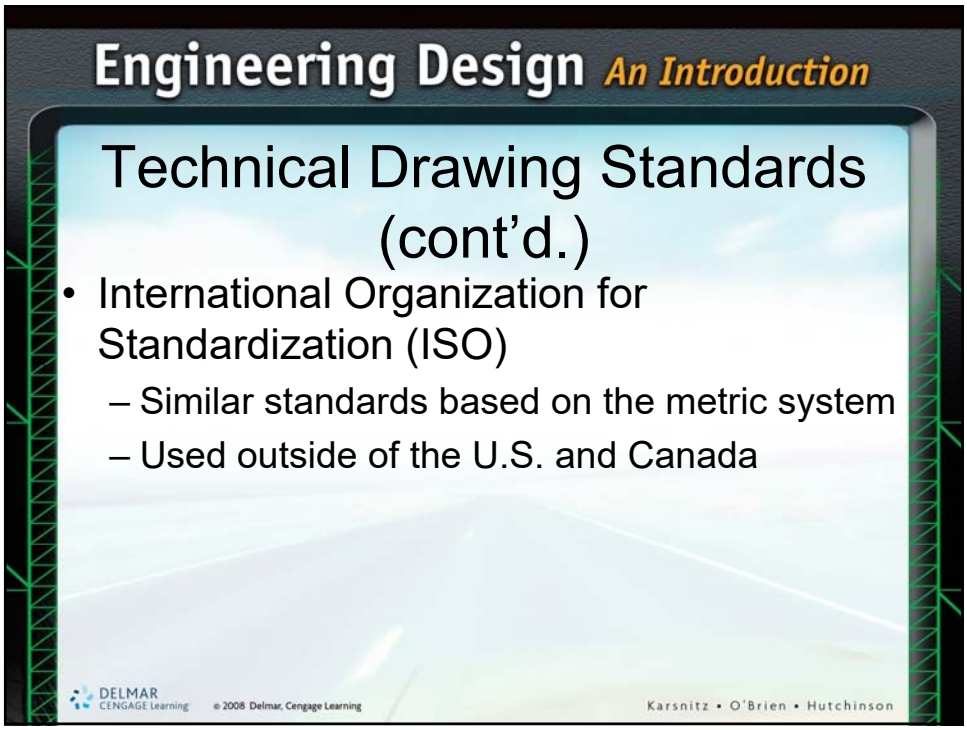
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Technical Drawing Standards (cont'd.)
• International Organization for Standardization (ISO)
– Similar standards based on the metric system
– Used outside of the U.S. and Canada
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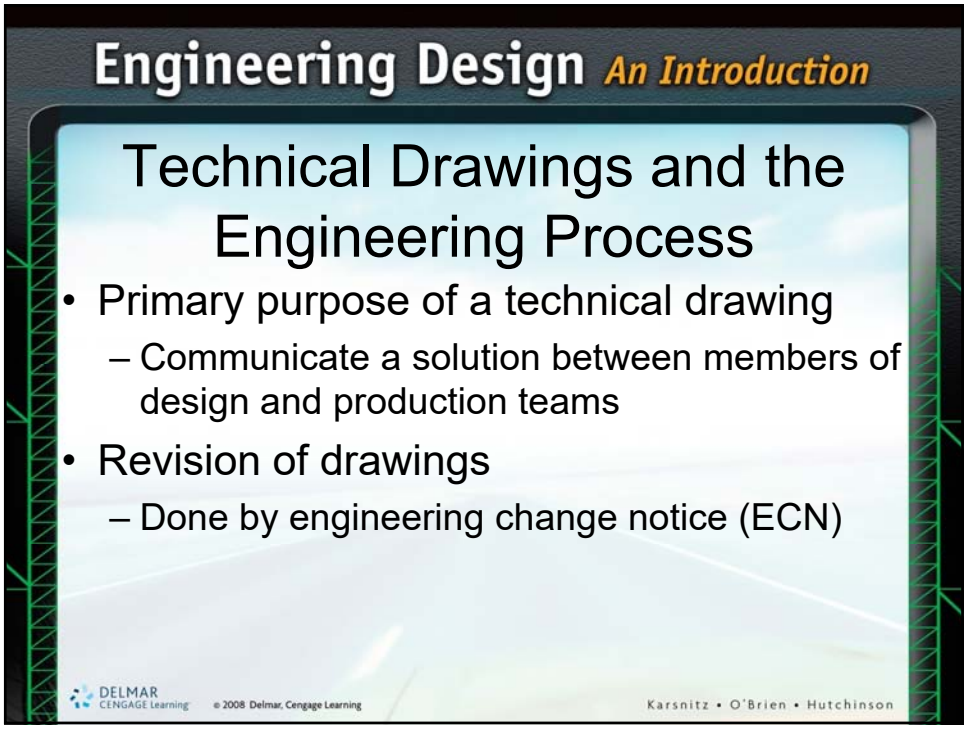
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Technical Drawings and the Engineering Process
• Primary purpose of a technical drawing
