Learn & Fly

Technical Drawing

Module #5

Co-funded by the
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Prehistoric Sites and Decorated Caves of the Vézère Valley

Learn & Fly

5. Technical Drawing

5.1. Technical drawing as comumunication tool

- Drawings are the first attempts to communication
- Graphical communication of ideas goes back to 12000 B.C.
- Even nowadays is practically impossible to exchange ideas only by written or spoken words
- In the industry drawings are a method of conveying ideas concerning the construction or assembly of objects

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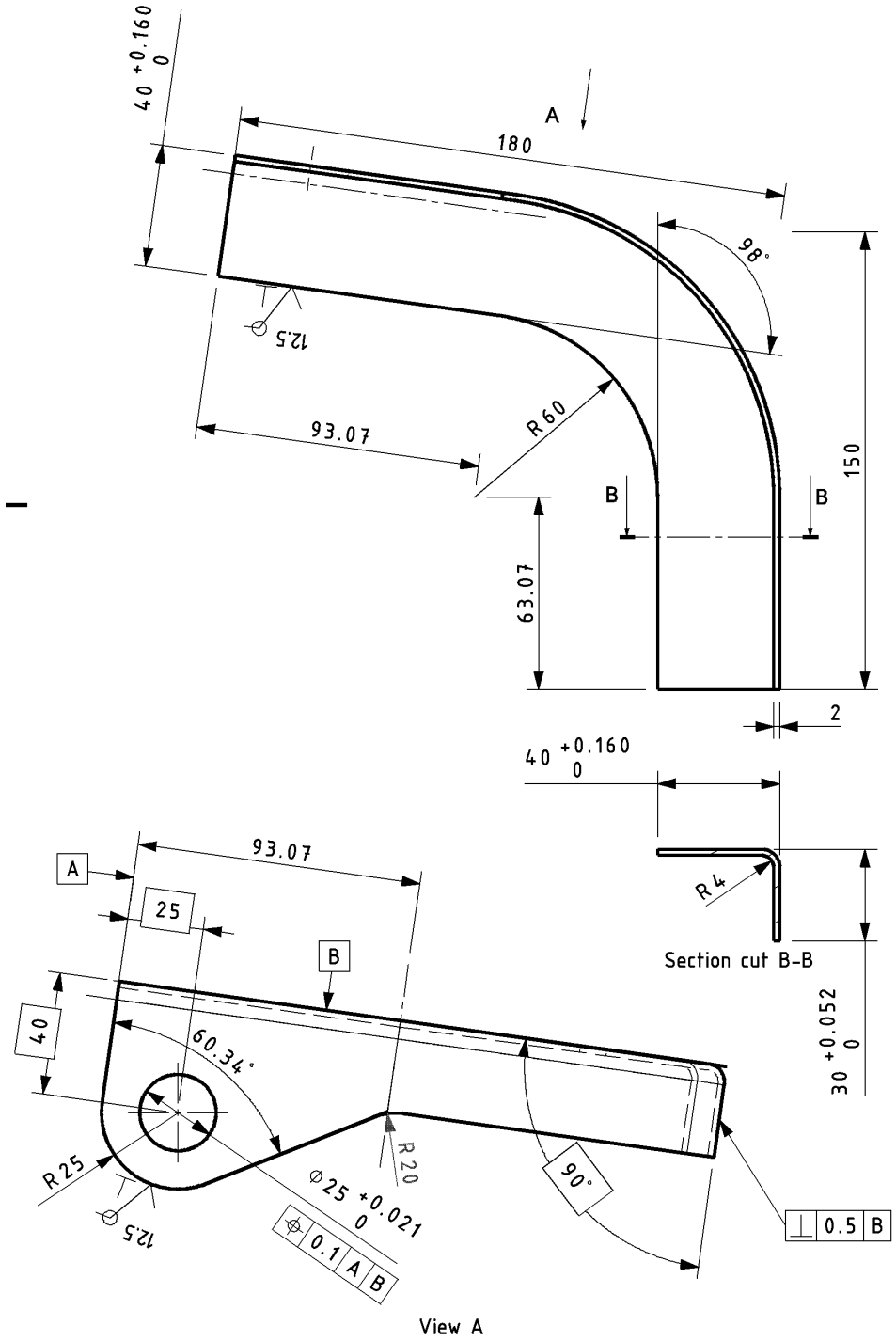
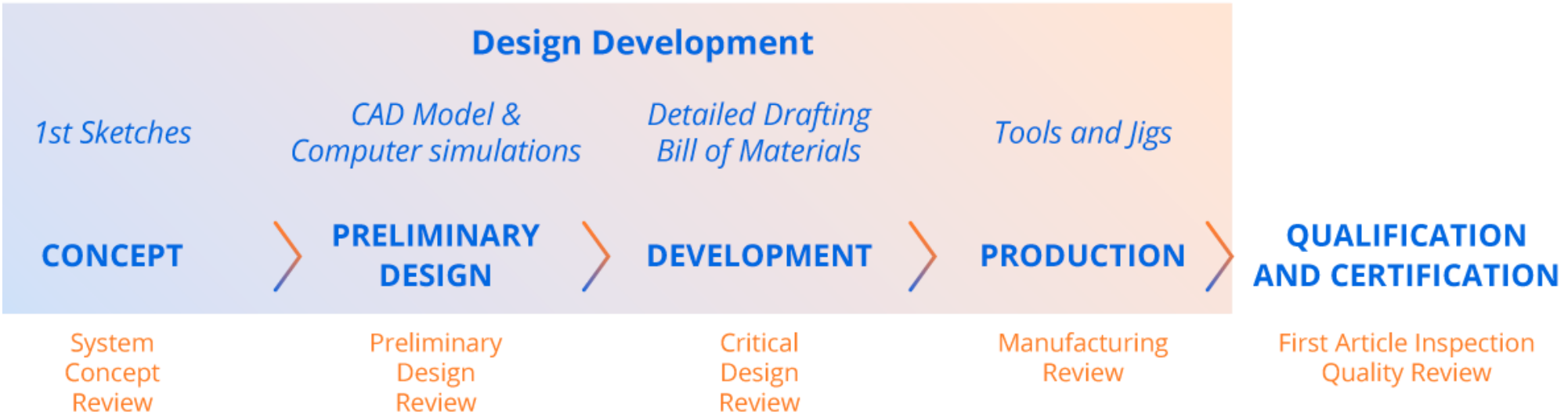
- Progressive evolution of communication
  - Egyptian hieroglyphs
  - Chinese characters
  - Alphabet
- Even with the advance of communication drawings are still important by their effectiveness

“...an image worth more than 1000 words”



Drawings are a link between design engineers and the workers who built, maintain and repair the aircraft. Most of these drawings, apart from the representation of the object, has notes, abbreviations and symbols. The information includes:

- Representation of the assembly, parts, group of parts, system or group of systems, etc...
- Details about some representations
- Notes about surface condition, including painting or other surface treatments
- Dimensional and geometrical tolerancing
- Symbols like: welding, reviting or fastening
- General notes, like: assembly notes, position were to mark the parts, etc...


Design Development
1st Sketches
CAD Model & Computer simulations
Detailed Drafting Bill of Materials
Tools and Jigs
CONCEPT
PRELIMINARY DESIGN
DEVELOPMENT
PRODUCTION
QUALIFICATION AND CERTIFICATION
System Concept Review
Preliminary Design Review
Critical Design Review
Manufacturing Review
First Article Inspection Quality Review

- Drawing representations are covered by a significant number of standards, these include:
    - Paper sizes and folding
    - Lettering
    - Lines
    - Scales
    - Title blocks and Bill of Materials (BOM)
    - Symbols (roughness, welding, riveting, screwing)
    - Representations
    - etc...
- The industry follows several different standards, being the more common the published by the International Organization for Standardization (ISO) or the American National Standards Institute (ANSI). In addition most of the countries follow national standards.

- The most common format used in Europe is the A series (ISO 216 and ISO 5457)
  - The base A0 size of paper is defined as having an area of 1 m2 and a dimension ratio of 1 to $\sqrt{2}$
  - Successive sizes, series A1, A2, A3, and so forth, are defined by halving the preceding paper size across the larger dimension
  - The most common size is A4

Format	Size (mm)
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

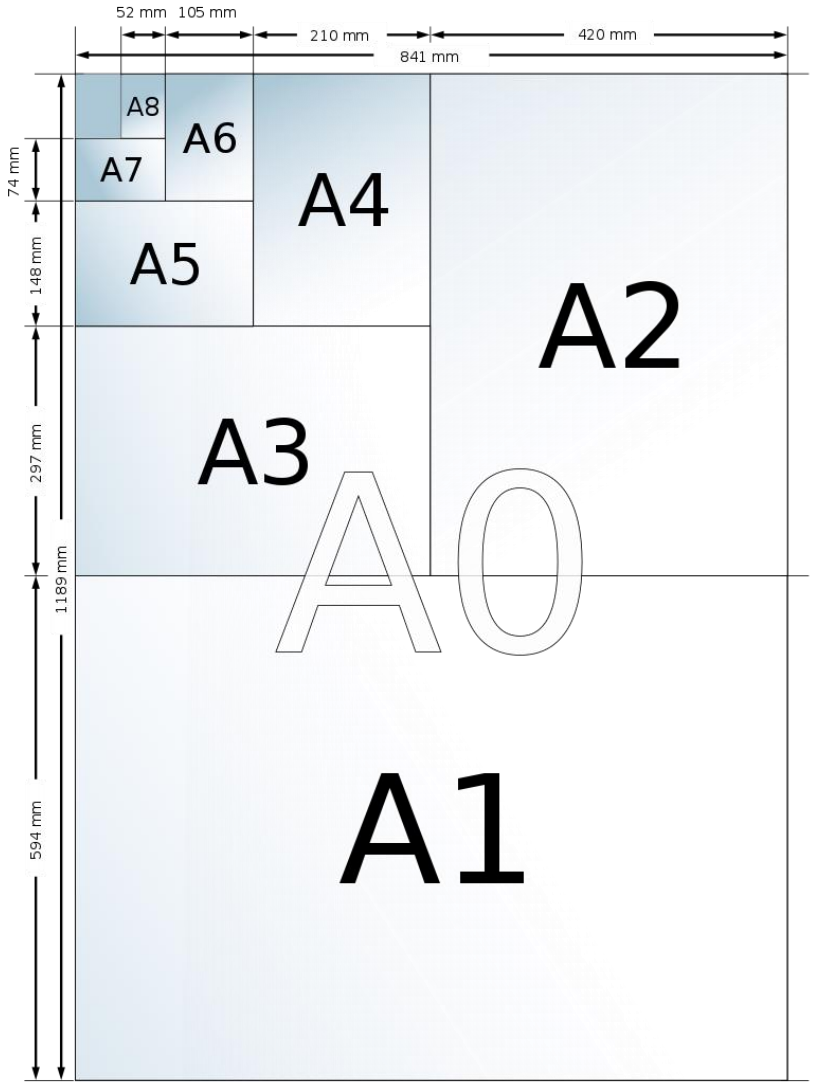
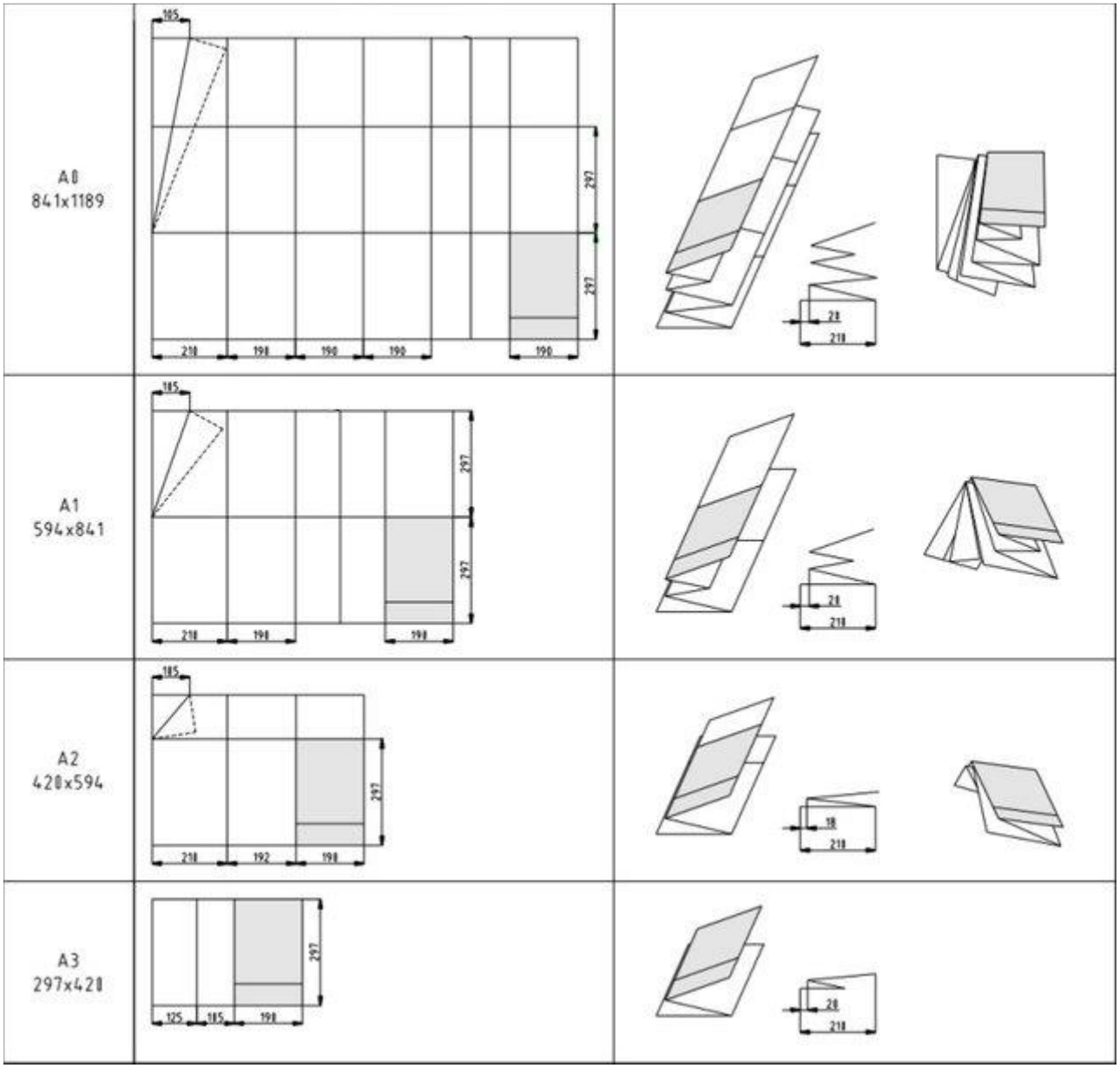
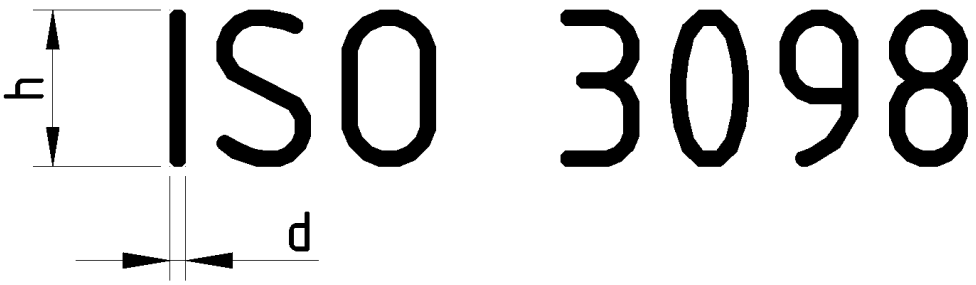


Image by Bromskloss, licensed under **CC BY-SA 3.0**



- All A size sheets must be folded to the final format A4 for easy handling and archiving
- The title block, where are several informations about the drawing, must become visibible without unfolding

- Normalized lettering must be used in technical drawings. ISO 3098 specifies the general requirements for lettering, in accordance with all other parts of this International Standard, to be used in technical product documentation
- Why standardized lettering
  - Legibility
  - Uniformity
  - Easy to reproduce without losing quality
- Standardised values of heights (h) of capitals:
  - 2.5 – 3.5 – 5 – 7 - 10 – 14 – 20 mm.
  - The thickness must be d/h 1/10 or 1/14. All the other proportions of the letters are defined by ISO 3098.

