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Mechanical Design/Drafting

University of South Florida

February 28, 2019

McCORMICK STEVENSON
ENGINEERING+DESIGN

FOUNDED IN 1999

OFFICES IN CLEARWATER, FL

40 EMPLOYEES

WOMAN-OWNED SMALL BUSINESS

SECRET PERSONNEL AND FACILITY CLEARANCES

Nat McCormick
Design Manager

We Deliver Mechanically Rugged Solutions for Aerospace, Defense, and Homeland Security

McCormick Stevenson (MCCST) is a mechanical engineering and product development firm primarily serving Prime Contractors in the Aerospace and Defense industry

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Armament Systems
(Weapons & Ancillaries)

- Missiles
- Munitions
- Launchers
- Guns
- Related Components

Defense Electronic Systems
(C4ISR)

- Communications
- Computers
- Surveillance
- Reconnaissance
- Avionics
- Guidance & Navigation

MINIMIZE
SIZE WEIGHT COST

MANAGE
RISK HEAT

SURVIVE
SHOCK VIBRATION TEMPERATURE

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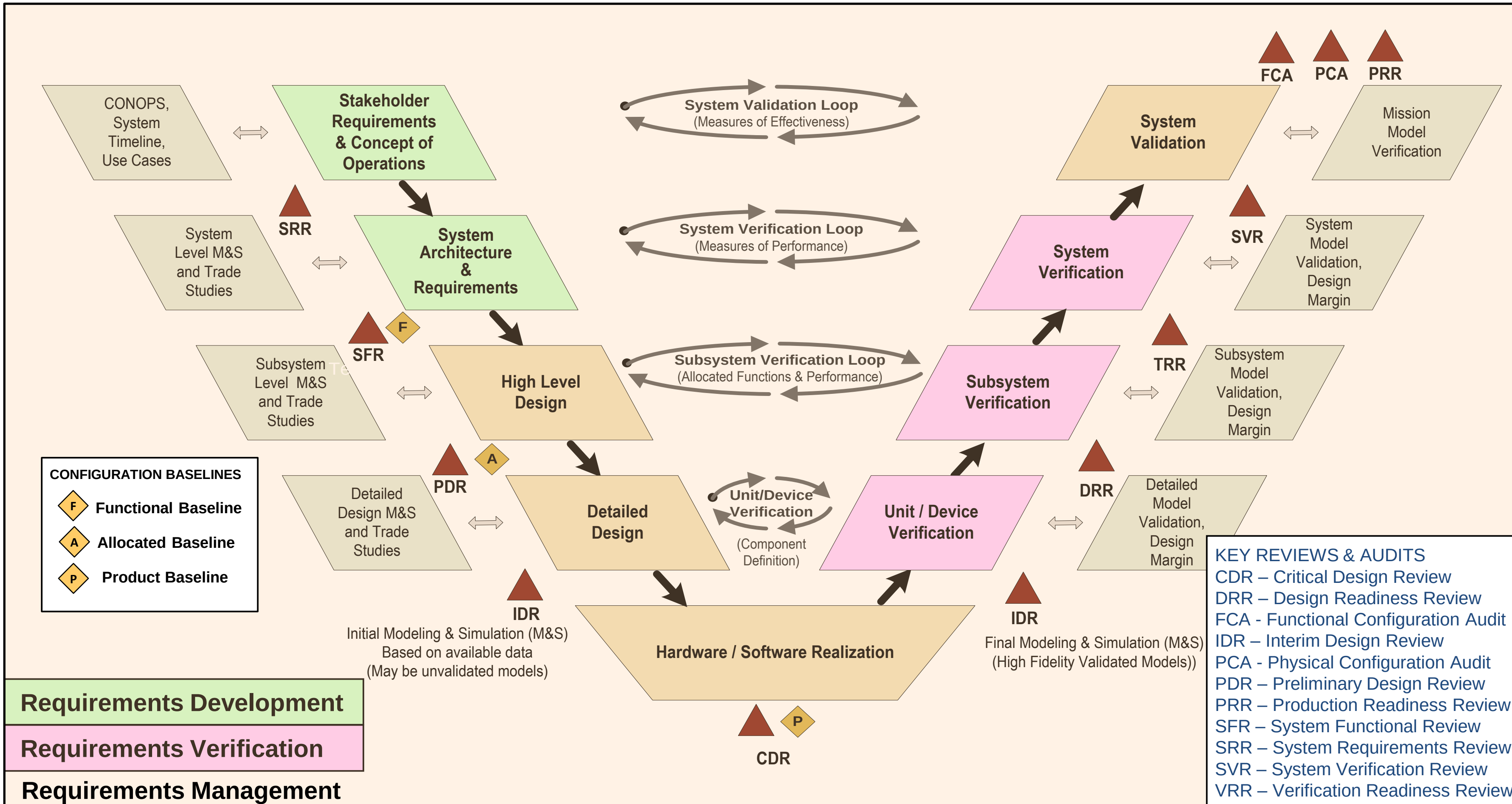
How does the design process work?