– Communicate a solution between members of design and production teams
• Revision of drawings
– Done by engineering change notice (ECN)
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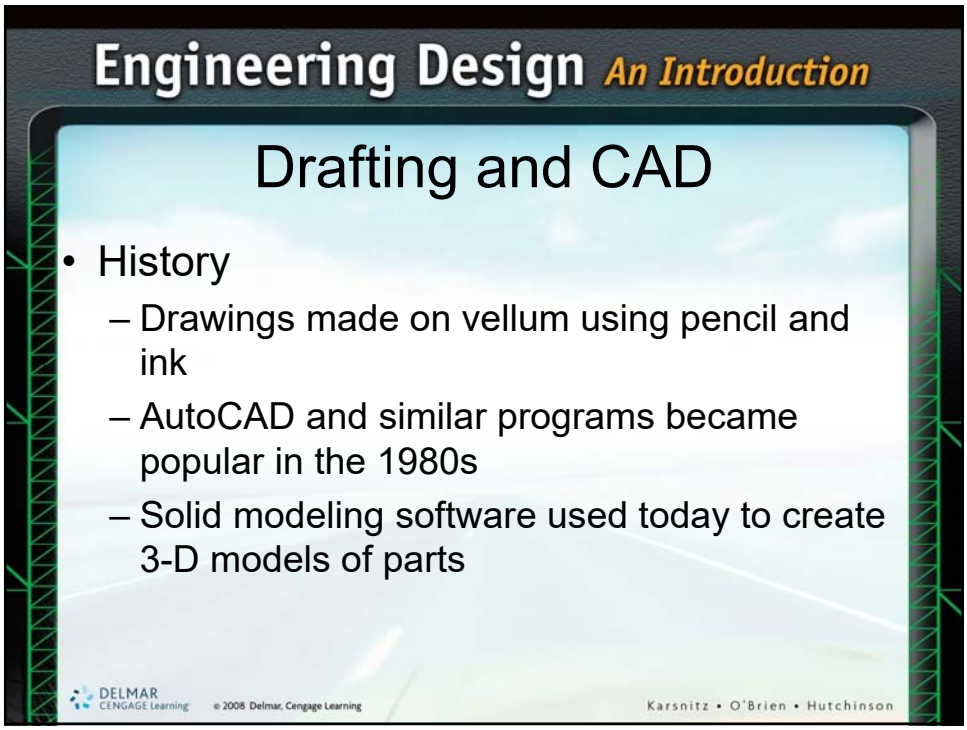
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Drafting and CAD
• History
– Drawings made on vellum using pencil and ink
– AutoCAD and similar programs became popular in the 1980s
– Solid modeling software used today to create 3-D models of parts
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Isometric and Oblique Pictorial Drawings