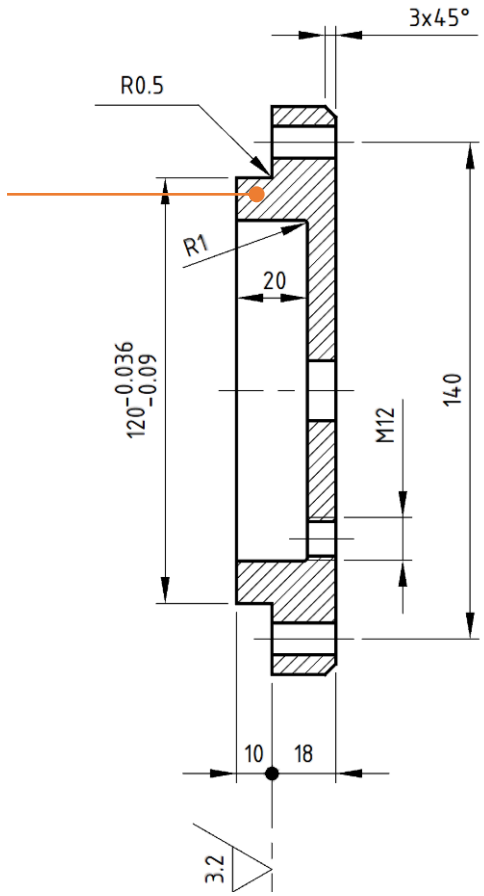


ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrtsuvwxyz
0123456789

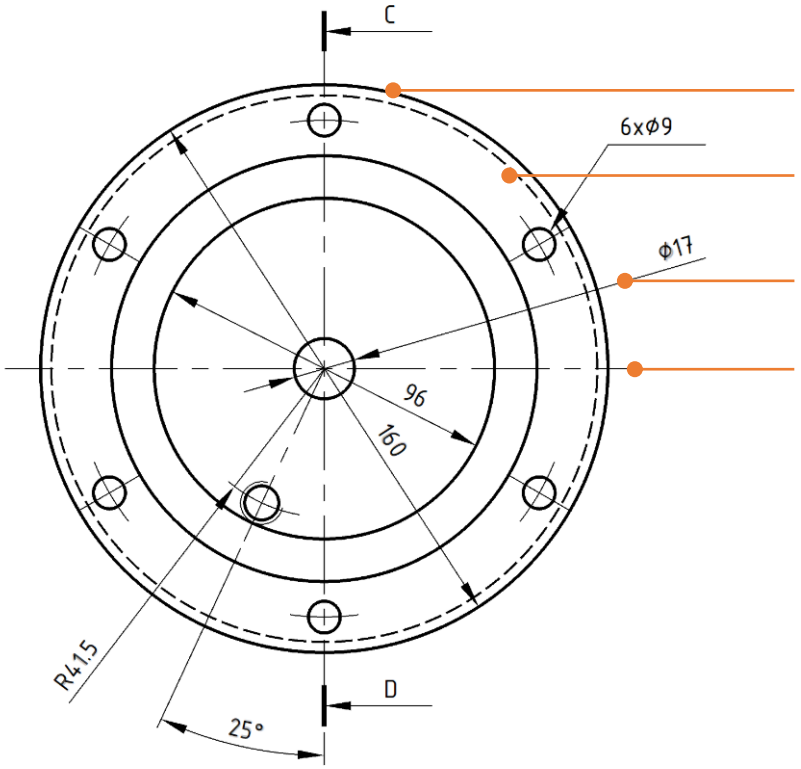
Lettering Stencil 3.5 mm

Standard ISO 128 defines several types of lines and thickness to be used in technical drawings. Some of the most common line types:

Line	Description	Where to use
	Continuous tick	Edges directly visible from a particular angle
	Continuous thin	Dimension lines, extension lines, hatching from cuts, construction lines
	Dashed medium thick	To represent hidden edges
	Chain thin	Centre line, lines of symmetry
	Continuous thin wary	To represent limits of views that are interrupted
	Chain thin and thick at ends	To represent cutting planes of views



Hatching



Visible Edge

Hidden Edge

Dimension line

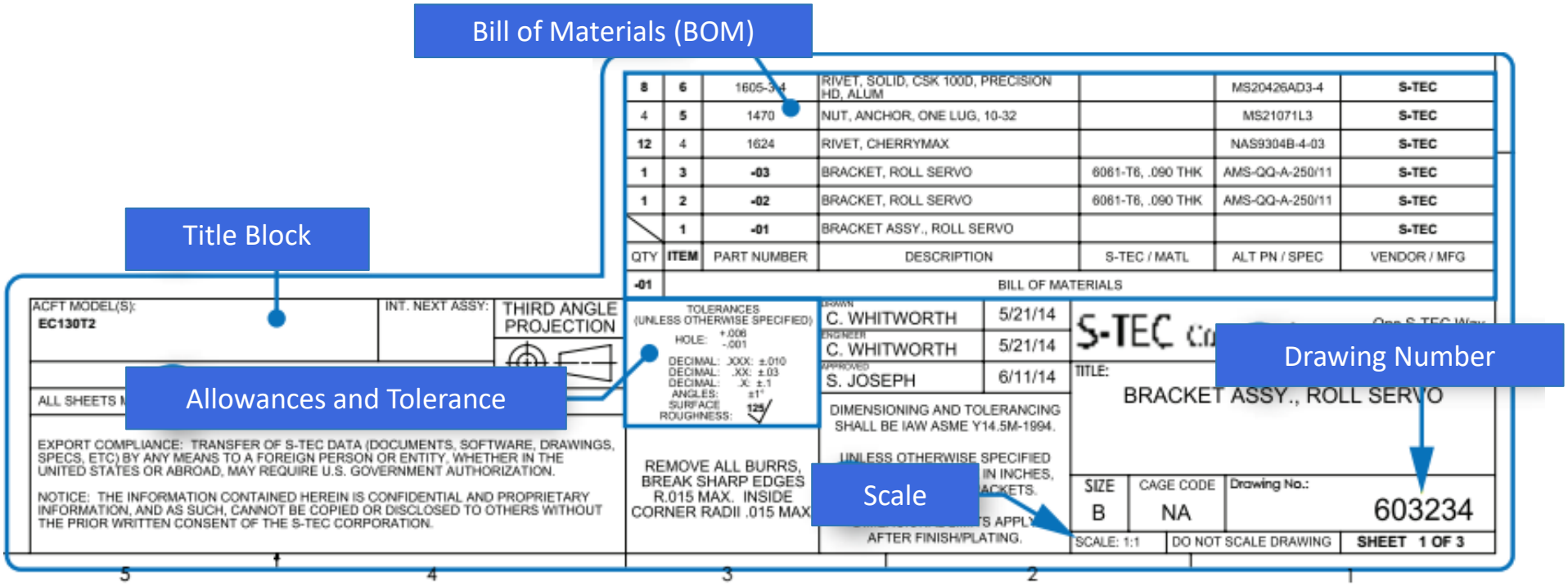
Centre line

- Standard ISO 5455 indicates the recommended scales and their designation for use in any field of engineering.
  - The scale is the relation between the dimension of the object represented in the paper and the real of physical dimension
  - The scale is chosen in order to represent contently all the drawing in the paper

  - Examples of scales:
    - Real: 1:1
    - Magnification : 2:1 5:1 10:1 20:1 50:1
    - Reduction: 1:2 1:5 1:10 1:20 1:100 1:200 1:500 1:1000 1:2000 1:5000 1:10000

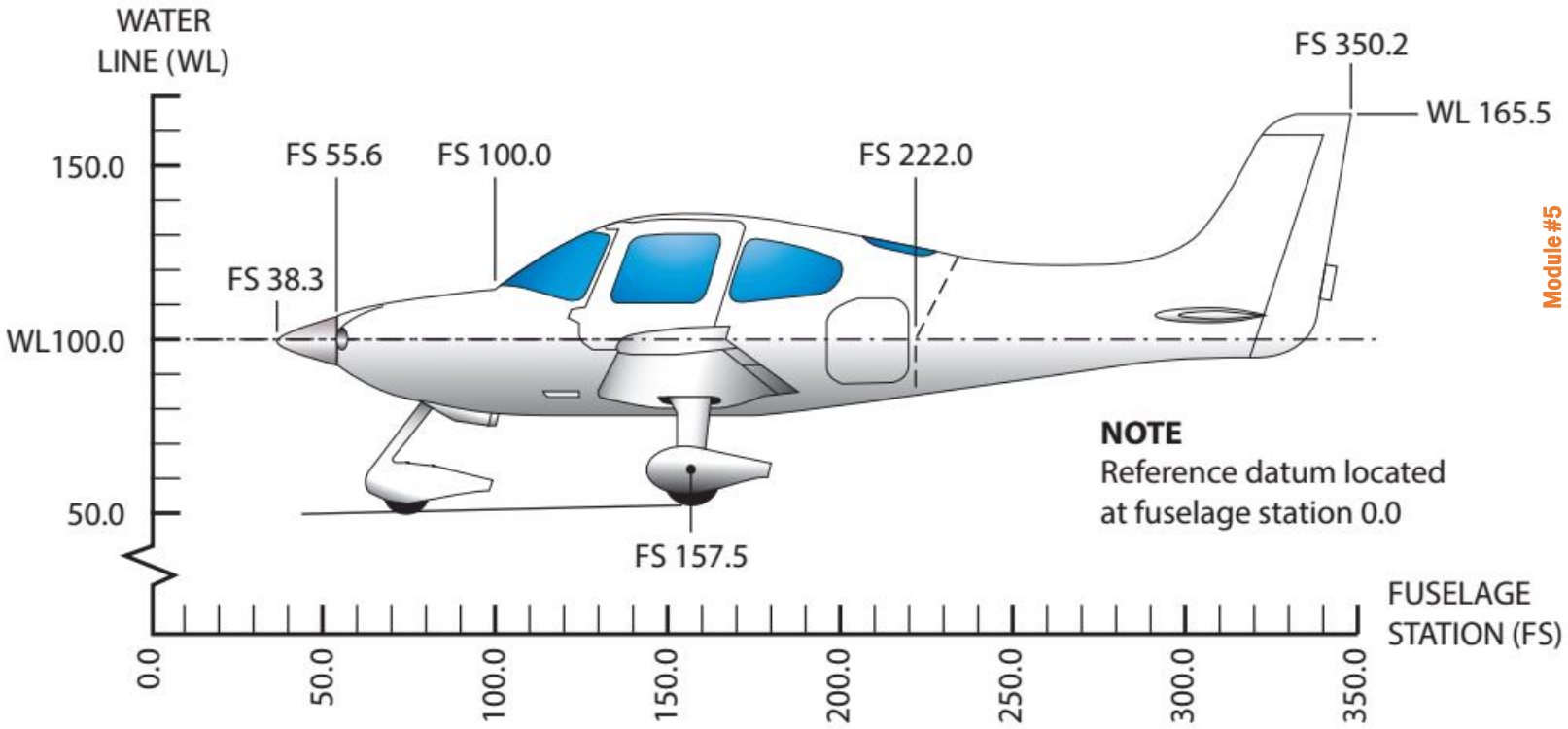
- Title blocks are located generally at the lower right corner of the drawing sheet
- Standard ISO 7200 defines the title blocks formats and information that should be included
- Should contain specific information about the drawing, namely:
    - Identification of the drawing:
        - Identification number
        - Title
        - Owner
    - Additional information such as:
        - Scales
        - Representation method
        - Dimensions units
        - Tolerances and surface finish
        - Revision
        - Dates
        - Responsible
        - Etc...

- A list of the materials and parts necessary for manufacturing or assembly of a component.
- This list contains information such as:
  - Part numbers
  - Nome of the parts
  - Materials
  - Quantities
  - Special treatments, like heat treatments
  - Weight
  - Molds and required tools
- On assemblies each part is identified by a number in a circle to locate this part in the BOM.