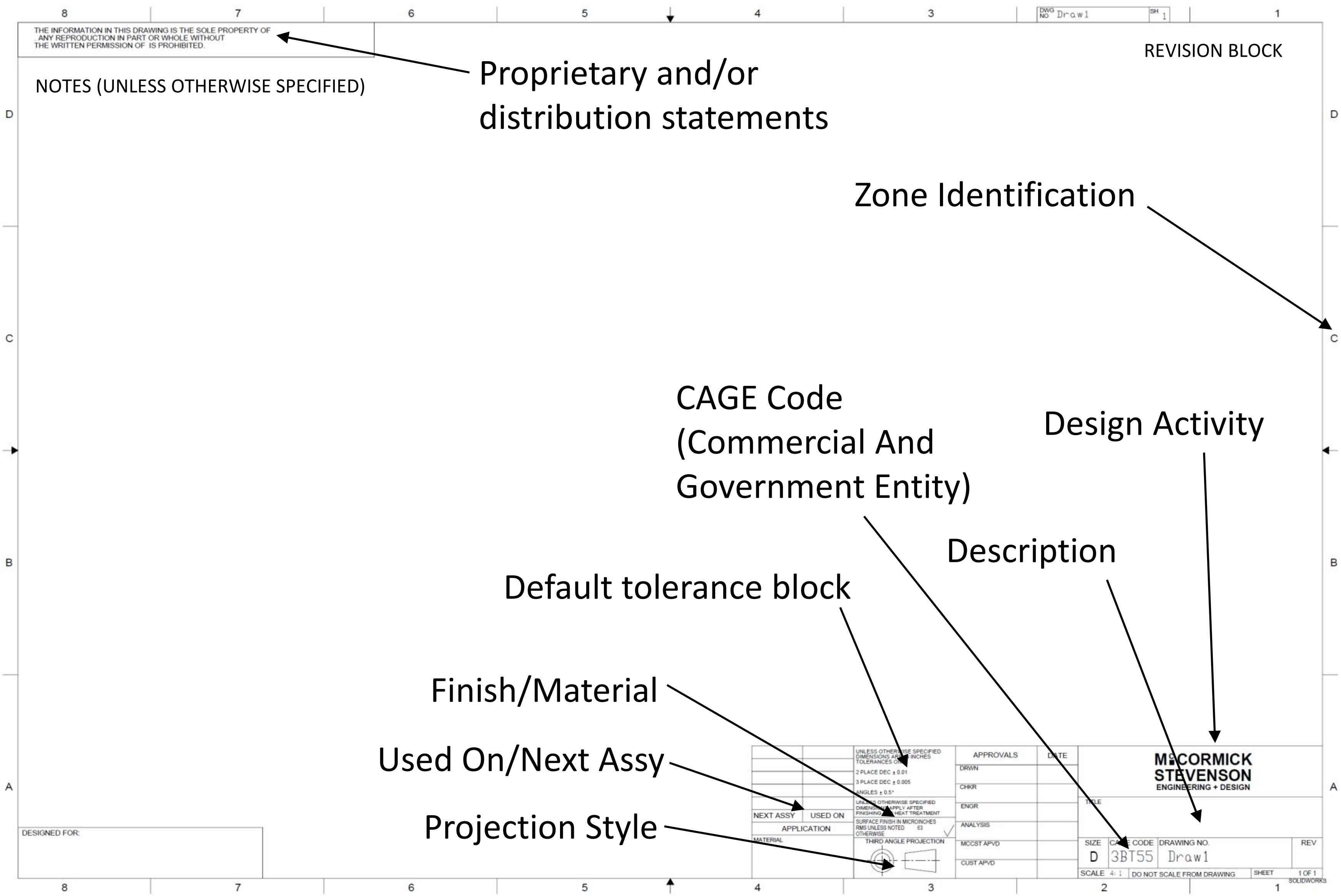


Helpful Design References

- Mil-Spec Reference
  - https://quicksearch.dla.mil/qsSearch.aspx
- Wrench clearance Calculator
  - http://icrank.com/cgi-bin/pageman/pageout.cgi?path=/data/wrench/wrench.html&t=2
- Material Stock
  - https://www.alro.com/datacatalog/metalsguidecatalog.aspx
- Hardware purchase
  - https://www.mcmaster.com/