- Projection
  - Exact representation of a 3-D object projected onto a plane from a specific location
- Common projections
  - Isometric
  - Dimetric
  - Trimetric

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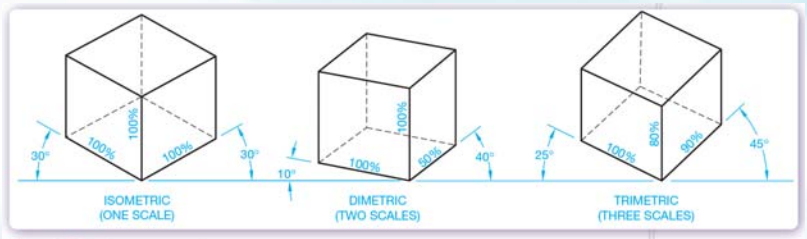

Figure 8-31: Three types of axonometric projections.

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Isometric Grid Paper

Figure 8-34: Isometric grid paper used to rapidly sketch isometric drawings.

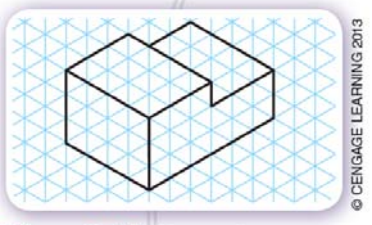

Figure 8-35: Using the isometric grid paper to sketch.

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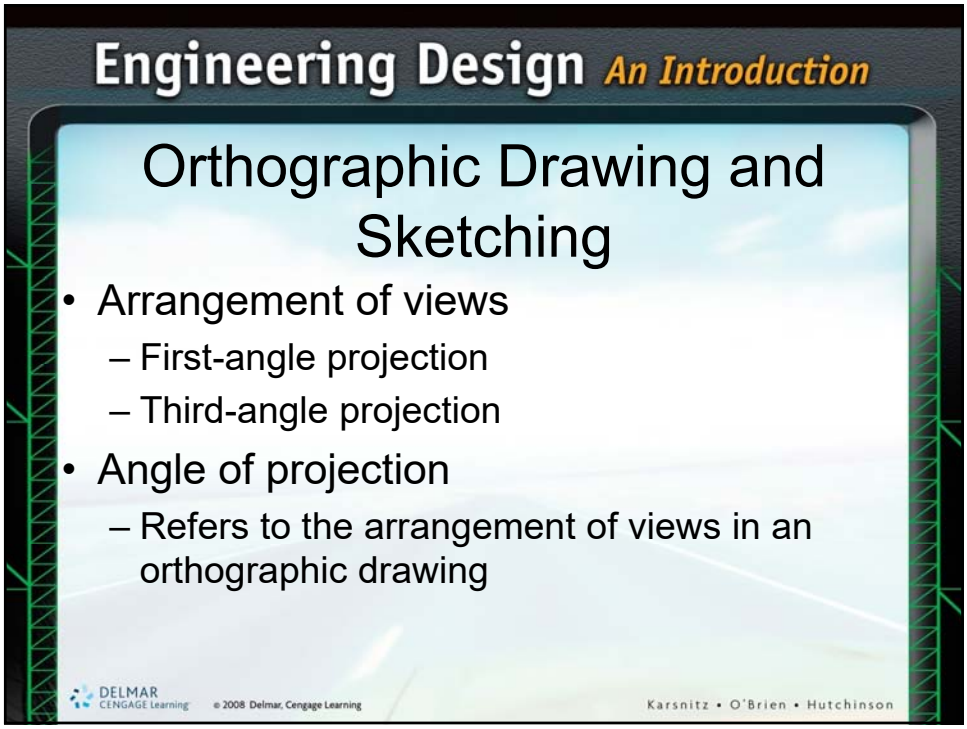
Oblique Views