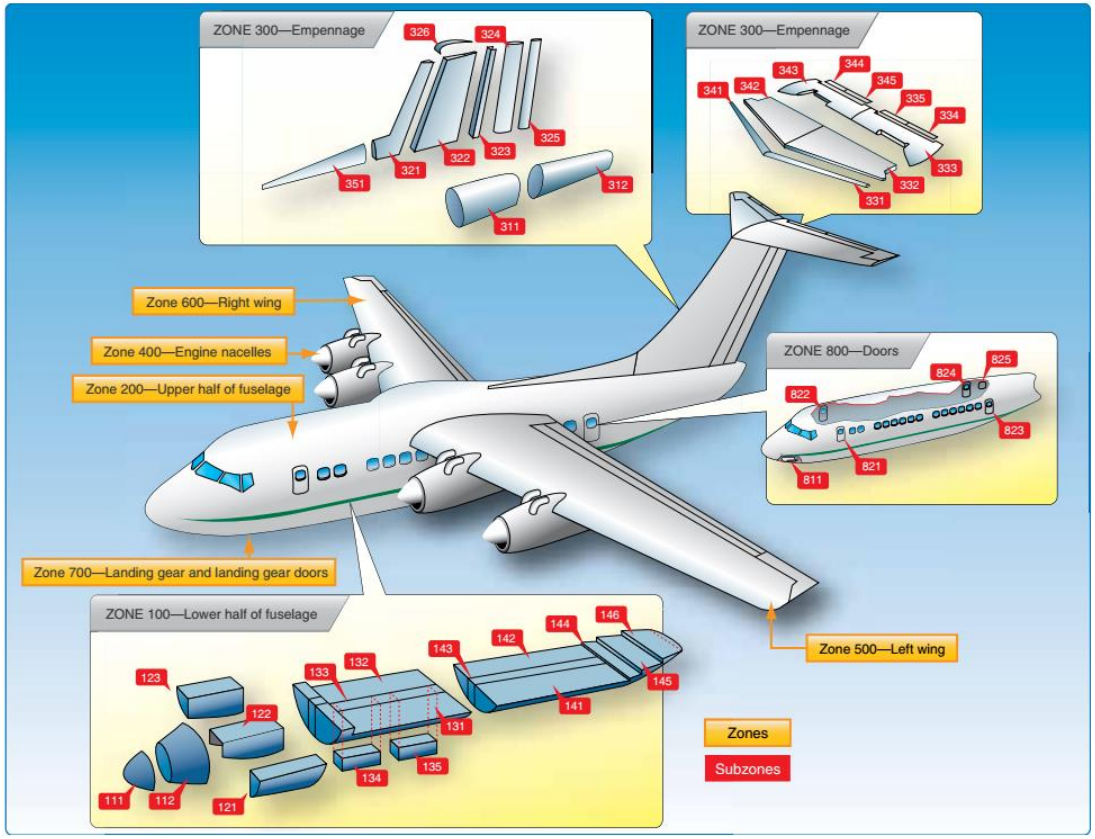
Aviation Maintenance Technician Handbook – General,: FAA-H-8083-30A, 2018

- A numbering system is used to locate easily assemblies or parts in the aircraft.
- For example FS 55.6 means that is a Fuselage Station at 55.6 inches from Water Line (WL)

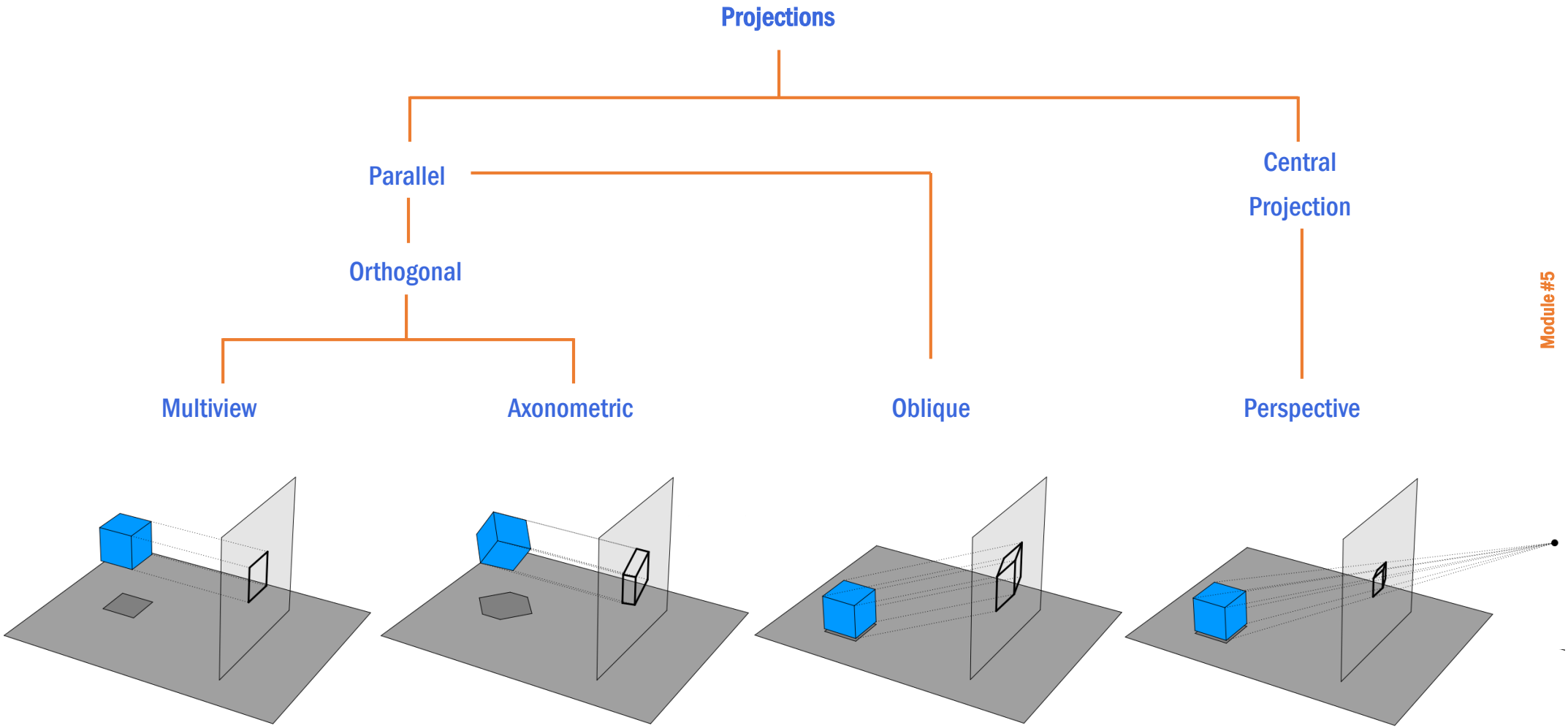


Aviation Maintenance Technician Handbook – General,: FAA-H-8083-30A, 2018

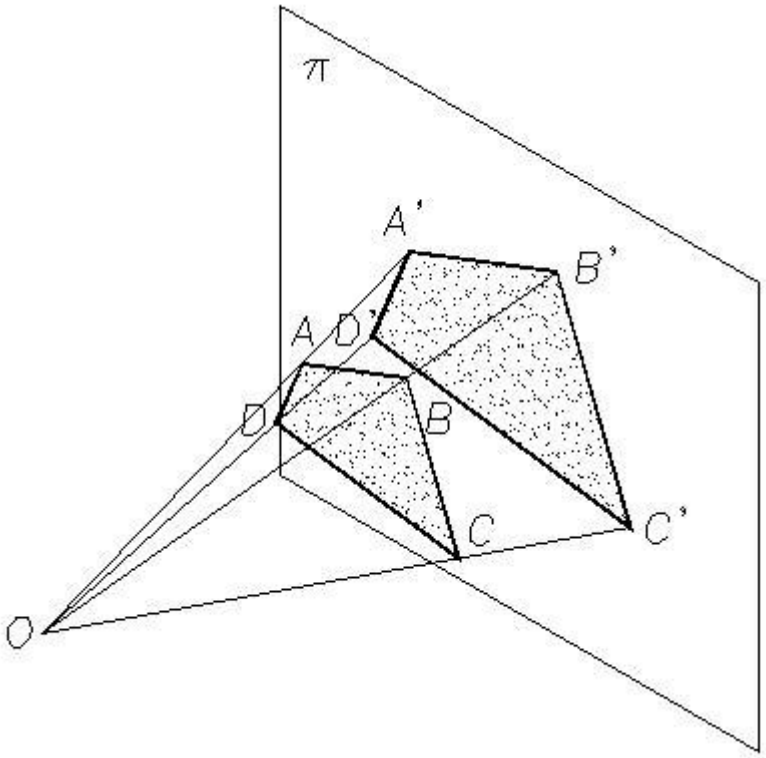
- On assembly drawings, each item is identified by a number in a circle or square. An arrow connecting the number with the item assists in locating it in the BOM
- Parts and assemblies are generally grouped by zones.



Aviation Maintenance Technician Handbook – General,: FAA-H-8083-30A, 2018

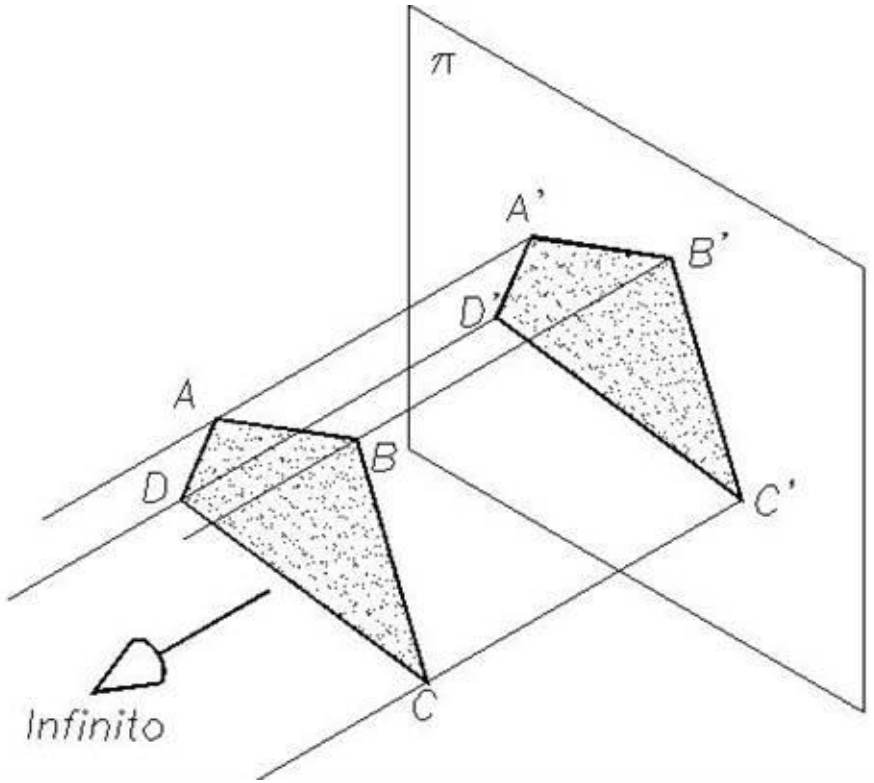


Perspective or Central projection



Observer (one viewpoint)

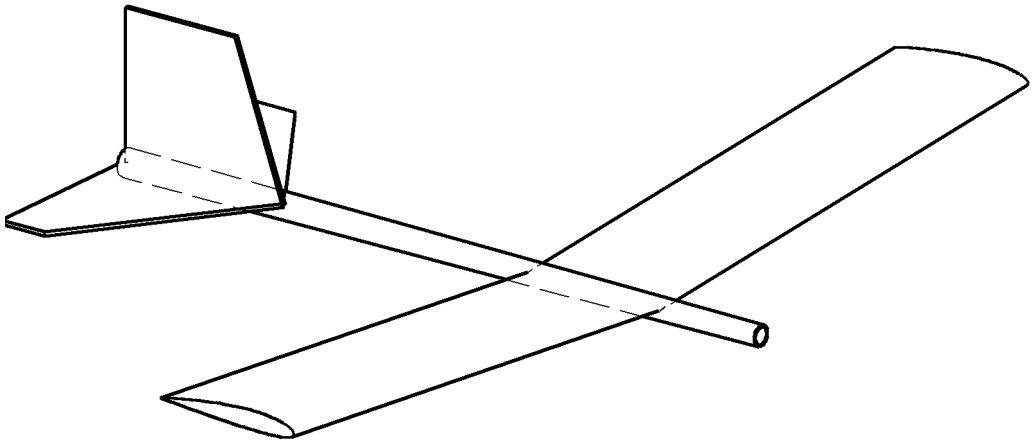
Parallel projection



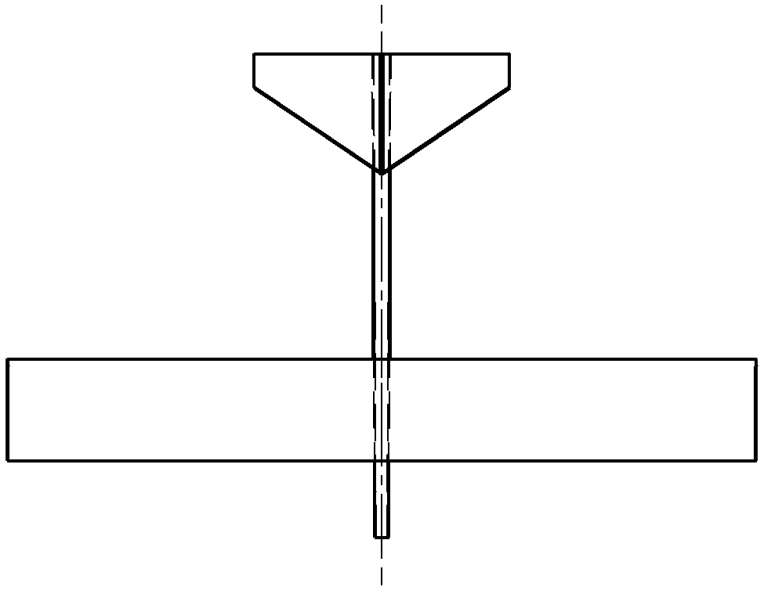
Observer (infinite view point normal to the plan)

Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

Perspective or central projection

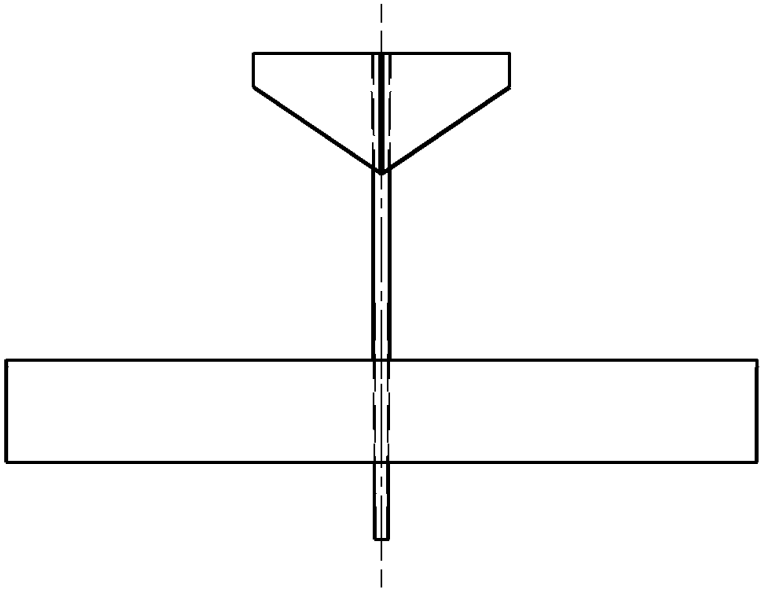


Parallel projection



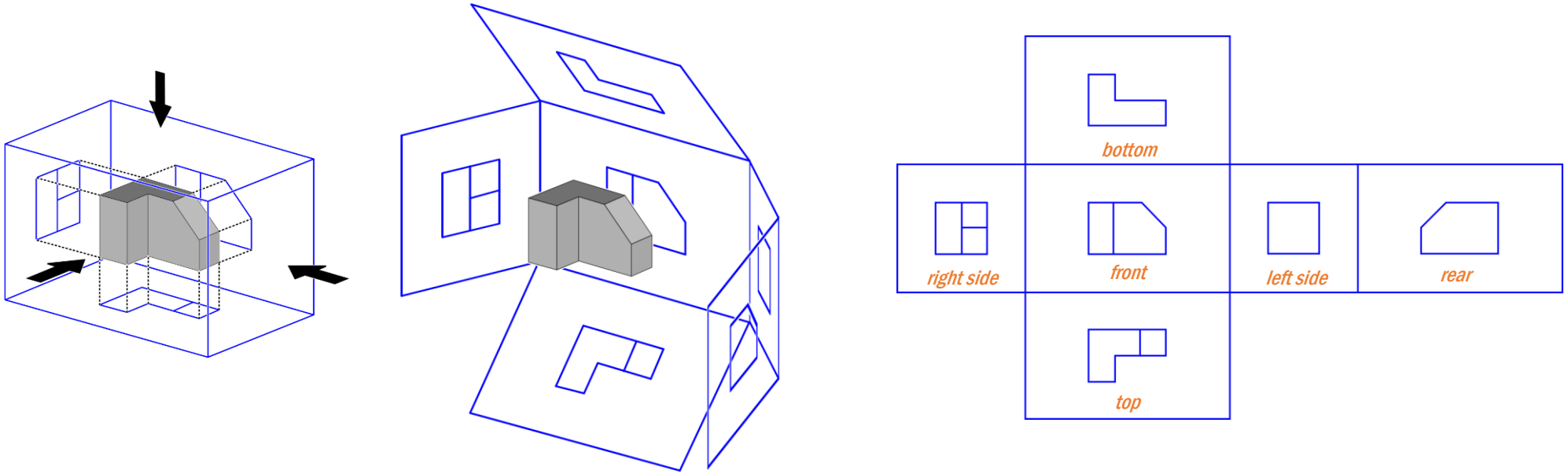
Front View

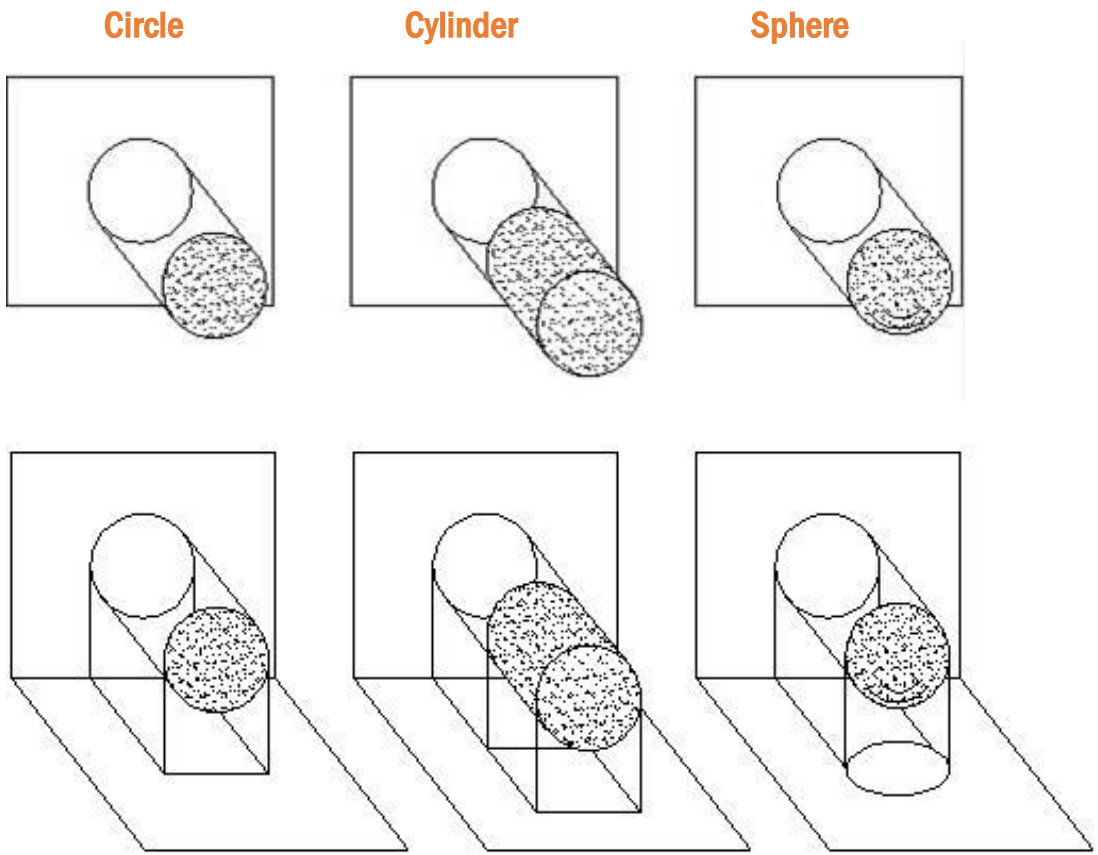
Left View

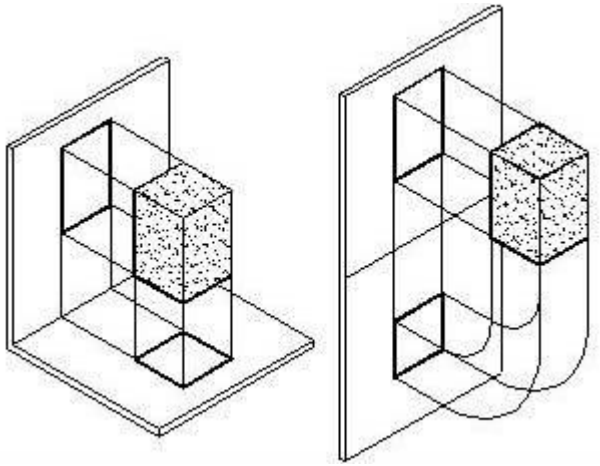


Top View

Generating a multiview drawing – six possible views

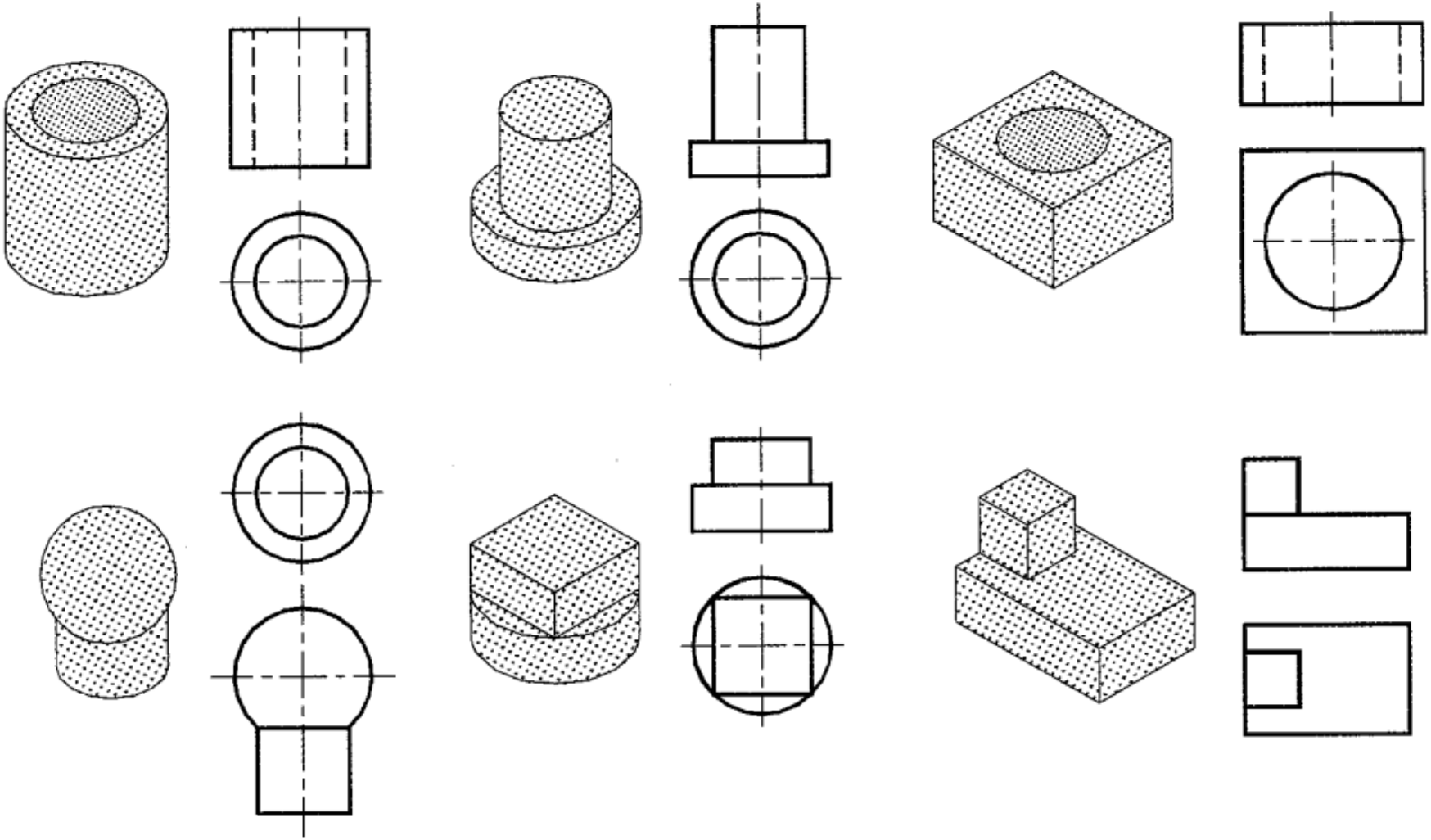






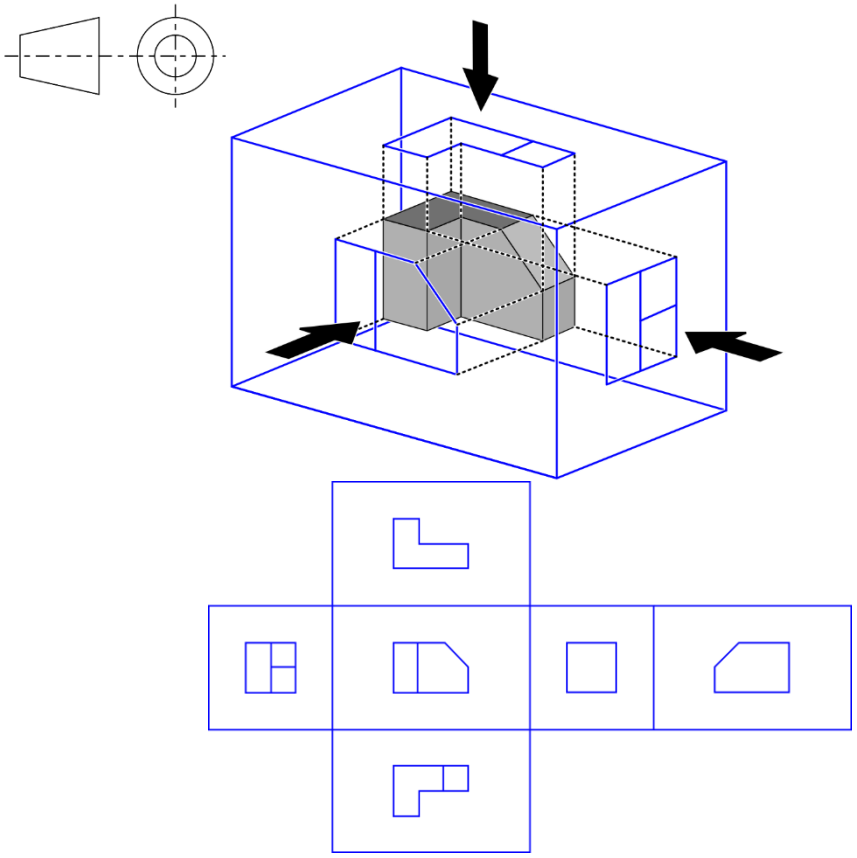
Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

Representations of several objects with two views

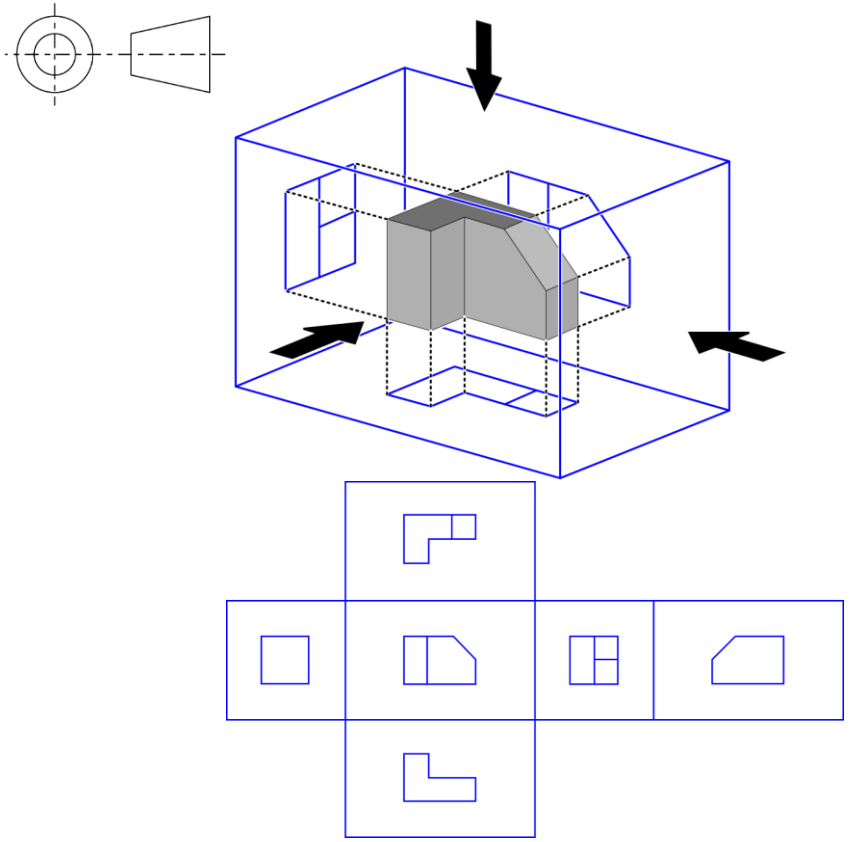


Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

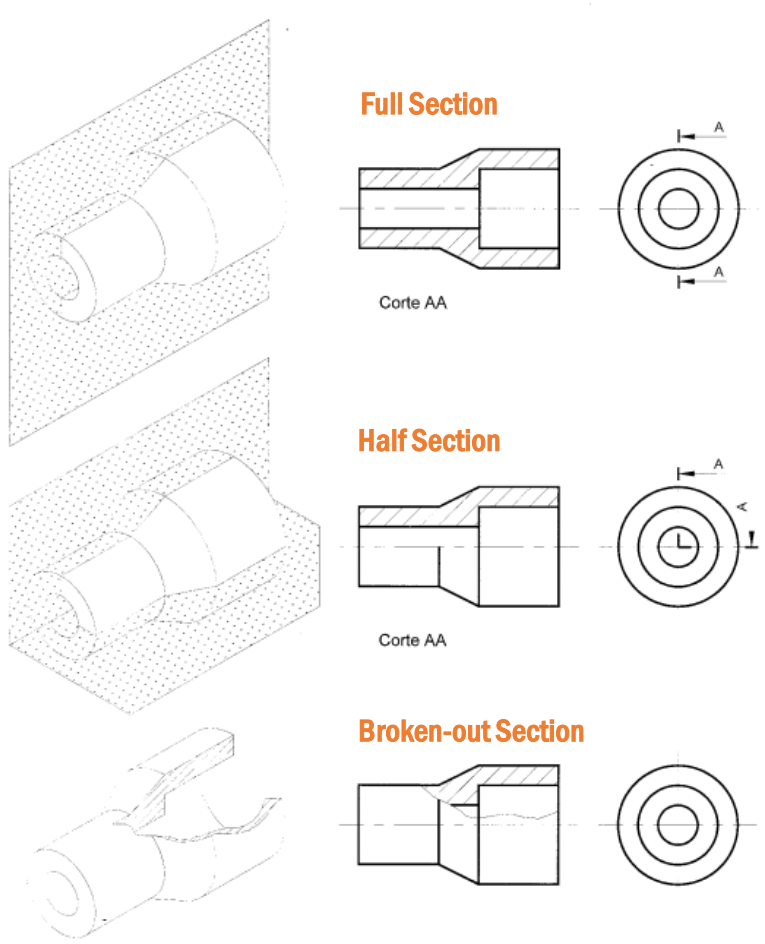
1st quadrant - Common in Europe and Asia and usually drawn in metric units