- Clearance holes, fits, threads and much more in Machinery's Handbook (GO BUY THIS)

Design References



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Drafting Basics

Drafting matters…

- Drawings are used as a requirements communication tool
  - Materials
  - Finishes
  - Tolerances
  - Threads
  - Part marking & Identification
  - Design intent
- Golden Rule: ABC (**A**LWAYS **B**E **C**LEAR)
  - Clear drawings are critical to project success
  - Other people need to be able to read the drawing and reach the same conclusion.
- This is an expensive process
  - Drawings take time to create, check, release
  - Manufacturer's then must live with them
- Take pride in your work

Critical Specifications

- ASME Y14.100 -2017 : Engineering Drawing Practices
- ASME Y14.5-2009 now 2018 : Dimensioning and Tolerancing (GO BUY THIS)
- ASME 14.24-2012 : Types and Applications of Engineering Drawings
- And many more…

Be Specific & Thoughtful

There Different types of dimensioning approaches

- Baseline
- Ordinate
- Rectangular (Linear)
- Polar
- Tabulated

Think about which method is applicable for your application

Fig. 1-6 Application of Dimensions

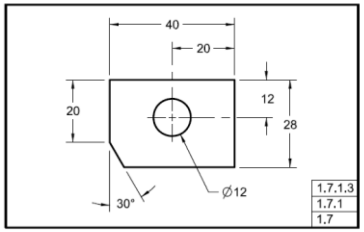


Fig. 1-7 Grouping of Dimensions

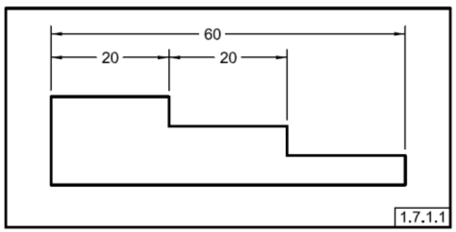


Fig. 1-8 Spacing of Dimension Lines

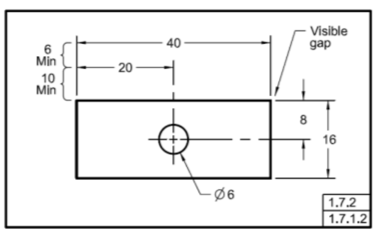
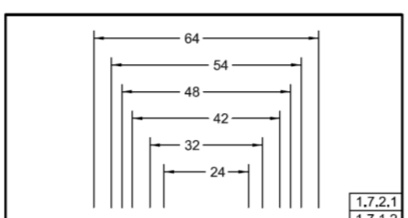
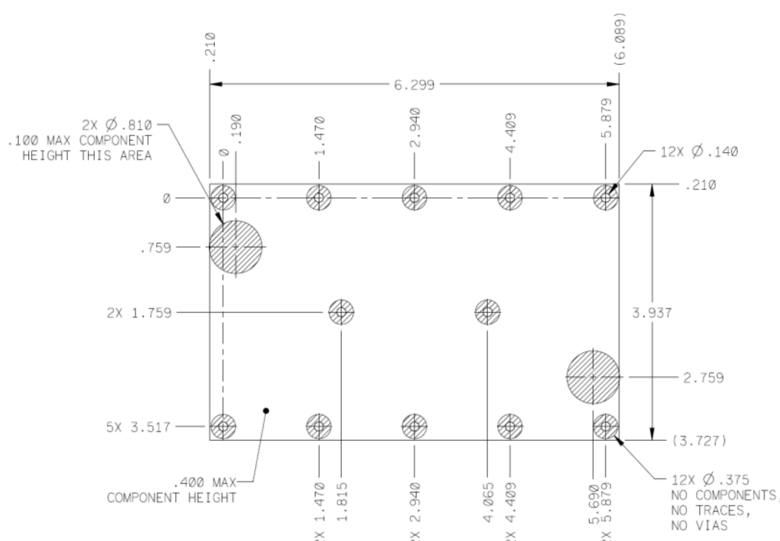


Fig. 1-9 Staggered Dimensions





BOTTOM SIDE

References: ASME Y14.5-2009

Be Clear

- Call out tolerance zones where helpful
- Add notes as needed
- Indicate holes in pattern
- Make sections
- Add Detail views
- Sheets are cheap with CAD tools!
- Add applicable reference information

Be Thorough & Precise

- Tolerances on all dimensions
- Think about the tolerances applied. Remember: This is a requirements document
- Check your own work before asking for peer review

Be Neat & Consistent

- Don't clutter views with dimensions
- Check text sizes meet specifications
- Group dimensions for like features
  - Hole patterns
  - External features
  - Basic dimensions
- Make sure components that mate have consistent orientations and that the dimensioning approaches on their drawing.