- Oblique projection drawing
  - Has one face parallel to the viewing plane
  - Other object planes shown at an angle
- Two common types of oblique projections
  - Cavalier
  - Cabinet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Orthographic Drawing and Sketching
• Arrangement of views
– First-angle projection
– Third-angle projection
• Angle of projection
– Refers to the arrangement of views in an orthographic drawing
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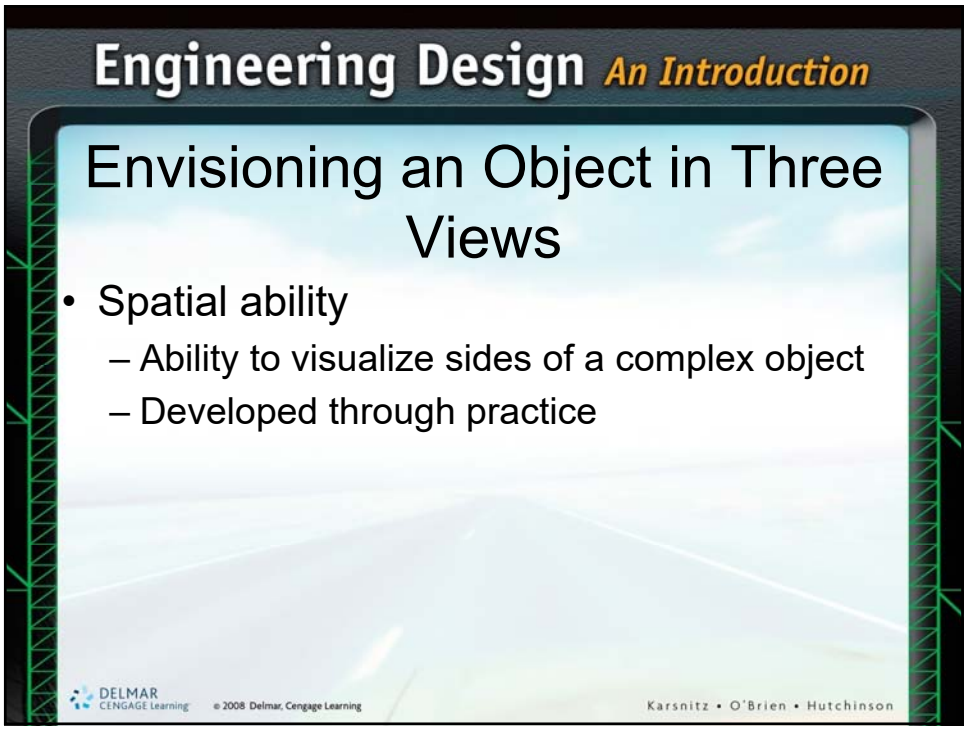
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Envisioning an Object in Three Views
• Spatial ability
– Ability to visualize sides of a complex object
– Developed through practice
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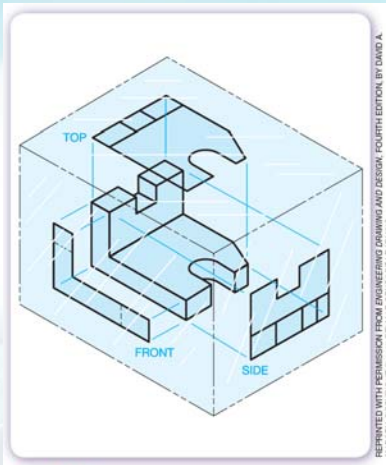

Figure 8-44: The glass box principle.

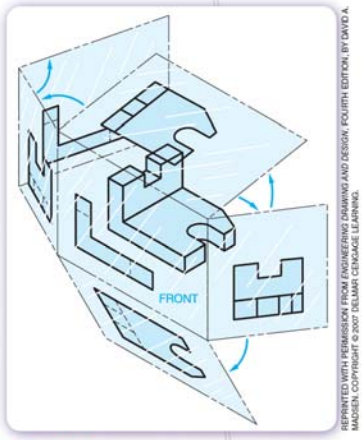

Figure 8-45: Unfolding the glass box at hinge lines, also called fold lines.

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Spacing Between Views

- No standards apply to spaces between views
- Dimensioning guidelines
  - Dimensions should be placed between the views
    - Whenever possible