3rd quadrant - Common in United States and Canada and usually drawn in feet & inches, decimal feet & inches

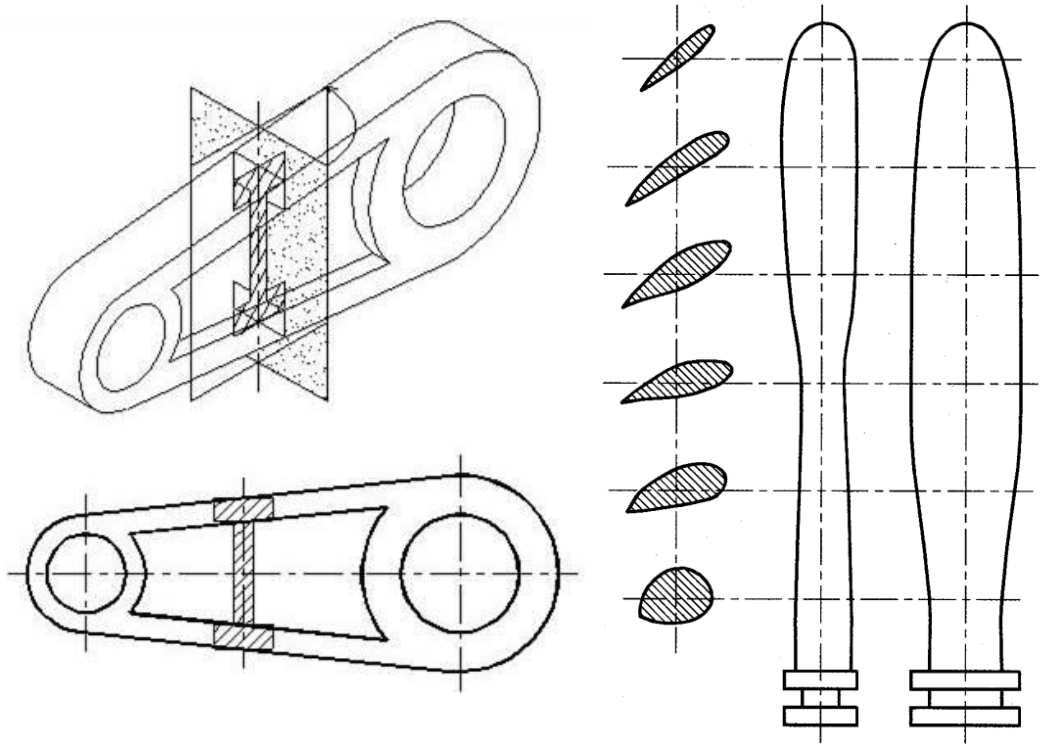


- Many parts, specially those that have a complicated interior are better represented with cuts
  - Hidden lines are removed (even those that may exist)
  - Better understanding of the whole part
  - Sections can be
    - Full
    - Half
      - Broken-out



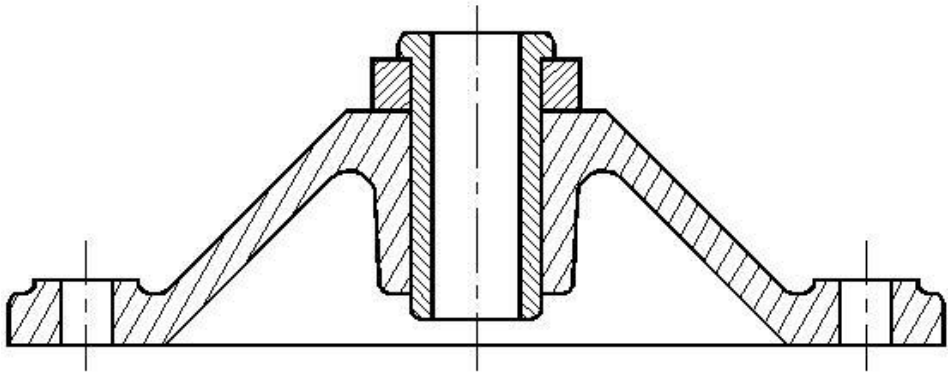
Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

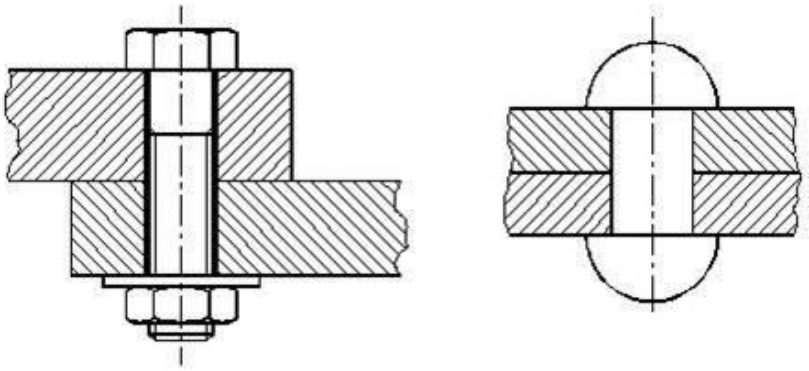
- The shape of the cross-section of a bar, arm, spoke, or other elongated object may be shown by means of a revolved section
- Another way to represent the sections, specially for those objects whose section changes, like a propeller, is to represent the section at several cutting planes



Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

- Representing assemblies
  - Each part has a different hatch (angle or direction)
  - Connecting elements like bolts, rivets or shafts are not sectioned;

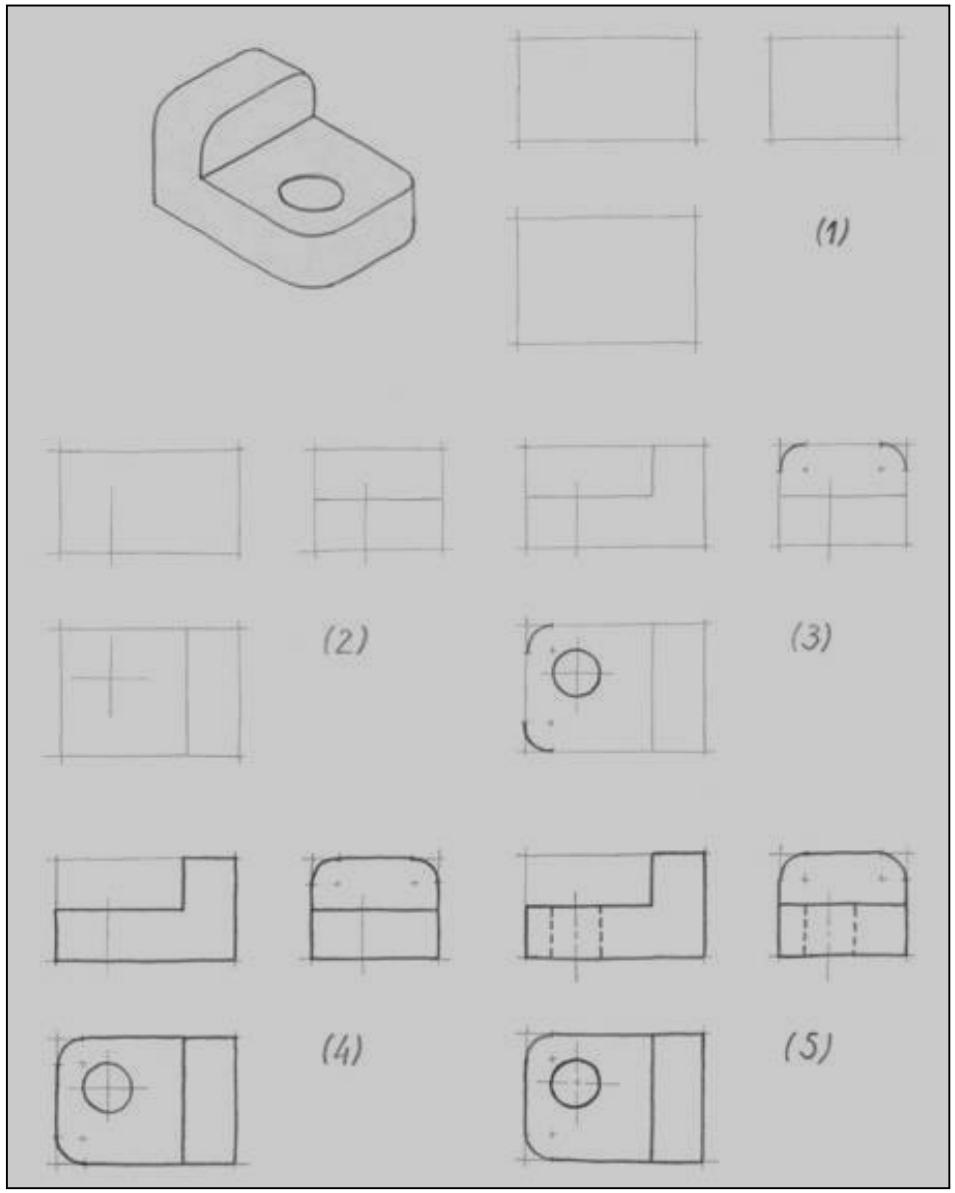




Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

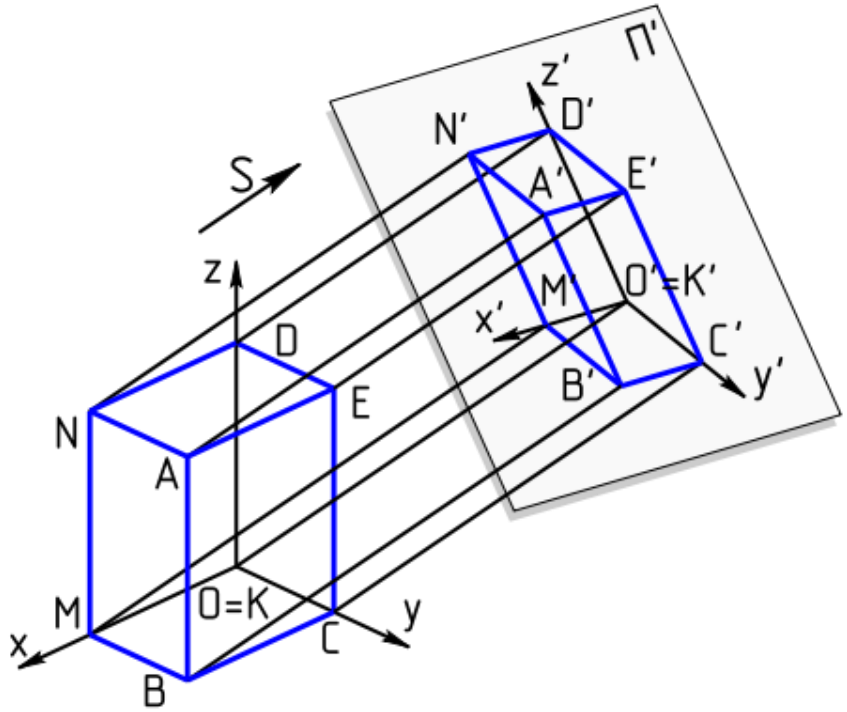
A sketch is a simple rough drawing that is made rapidly. I general sketches are used to transmit ideas and are represented using multiview projections

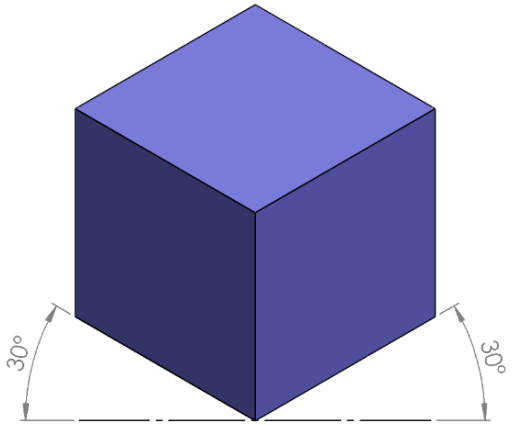
- First determine what views are necessary
- Block in the views with light construction lines, making sure that all views are aligned and that proportions are right
- Detail views
- Remove all extra construction lines with a rubber
- Repair drawing darken the contour lines and drawing hidden and centre lines
- Complete the drawing by adding notes, dimensions, etc...



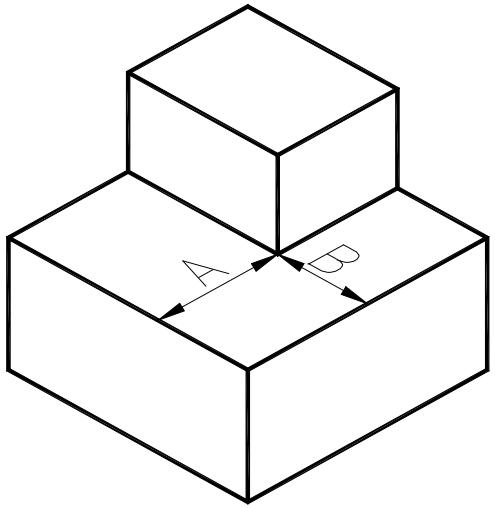
Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

- Isometric view is frequently used to represent three-dimensional objects in two dimensions in technical and engineering drawings
- The three coordinate axes appear equally foreshortened and the angle between them is 120 degrees, becoming 30° with horizontal

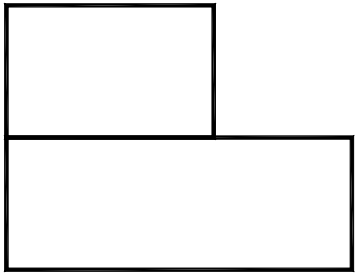




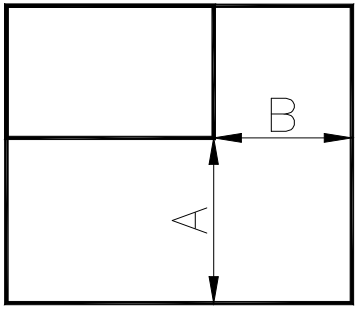
- In the simplified representation of an object view all the dimensions are proportional to the real size.