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Drafting Basics

Fig. 1-11 Breaks in Extension Lines

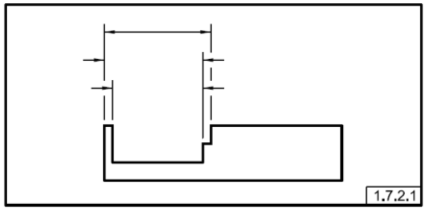


Fig. 1-12 Point Locations

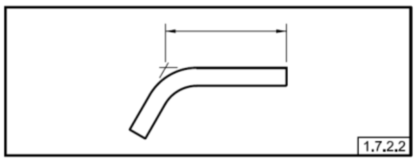


Fig. 1-14 Leaders

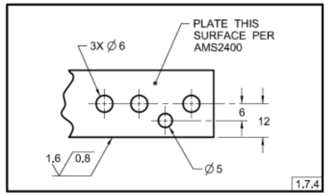


Fig. 1-15 Leader-Directed Dimensions

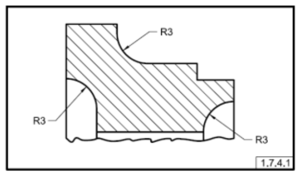


Fig. 1-16 Minimizing Leaders

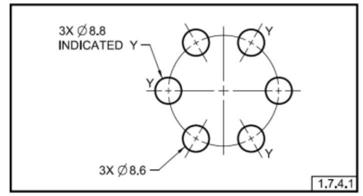
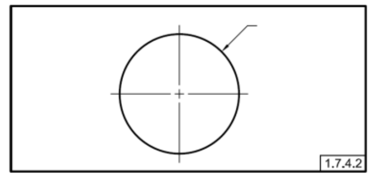


Fig. 1-17 Leader Directions



1.7.8 Dimensioning Within the Outline of a View

Dimensions are usually placed outside the outline of a view. Where directness of application makes it desirable, or where extension lines or leader lines would be excessively long, dimensions may be placed within the outline of a view.