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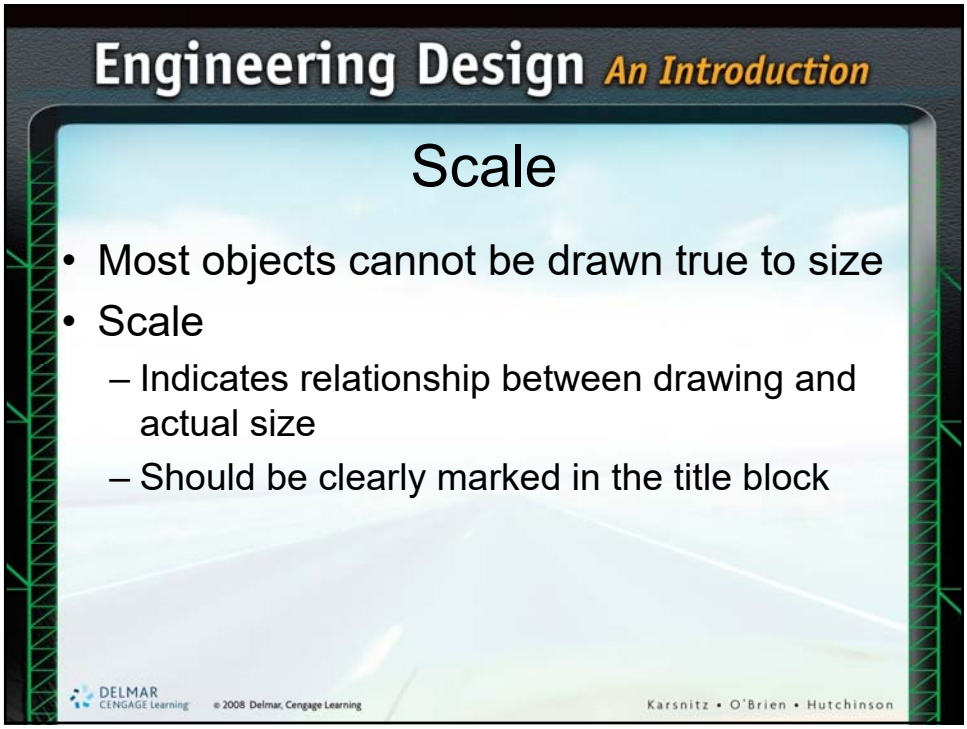
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Scale
• Most objects cannot be drawn true to size
• Scale
– Indicates relationship between drawing and actual size
– Should be clearly marked in the title block
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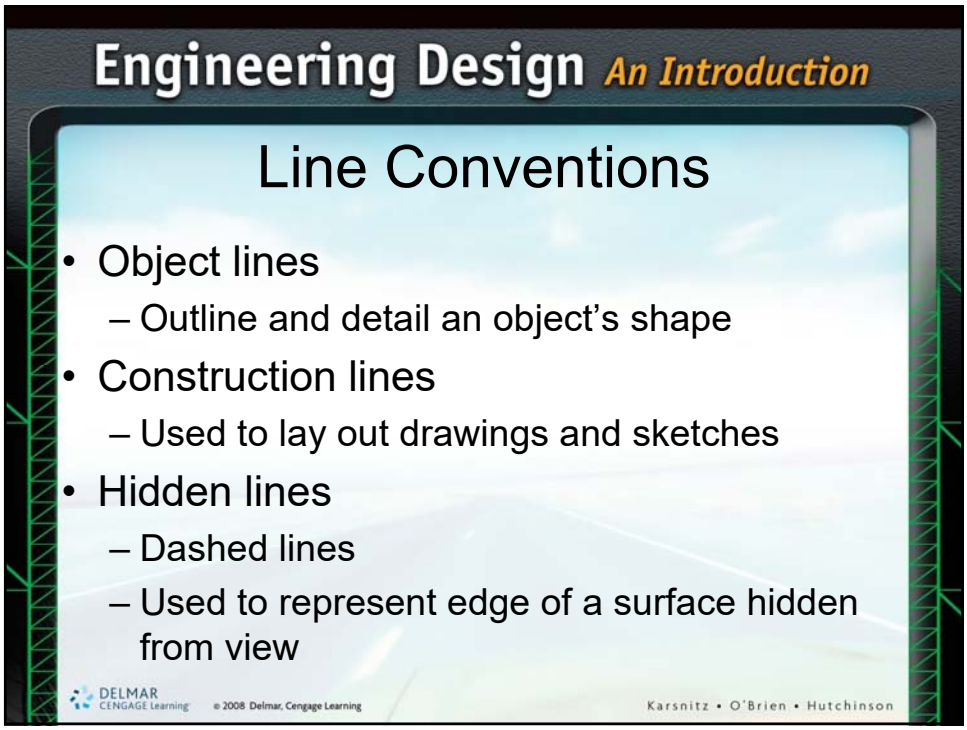
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Line Conventions
• Object lines
– Outline and detail an object's shape
• Construction lines
– Used to lay out drawings and sketches
• Hidden lines
– Dashed lines
– Used to represent edge of a surface hidden from view
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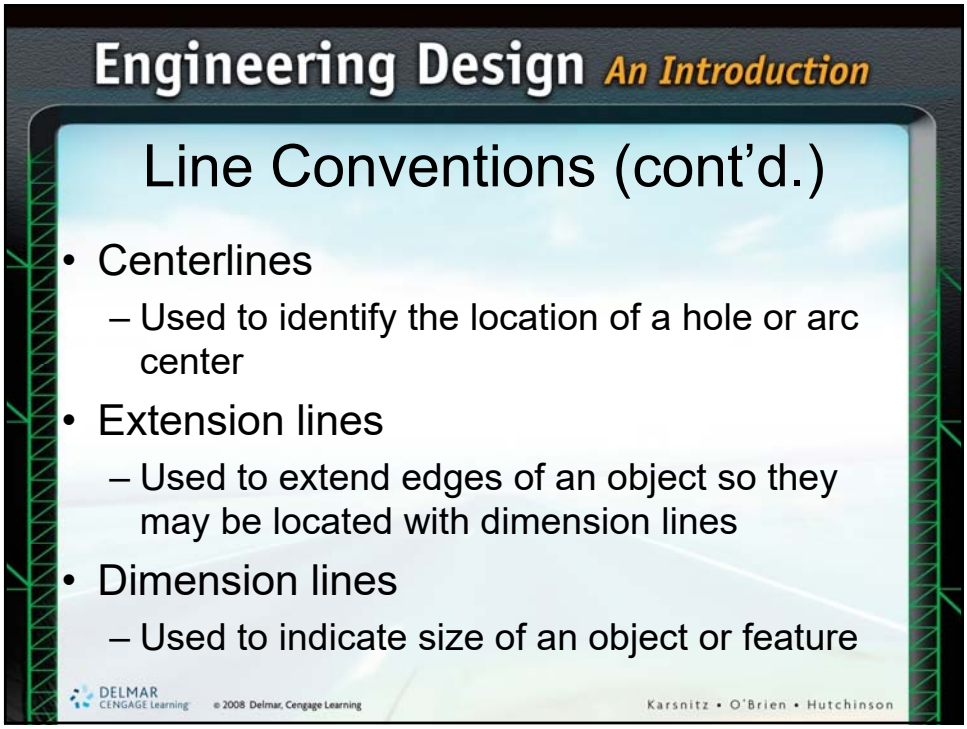