Isometric view



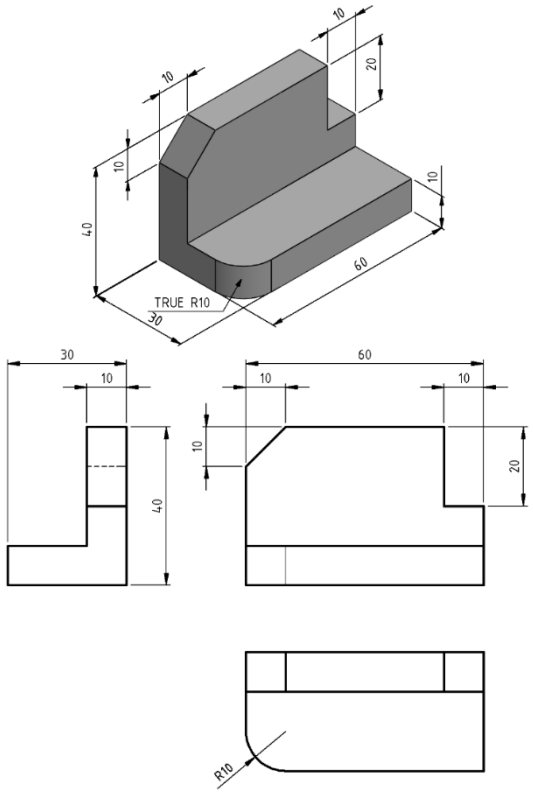
Front view

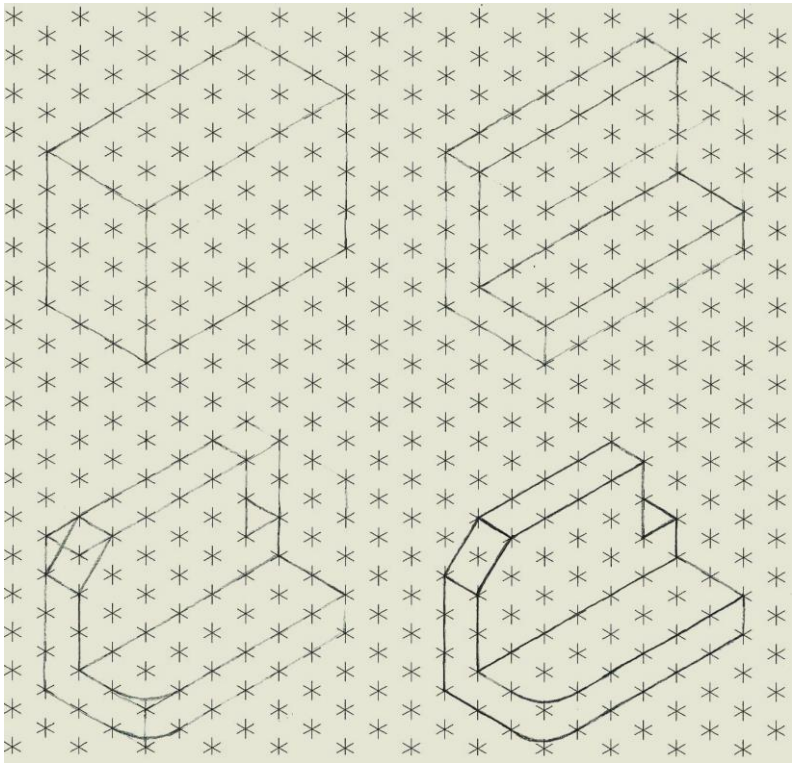


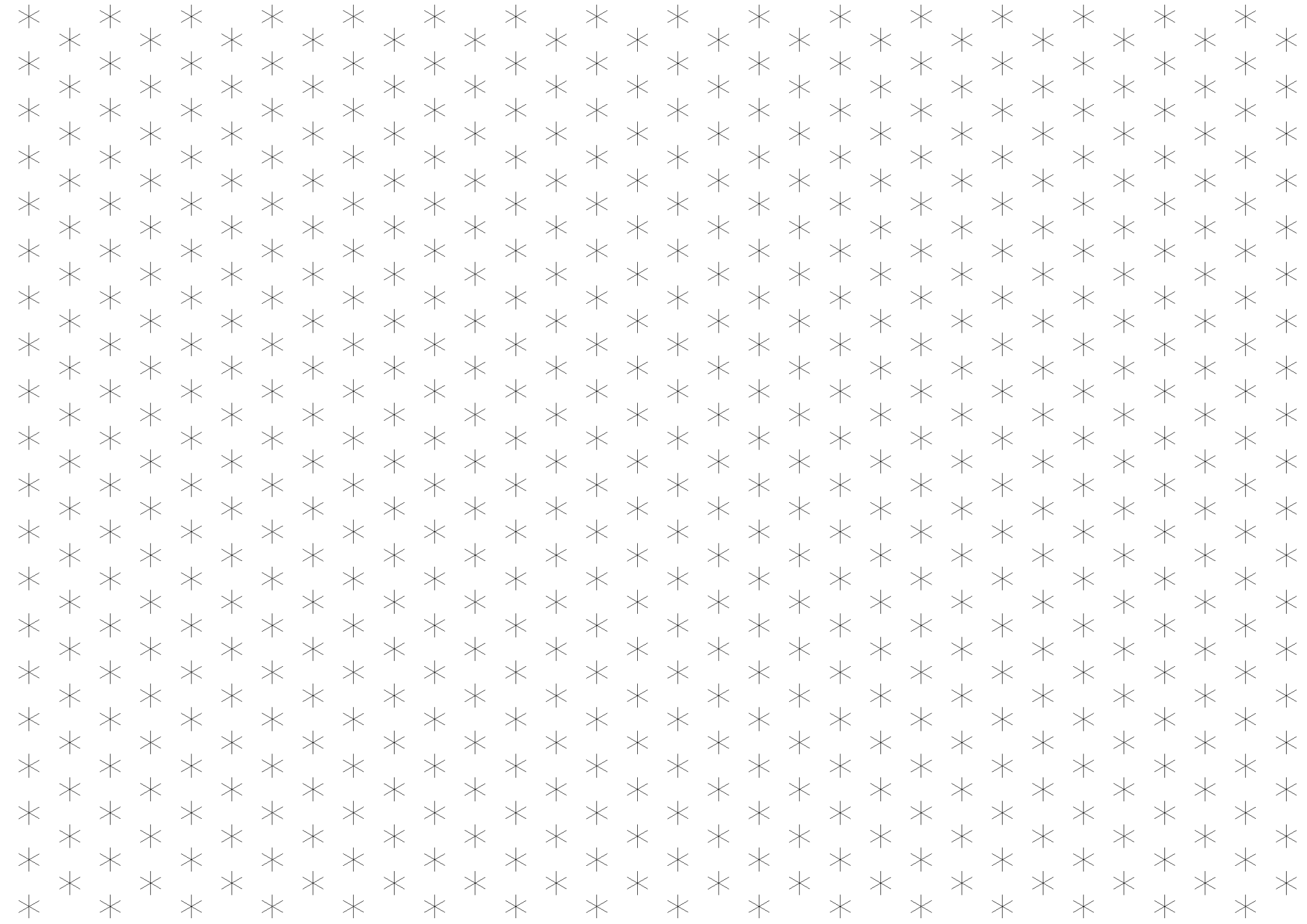
Top view

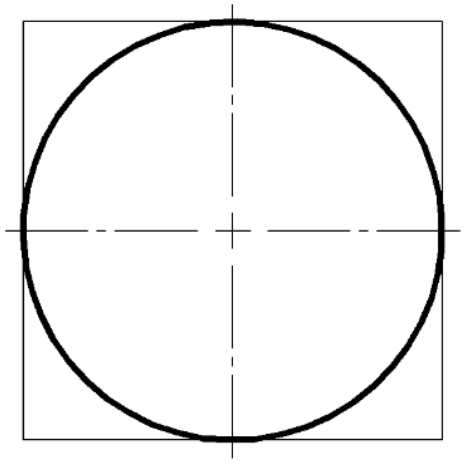
Silva, A., Dias, J., Sousa, L., Ribeiro, C.T., "Desenho Técnico Moderno", Lidel, 2004.

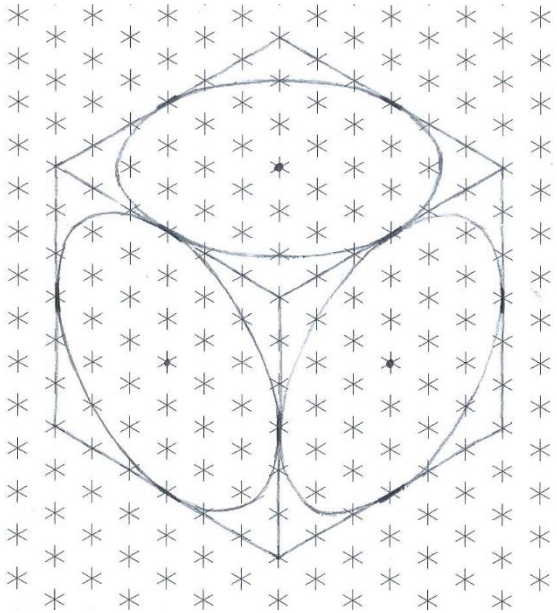
- It is recommended to use paper with an isometric grid (next slide)
- Draw the boundary box that involves the part. It is important to ensure proportions
- Detail the part according to the views
- Remove all extra construction lines with a rubber
- Repair drawing darken the contour lines and drawing hidden and centre lines
- Complete the drawing by adding notes, dimensions, etc...





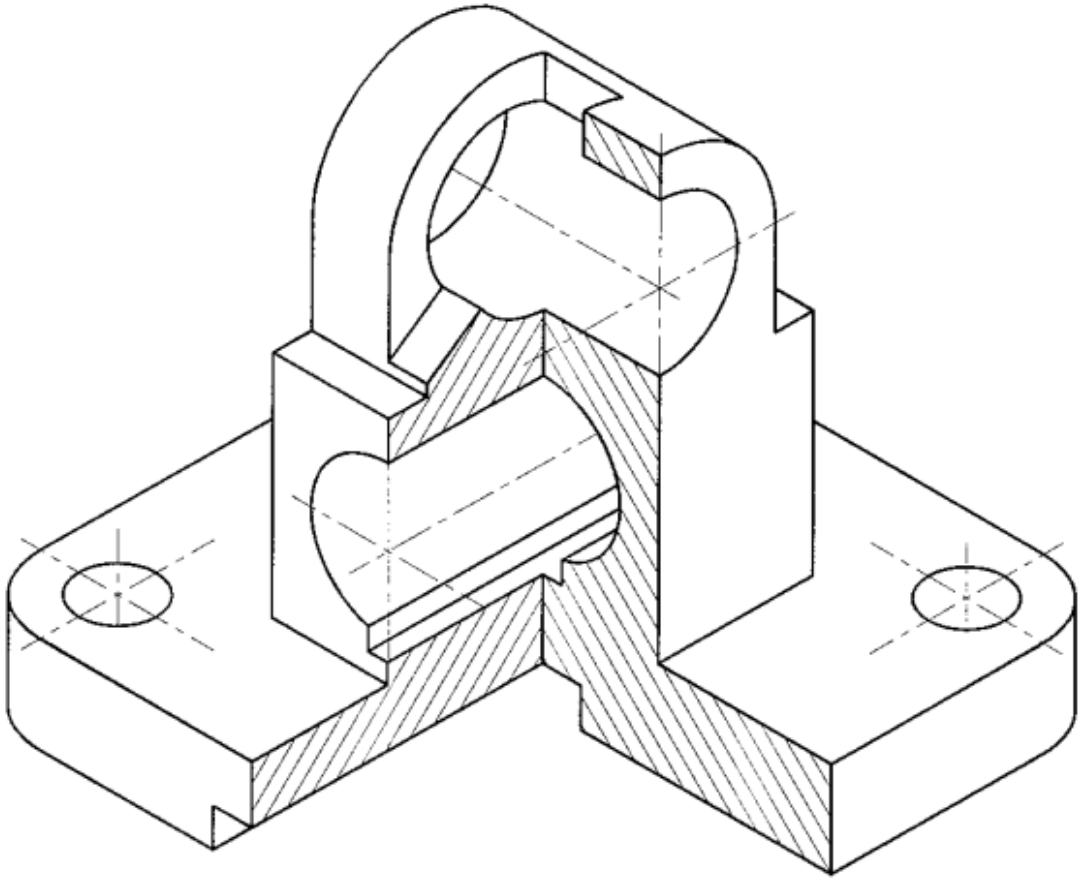


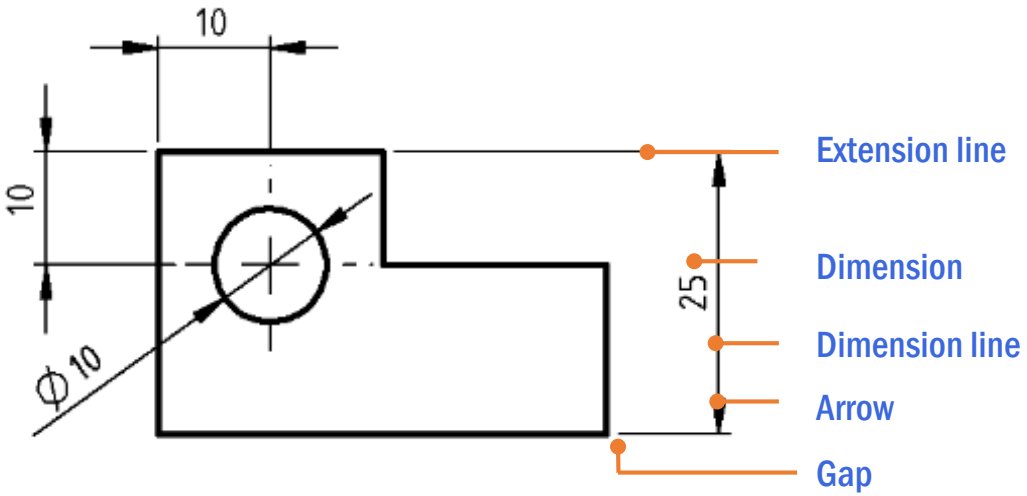




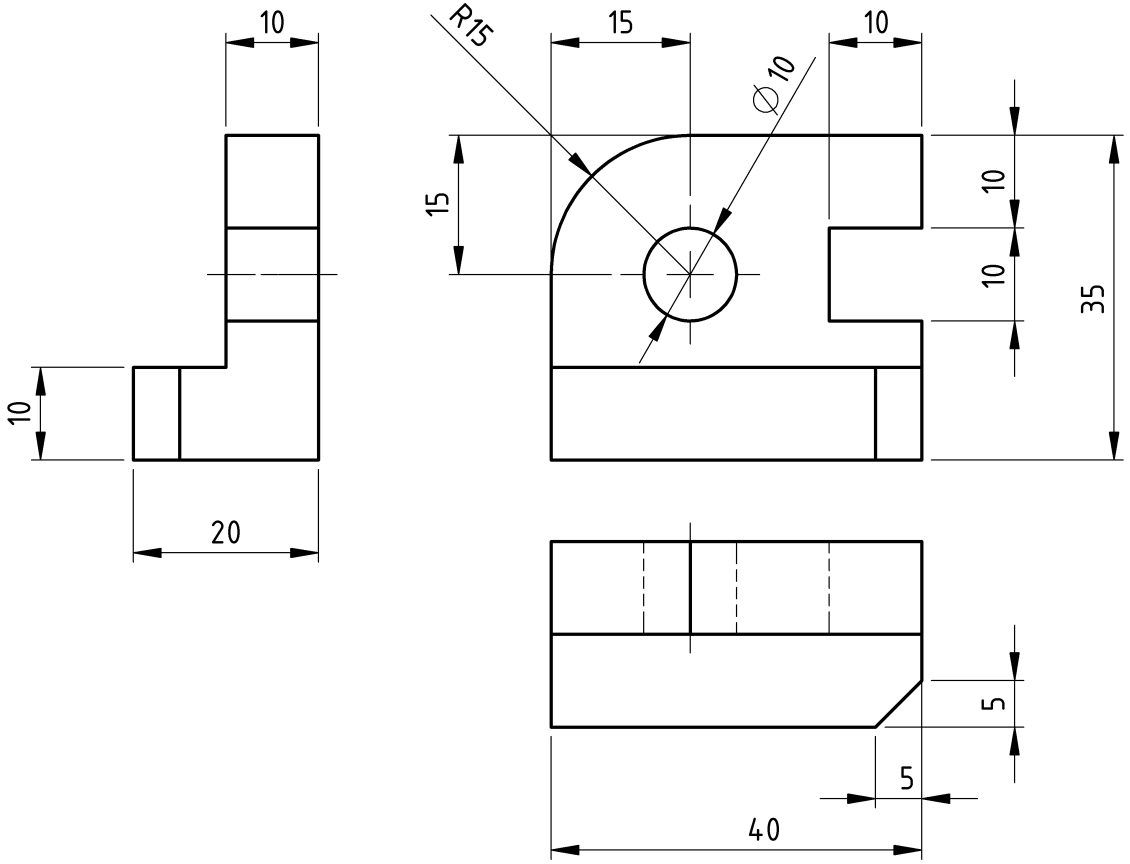
- Draw the square that involves the circle (in isometric space becomes a lozenge)
- Get at least the four tangencies with the intersection between the centre line and the lozenge
- Join the tangencies to form the circle in the isometric space