Fig. 1-20 Overall Reference Dimension

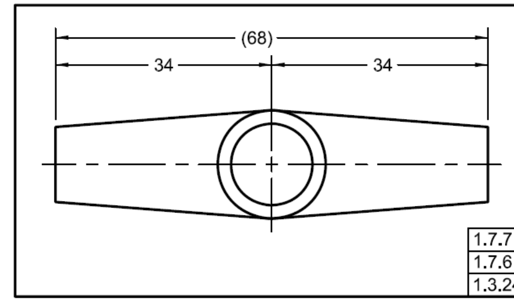


Fig. 1-22 Radii

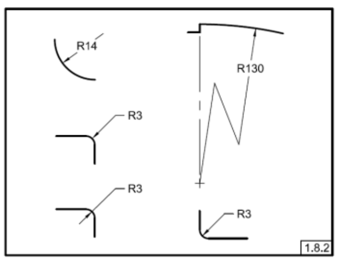


Fig. 1-24 Radii With Unlocated Centers

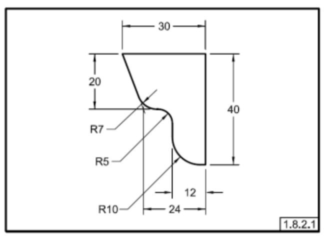


Fig. 1-23 Radius With Located Center

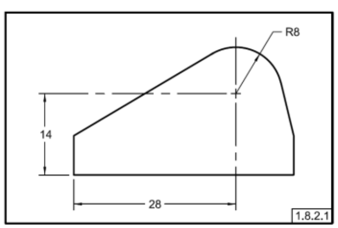


Fig. 1-25 Foreshortened Radii

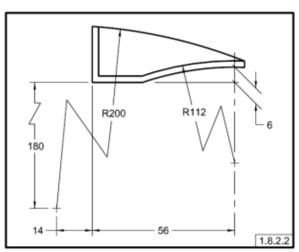


Fig. 1-13 Limited Length or Area Indication

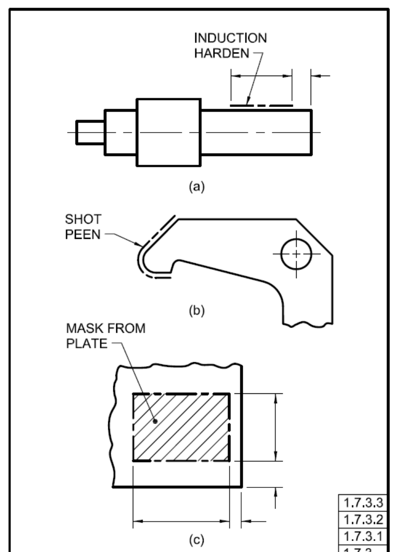


Fig. 1-29 Slotted Holes

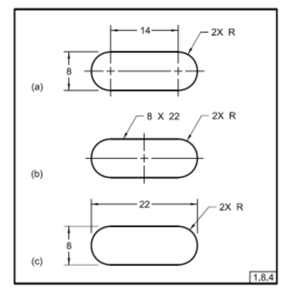


Fig. 1-26 True Radius

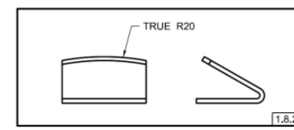


Fig. 1-27 Spherical Radius

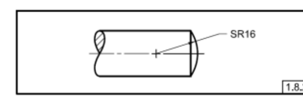


Fig. 1-28 Dimensioning Chords, Arcs, and Angles

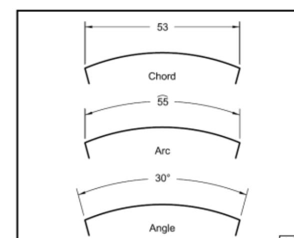


Fig. 1-30 Partially Rounded Ends

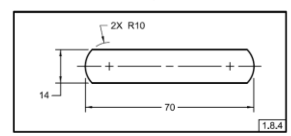
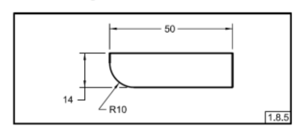


Fig. 1-31 Rounded Corners



References: ASME Y14.5-2009

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How does the design process work?

Fig. 1-32 Circular Arc Outline

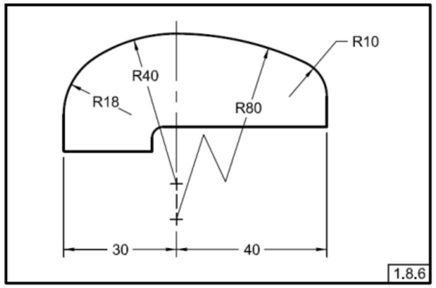


Fig. 1-33 Coordinate or Offset Outline

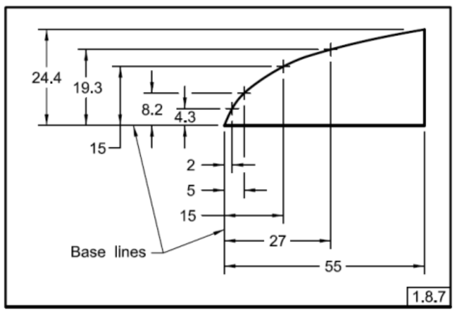


Fig. 1-37 Counterbored Holes

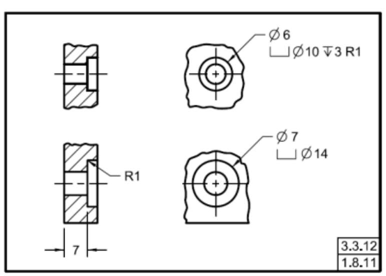
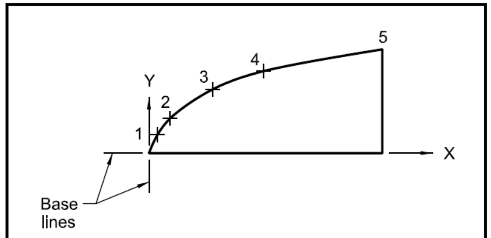