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Line Conventions (cont'd.)
• Centerlines
– Used to identify the location of a hole or arc center
• Extension lines
– Used to extend edges of an object so they may be located with dimension lines
• Dimension lines
– Used to indicate size of an object or feature
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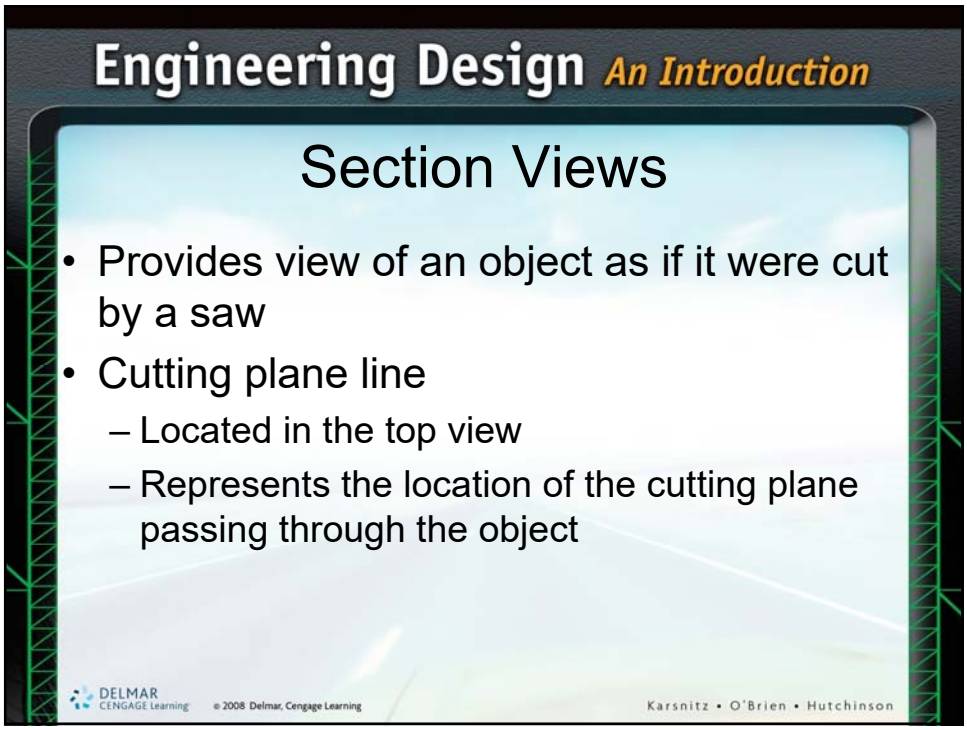
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Section Views
• Provides view of an object as if it were cut by a saw
• Cutting plane line
– Located in the top view
– Represents the location of the cutting plane passing through the object
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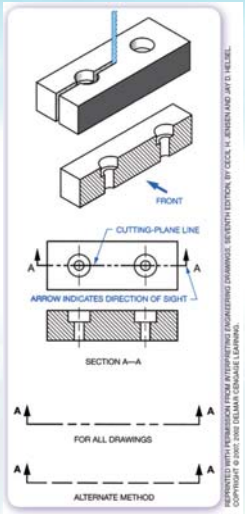