- In general invisible lines are not represented in isometric views
- Sections are not usual but can be used to show interior features. The hatching in perpendicular planes is drawn in opposite directions

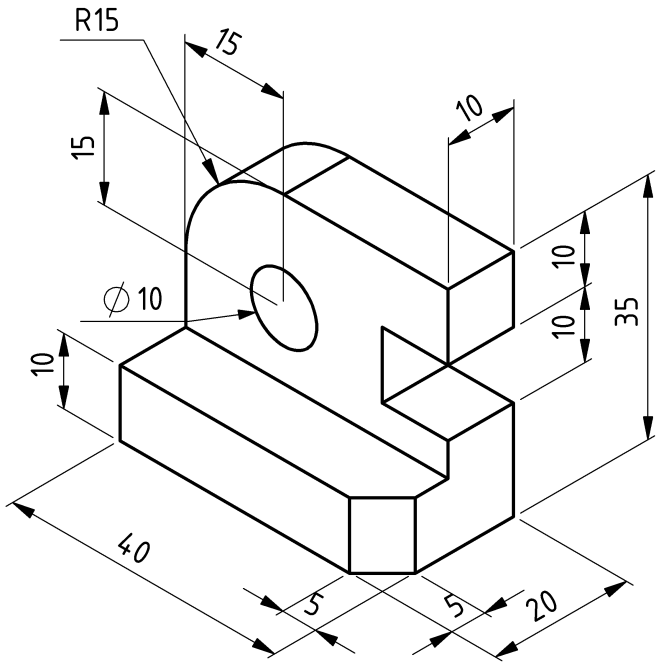




- Apart from geometric representation is necessary to provide all the dimensions of a part
- ISO 129 establishes the general principles of dimensioning applicable for all types of technical drawings
  - Mechanical drawings has dimensions in (mm) or (inches) giving the real size. In Europe is common (mm).
  - Each element must have a dimension and unique
  - Dimensions should be positioned clearly
  - Position all elements, preferably by their centre lines
  - Circles are dimensioned with the ϕ symbol
  - Avoid putting dimensions inside the view or crossing dimension lines
  - In this style shown, dimensions are above the dimension line

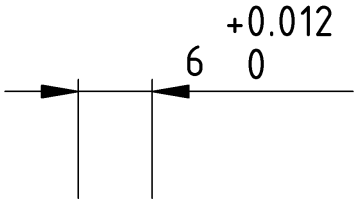


Multiview

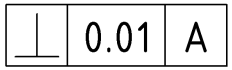


Isometric view

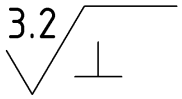
- The multiview representation is the system used to technically represent the exact size and shape of a part
  - The example above represents a piston of an engine
    - 3 views are enough to represent unequivocally the piston
      - front, bottom and left side
        - Left side is a section of the front, which includes a detail
    - Isometric view in the top right corner is presented as indicative
  - This drawing includes several symbols for dimensional and geometric tolerancing and surface finishing.



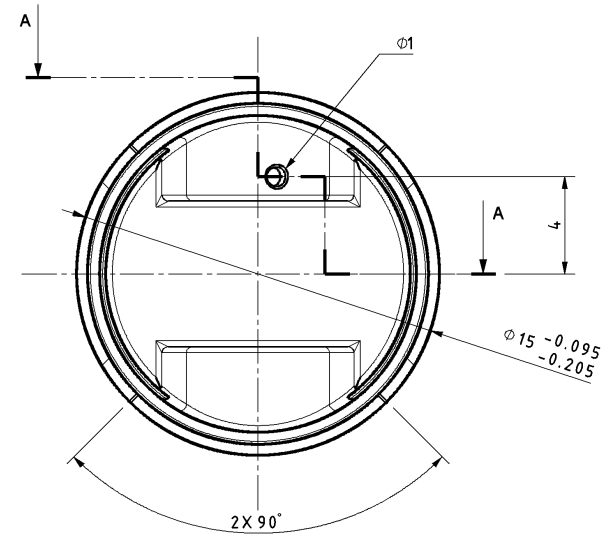
This dimension can become between 6.000 mm and 6.012mm

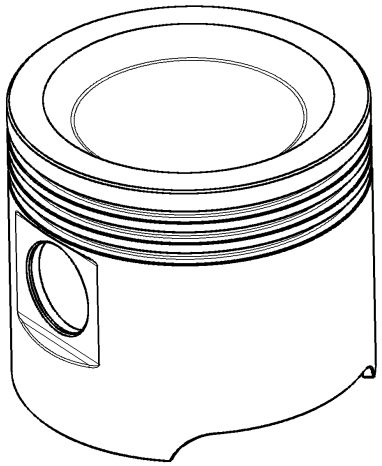


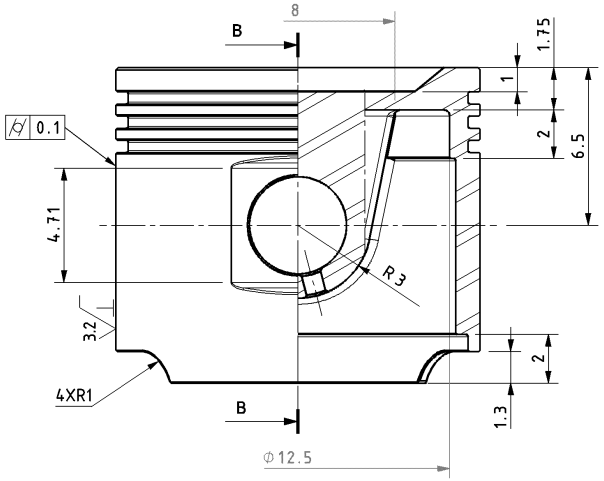
Axis must be perpendicular to reference A with maximum deviation of 0.01 mm



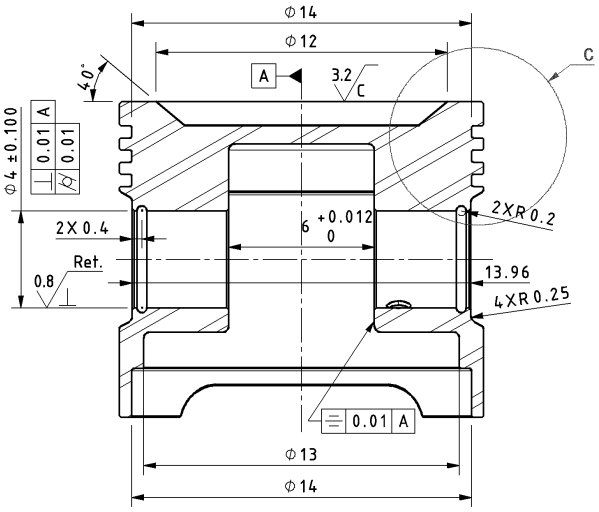
Roughness below 12μm perpendicular to surface



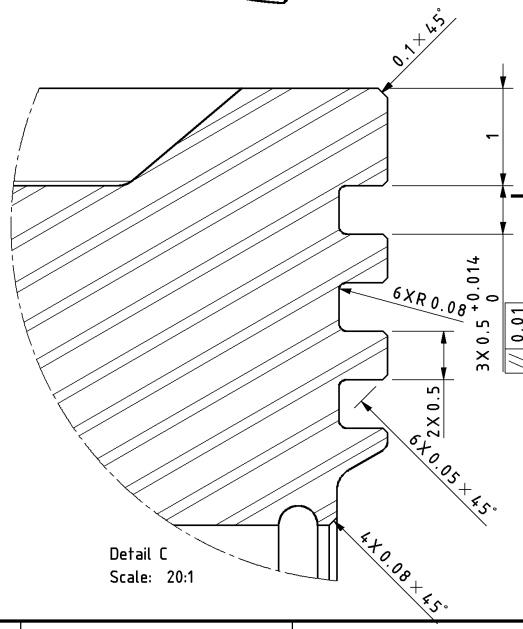




SectionA-A
Scale: 5:1



Section B-B
Scale: 5:1



Detail C
Scale: 20:1

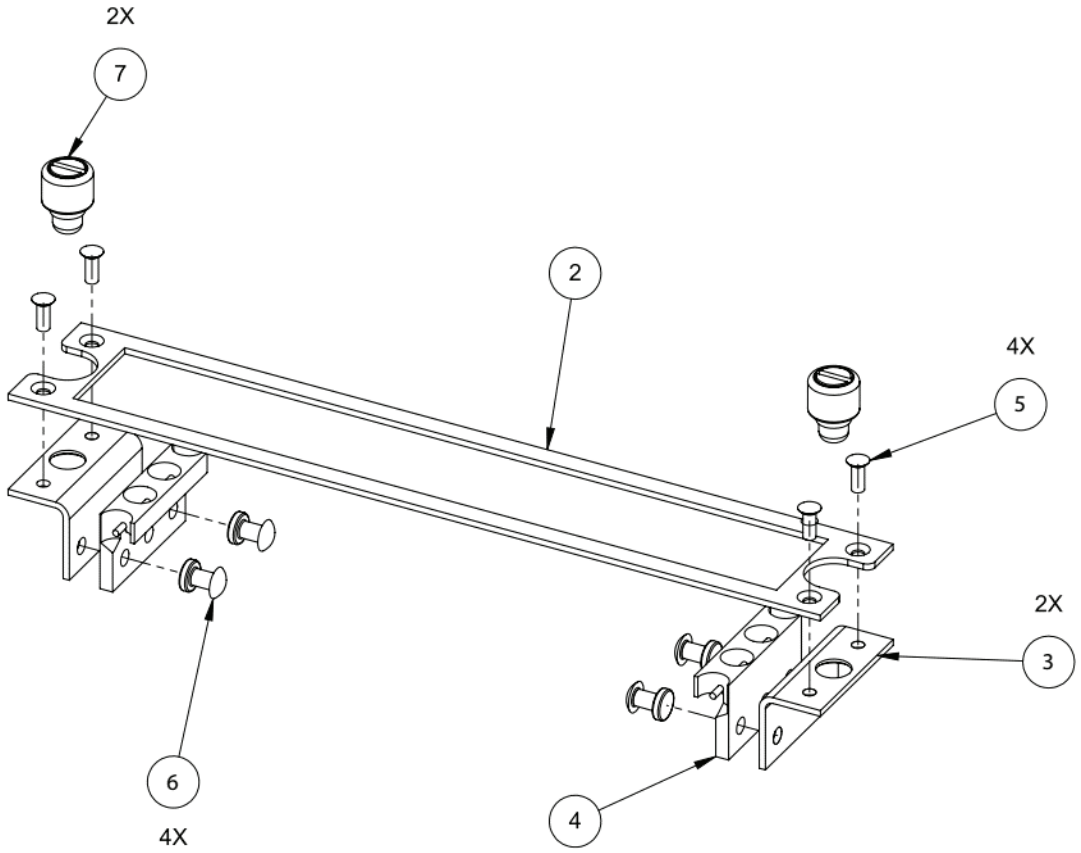
Note: Fillets with R0.25 otherwise specified

12.5

Proj.			Learn & Fly
Des.			
Copiou			
Ver.			
Scale 5:1	Piston 0006C		Example Drawing
Tol. ISO 2768 f-H			Des. nº: 6
			Substitui:
			Substituido por:

0000C-A3b Rev01

- An isometric exploded view contains information how to assembly parts and in general includes a bill of materials
- Most of these drawings can be also found in maintenance manuals