Fig. 1-34 Tabulated Outline



STATION	1	2	3	4	5
X	2	5	15	27	55
Y	4.3	8.2	15	19.3	24.4

1.8.7

Fig. 1-38 Counterbored Holes

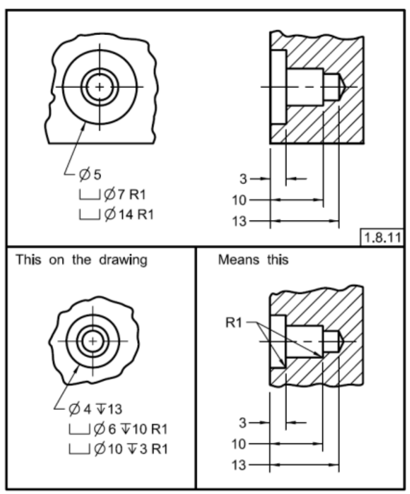


Fig. 1-39 Countersunk and Counterdrilled Holes

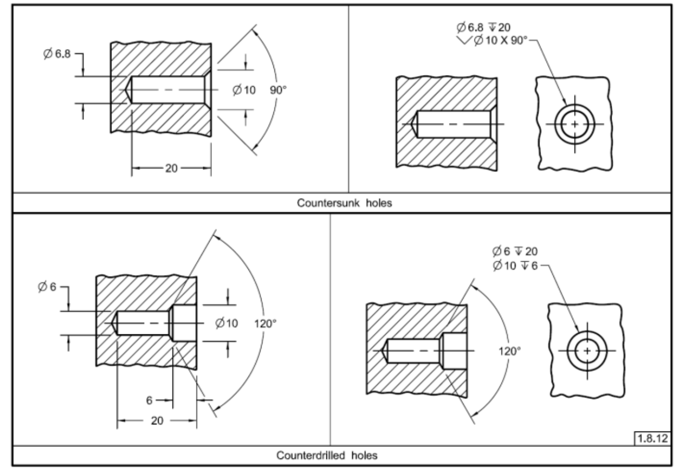
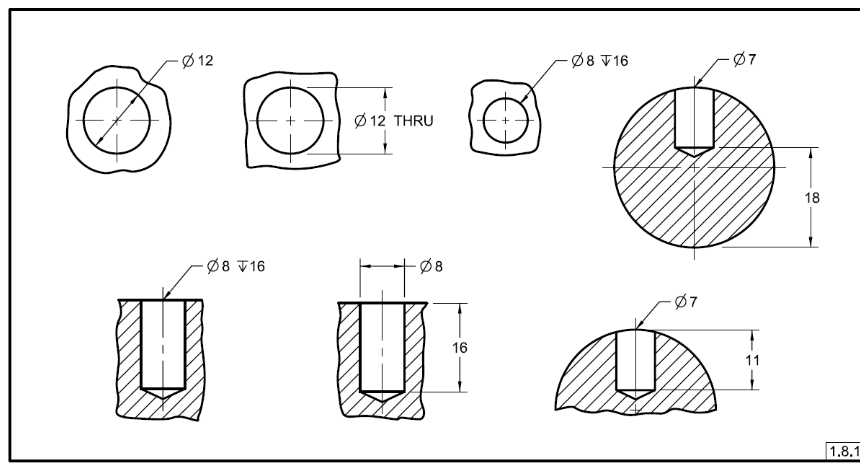


Fig. 1-36 Round Holes



References: ASME Y14.5-2009

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How does the design process work?