Figure 8-60: A section view is like cutting the object with a saw.

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Auxiliary Views

- Used to show a surface not parallel to any of the principal view planes
- Projection line
  - Horizontal or vertical line that can be used to locate entities in an adjacent view

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Dimensioning

- Common methods of dimensioning
  - Chain dimensioning
  - Datum dimensioning
  - Baseline dimensioning
- Dimension precision
  - Determine considering material's physical properties and manufacturing method

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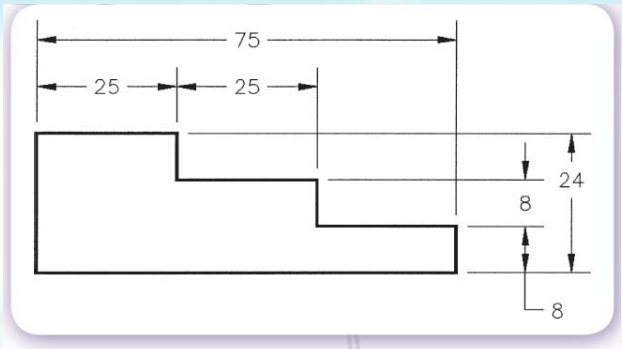

Figure 8-64: *Chain dimensioning.*

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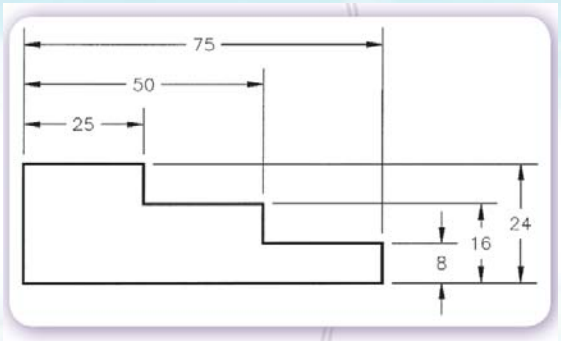

Figure 8-65: Datum dimensioning from a common surface.

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Dimensioning (cont'd.)

- Dimension tolerances
  - Bilateral tolerances
  - Unilateral tolerances
  - Limit dimensions

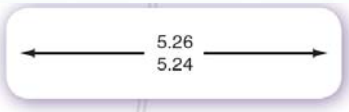


Figure 8-69: Limit tolerance dimensioning.

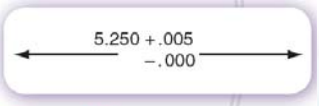
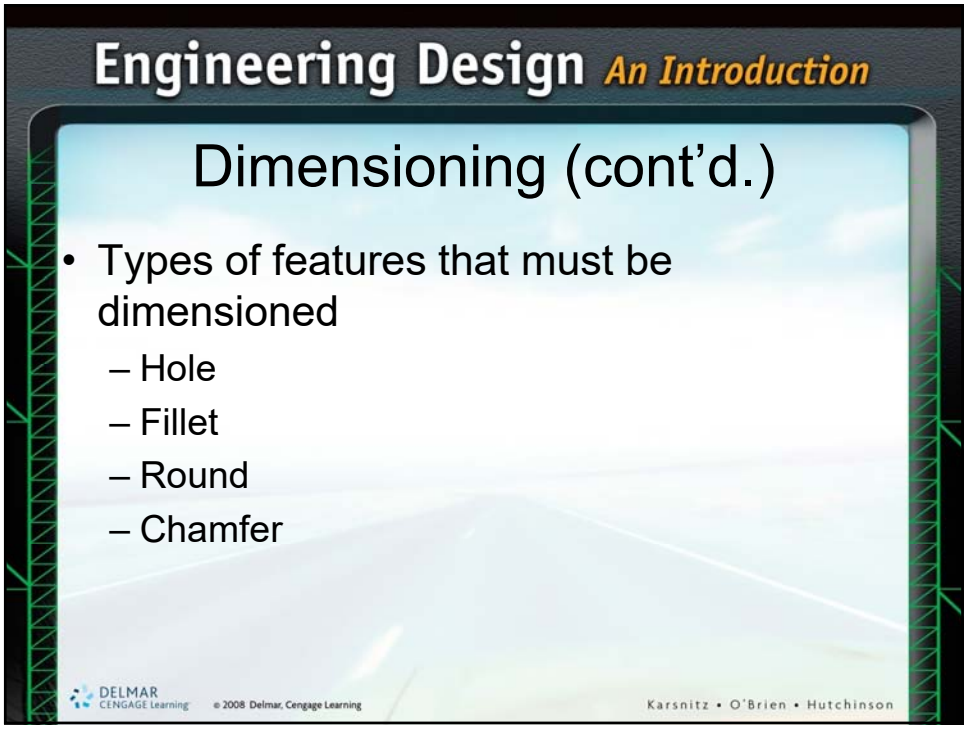