Aviation Maintenance Technician Handbook – General,: FAA-H-8083-30A, 2018

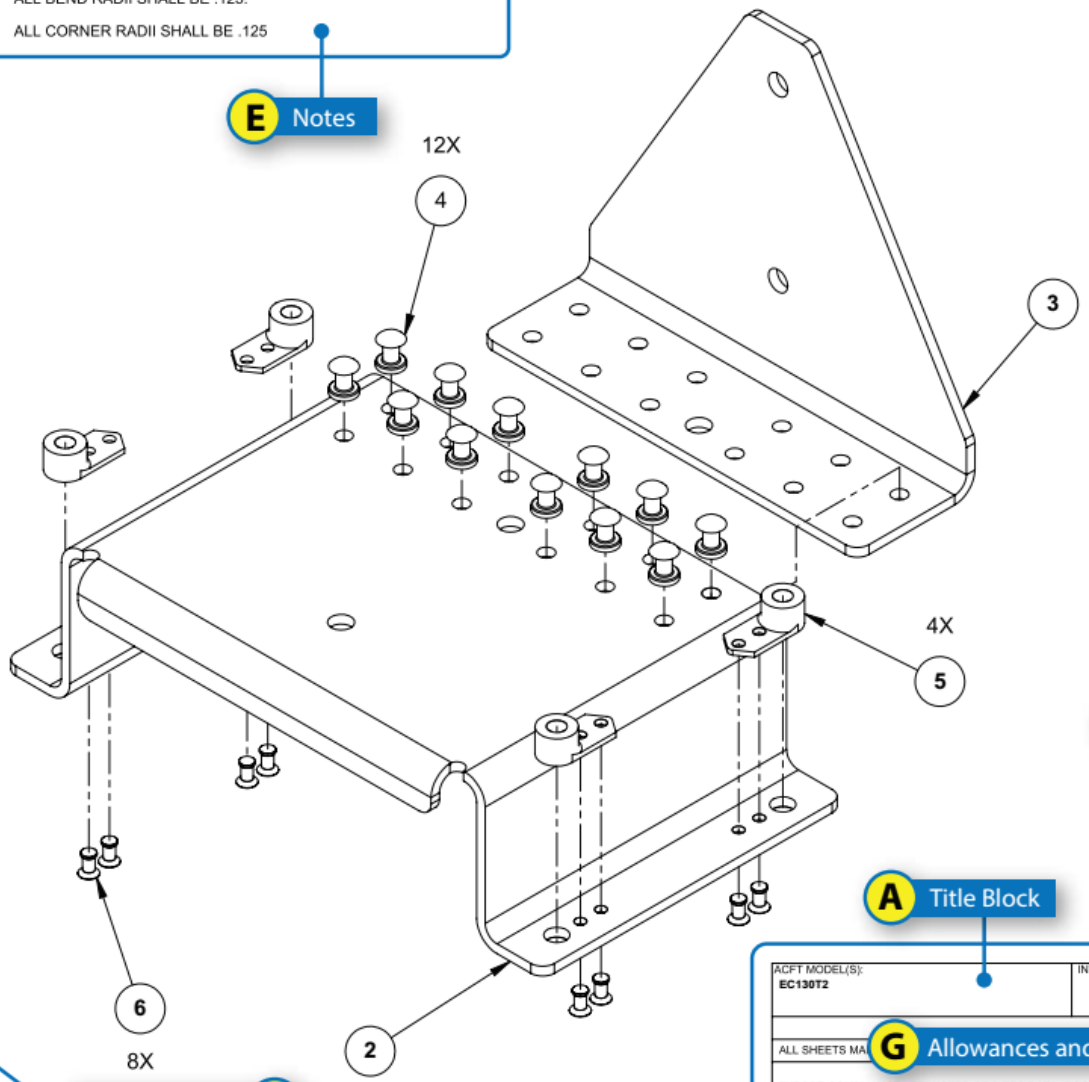
NOTES: UNLESS OTHERWISE SPECIFIED

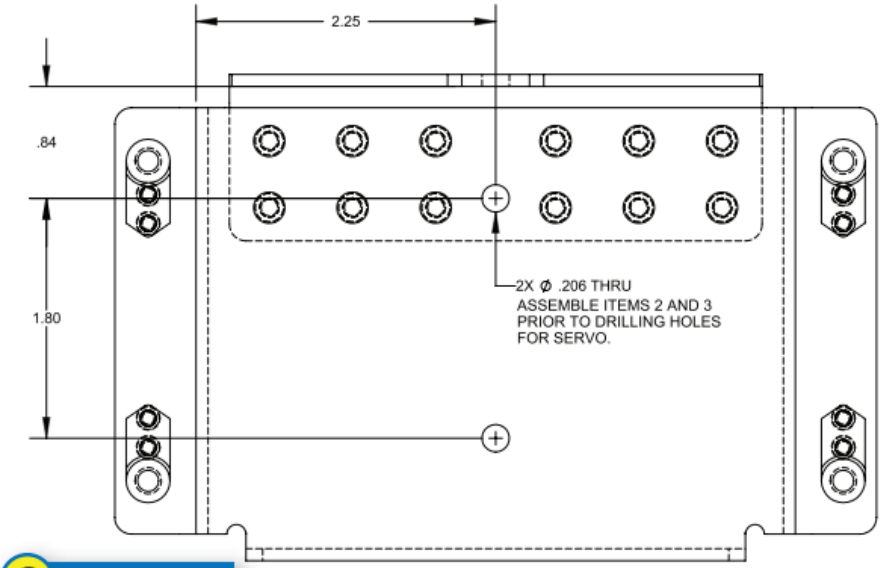
1. FINISH: CHEM FILM PER MIL-DTL-5541, TYPE I, CLASS 1A.
2. PART WILL BE MARKED IAW S-TEC SOP 3.0-03.
3. MARK PART NUMBER AND REVISION LETTER IN CONTRASTING COLOR CHARACTERS.
4. ALL BEND RADII SHALL BE .125.
5. ALL CORNER RADII SHALL BE .125

E Notes

D Revision Block

REVISIONS			
REV.	DESCRIPTION	CHECKED	DATE
-	RELEASED PER ECO 22225	J. WHITE	6-11-14
A	REVISED PER ECO 22276	J. WHITE	7-21-14





C Bill of Materials

QTY	ITEM	PART NUMBER	DESCRIPTION	S-TEC / MATL	ALT PN / SPEC	VENDOR / MFG
8	6	1605-3-4	RIVET, SOLID, CSK 100D, PRECISION HD, ALUM		MS20426AD3-4	S-TEC
4	5	1470	NUT, ANCHOR, ONE LUG, 10-32		MS21071L3	S-TEC
12	4	1624	RIVET, CHERRYMAX		NAS9304B-4-03	S-TEC
1	3	-03	BRACKET, ROLL SERVO	6061-T6, .090 THK	AMS-QQ-A-250/11	S-TEC
1	2	-02	BRACKET, ROLL SERVO	6061-T6, .090 THK	AMS-QQ-A-250/11	S-TEC
	1	-01	BRACKET ASSY., ROLL SERVO			S-TEC
-01			BILL OF MATERIALS			

A Title Block

G Allowances and Tolerance

F Zone Numbers

H Scale

B Drawing Number

ACFT MODEL(S): EC130T2

INT. NEXT ASSY:

THIRD ANGLE PROJECTION

ALL SHEETS MA

TOLERANCES (UNLESS OTHERWISE SPECIFIED)
HOLE: +.006 -.001
DECIMAL: .XXX: ±.010
DECIMAL: .XX: ±.03
DECIMAL: .X: ±.1
ANGLES: ±1°
SURFACE ROUGHNESS: 125

DRAWN C. WHITWORTH 5/21/14
ENGINEER C. WHITWORTH 5/21/14
APPROVED S. JOSEPH 6/11/14

S-TEC Corporation One S-TEC Way

TITLE: BRACKET ASSY., ROLL SERVO

DIMENSIONING AND TOLERANCING SHALL BE IAW ASME Y14.5M-1994.

UNLESS OTHERWISE SPECIFIED [illegible] IN INCHES, [illegible] BRACKETS.

DIMENSIONAL LIMITS APPLY AFTER FINISH/PLATING.

EXPORT COMPLIANCE: TRANSFER OF S-TEC DATA (DOCUMENTS, SOFTWARE, DRAWINGS, SPECS, ETC) BY ANY MEANS TO A FOREIGN PERSON OR ENTITY, WHETHER IN THE UNITED STATES OR ABROAD, MAY REQUIRE U.S. GOVERNMENT AUTHORIZATION.

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REMOVE ALL BURRS, BREAK SHARP EDGES R.015 MAX. INSIDE CORNER RADII .015 MAX.

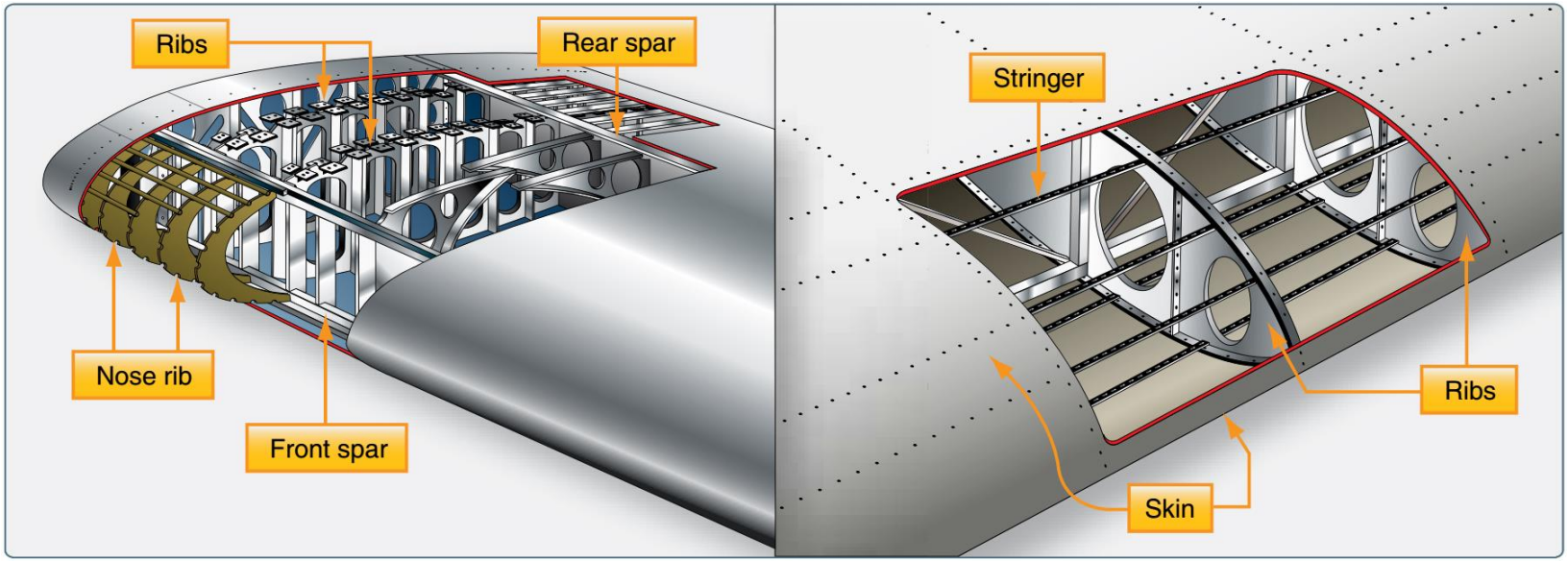
SIZE	CAGE CODE	Drawing No.:
B	NA	603234

SCALE: 1:1 | DO NOT SCALE DRAWING | SHEET 1 OF 3

FORM (SWorks) 86359 REV

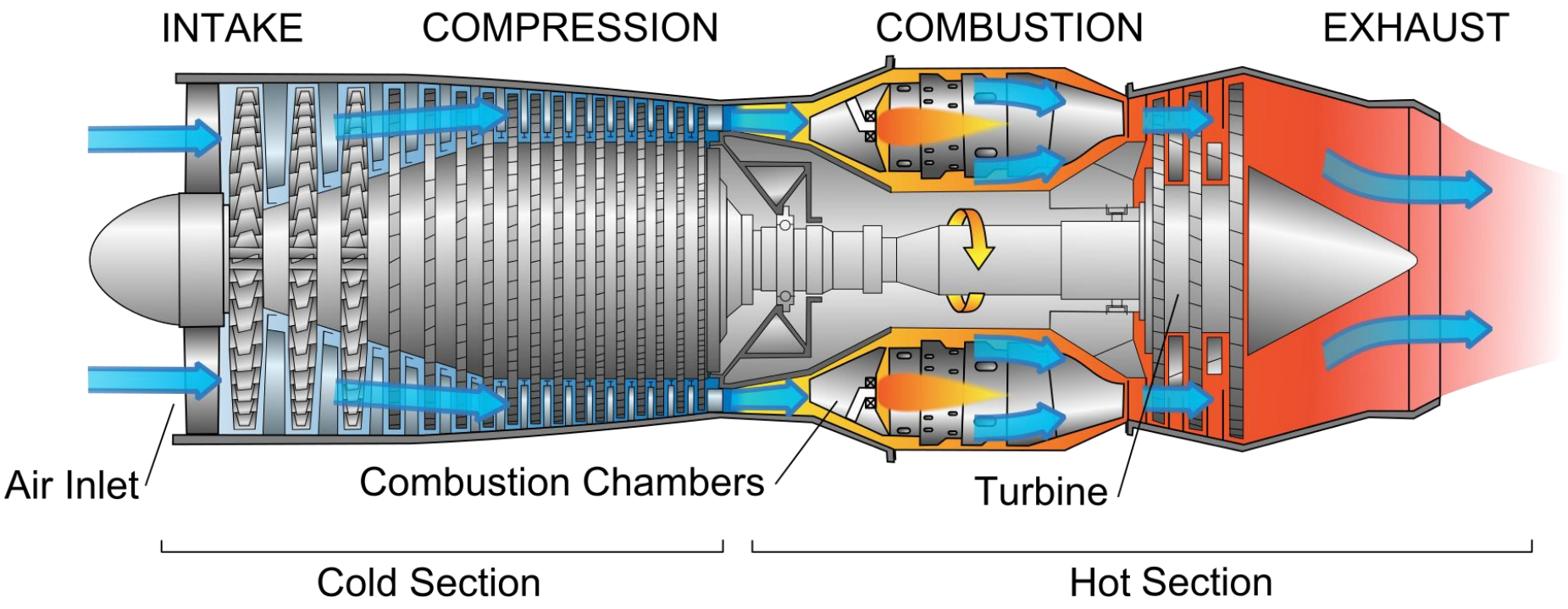
Pictorial drawings are used mostly for demonstration purposes or to produce manuals (maintenance, parts catalog, etc...)

In general these are represented in perspective, isometric or exploded view



Aviation Maintenance Technician Handbook – General,: FAA-H-8083-30A, 2018

Section of a gas turbine engine commonly used in military aircrafts



Today, most of the Computer Aided Design systems (CAD) are able to provide support to the whole product development. This includes, concept, preliminary design, ergonomics studies, details and calculations, generation of 3-D models and detailed drawings, as well as interfacing with analysis, marketing, manufacturing, quality control and end-user

From aerospace, shipbuilding, automotive to electronics, CAD is used everywhere in all industries. CAD encourages creativity and speeds up productivity, it is becoming more and more useful as an important tool validate products before production and to manage all the development

Co-funded by the
Erasmus+ Programme
of the European Union

2D CAD

this is the pioneer of CAD software, developed in the early 70s, in which parts were modeled in a 2D environment similar to what designers used to do in a drawing table. One of the most well known and common software is AutoCAD from Autodesk.

3D CAD

Wire-frame models

this was beginning of 3D CAD models when computer performance was a problem. The structure was modeled as a skeleton with lines and arcs in a 3D environment

Surface models

this is a evolution to wire-frame models in which lines and arc were replaced by complex surfaces. Nowadays surface models are still quite used as an advanced modeling technique to prepare work to generate solid models

Solid models

this is considered to be the most useful CAD model. In advanced modeling surfaces are closed or thicken to give solids, having additional properties like weight, volume and density, just like physical objects

In computer engineering there are several acronyms frequently used, some of these are:

- CAD – Computer Aided Design

  Use of computers to aid in the creation of drawings, 2D or 3D.

- CAE – Computer Aided Engineering

  Use of computers to perform engineering calculus. One of these examples is the Finite Element Method in which the geometry is divided in several small parts (mesh) to compute for example part stresses (internal forces of components)

- CAM – Computer Aided Manufacturing

  Use of computer prepare the manufacturing process of components for numeric control machines tools

- CNC – Computer Numerical Control

  Is the automated control of machining tools by means of a computer, whose instructions can be prepared by a CAM software and the geometry prepared by a CAD software

Free software

FreeCAD
Open Source parametric 3D CAD modeler

SketchUp

AUTODESK ®
TINKERCAD ®

Commercial software

(some of these are free for students or non commercial purposes)

CATIA

SolidWorks

SOLID EDGE

PLM Software
SIEMENS
NX

AUTODESK®
FUSION 360

AUTODESK®
INVENTOR®

Onshape

creo®

See you on the

Module #6

Learn & Fly

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