Fig. 1-41 Spotfaced Holes

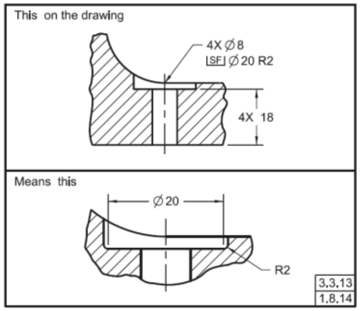


Fig. 1-42 Chamfers

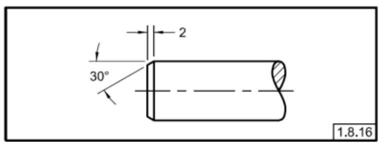


Fig. 1-43 45° Chamfer

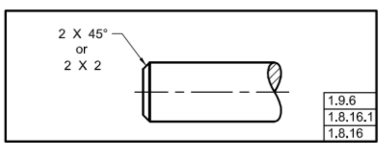


Fig. 1-44 Internal Chamfers

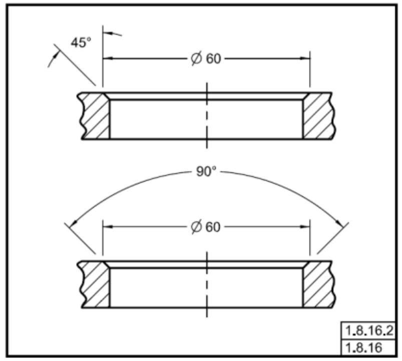


Fig. 1-45 Chamfers Between Surfaces at Other Than 90°

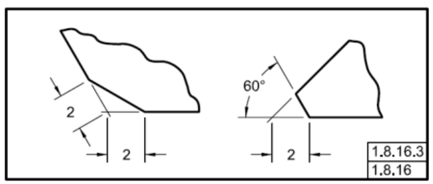


Fig. 1-46 Keyseats

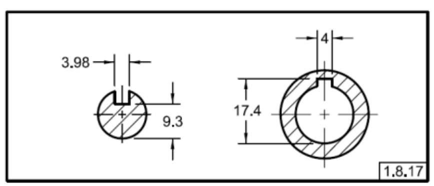


Fig. 1-49 Rectangular Coordinate Dimensioning

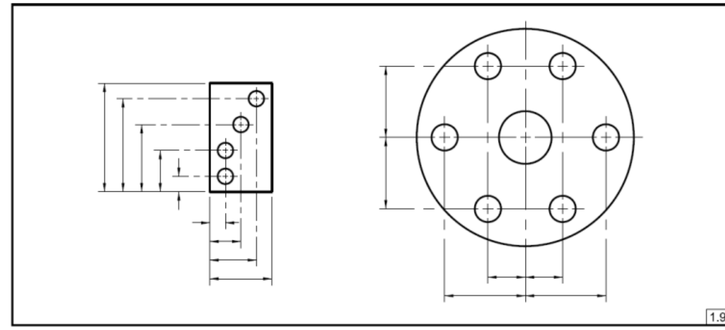
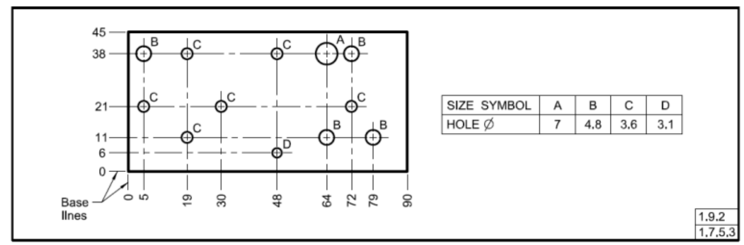
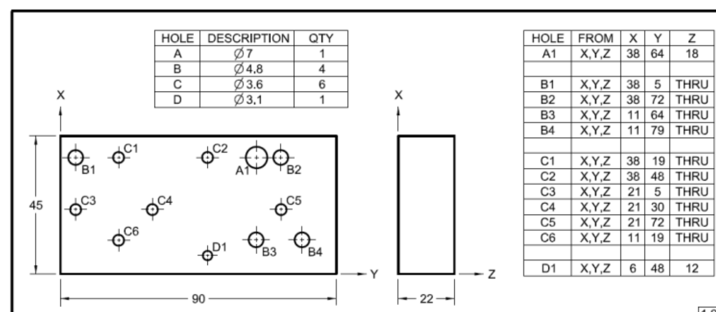


Fig. 1-50 Rectangular Coordinate Dimensioning Without Dimension Lines



SIZE SYMBOL	A	B	C	D
HOLE Ø	7	4.8	3.6	3.1

Fig. 1-51 Rectangular Coordinate Dimensioning in Tabular Form



HOLE	DESCRIPTION	QTY
A	Ø7	1
B	Ø4.8	4
C	Ø3.6	6
D	Ø3.1	1

HOLE	FROM	X	Y	Z
A1	X,Y,Z	38	64	18
B1	X,Y,Z	38	5	THRU
B2	X,Y,Z	38	72	THRU
B3	X,Y,Z	11	64	THRU
B4	X,Y,Z	11	79	THRU
C1	X,Y,Z	38	19	THRU
C2	X,Y,Z	38	48	THRU
C3	X,Y,Z	21	5	THRU
C4	X,Y,Z	21	30	THRU
C5	X,Y,Z	21	72	THRU
C6	X,Y,Z	11	19	THRU
D1	X,Y,Z	6	48	12

References: ASME Y14.5-2009

How does the design process work?