Figure 8-68: Unilateral tolerance varies in only one direction from the specified dimension.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Dimensioning (cont'd.)
• Types of features that must be dimensioned
– Hole
– Fillet
– Round
– Chamfer
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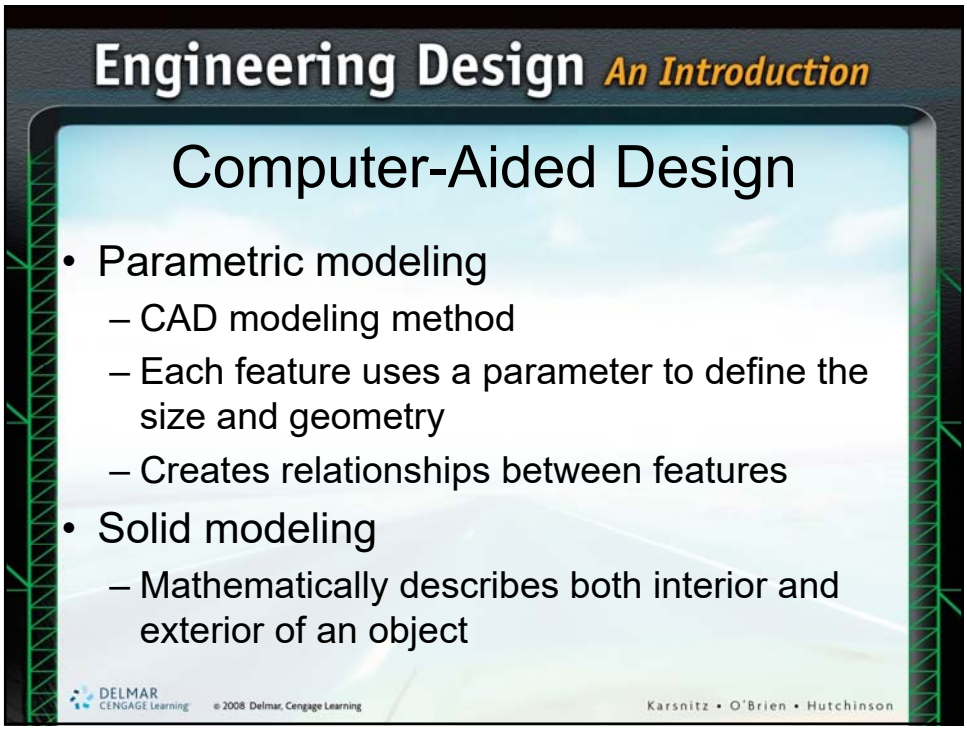
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Computer-Aided Design
• Parametric modeling
– CAD modeling method
– Each feature uses a parameter to define the size and geometry
– Creates relationships between features
• Solid modeling
– Mathematically describes both interior and exterior of an object
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Creating Sketches in Solid Modeling Software

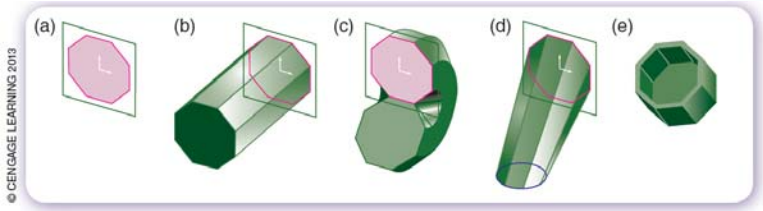

Figure 8-81: These 2-D sketches were used to create 3-D models using "features": (a) sketch, (b) extrusion, (c) revolve (220 degrees), (d) two sketches on perpendicular work planes with a loft created between them, and (e) shell feature applied to a solid.

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