Fig. 1-52 Polar Coordinate Dimensioning

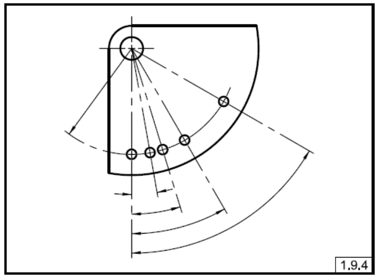


Fig. 1-53 Repetitive Features

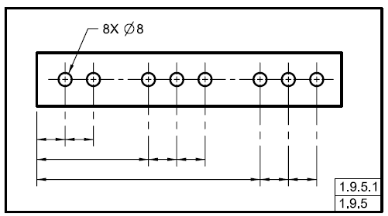


Fig. 1-54 Repetitive Features

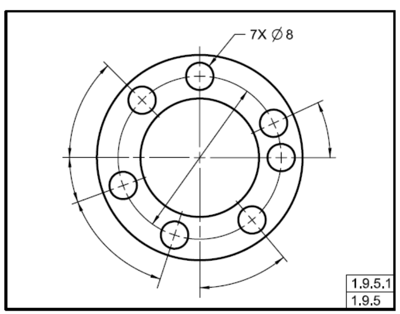


Fig. 1-55 Repetitive Features and Dimensions

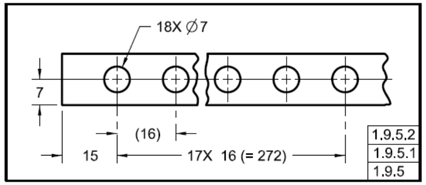


Fig. 1-56 Repetitive Features and Dimensions

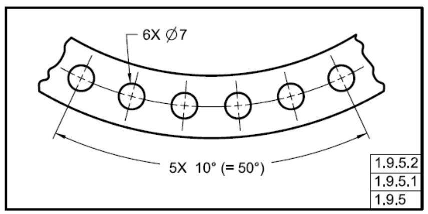
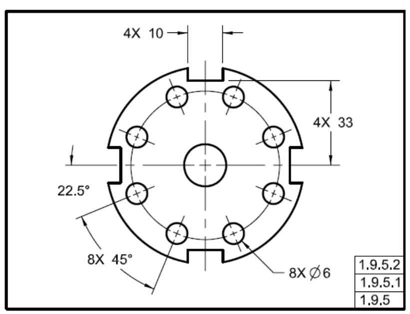


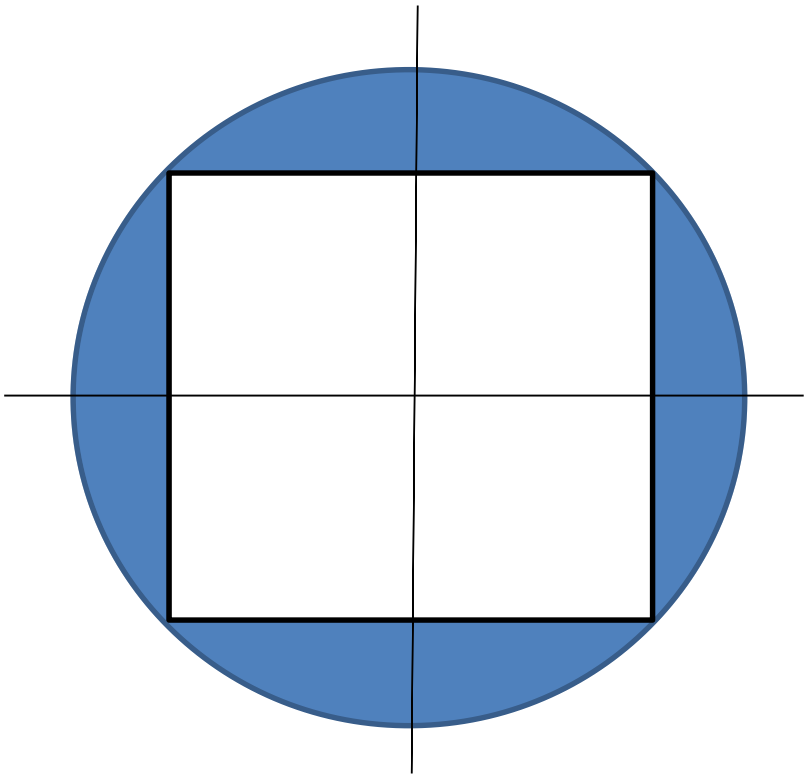
Fig. 1-57 Repetitive Features and Dimensions



References: ASME Y14.5-2009

Background

- Controlled by ASME Y14.5
- Communicates design intent
- Easier that rectangular tolerancing
- Helps with inspection



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Process

- Consider how part will be inspected
- Establish datum setup based on design intent
- Think of form and orientation tolerances as needed
- Apply location tolerances to features

Definitions

- Form tolerances: How much a feature can vary relative to it's perfect counterpart. HAVE NO DATUM REFERENCES (Flatness, Straightness, Circularity, Cylindricity)
- Orientation tolerances: Control the orientation of a feature or group of features relative to specified datums. (Perpendicularity, Parallelism, Angularity)
- Location tolerances: Control the location of a feature or group of features relative to specified datums. (Position, Concentricity, Symmetry)
- Runout tolerances: Controls functional relationship of features to datum axis.
- Profile Tolerances: Can control size, form, orientation, and location.

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