TVET CERTIFICATE V in MANUFACTURING WELDING

DESIGN AND COMMUNICATION GRAPHICS

WLDDG501

Perform Design and Communication Graphics

Competence

Credits: 9

Learning hours: 90

Sector: Mining and Manufacturing.

Sub-sector: Welding

Module Note Issue date: June, 2020

Purpose statement

This course presents the basic drafting skills and concepts that are needed for entry-level competencies in industrial/ technical fields. Design and communication graphics afford the trainee, the opportunities to develop skills in graphical communication, creative problem solving, and spatial visualization, design capabilities, computer graphics and CAD modeling.

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Learning Unit 1 – Analyze the DCG Work.

LO 1.1 – Identify the DCG Work.

Content/Topic 1: Introduction to DCG and Communication Graphics.

Graphic design can be described as the sphere of human activity that lies on the crossroads of several directions, first of all, visual arts, communication, and psychology. Basically, graphic designers do the job of communication to others by means of graphic (visual) elements such as images of different styles and complexity, types and fonts, pictograms, shapes and sizes, colors and shades, lines and curves, etc.

The Design and Communication Graphics (DCG) course makes a unique contribution to the student's cognitive and practical skills development. These skills include graphic communication, creative problem solving, spatial abilities/visualization, design capabilities, computer graphics and CAD modelling.

The creative and decision-making capabilities of students in the activities associated with design are developed through three principal areas of study:

- design and communication graphics,
- plane and descriptive geometries, and
- Applied graphics.

This program is designed and structured to take cognizance of important developments in the modes of communicating design information; it is intended to develop the creative thinking and problem-solving abilities of students.

Plane and descriptive geometries are central in developing an understanding of the graphical coding and decoding of information (graphics code), and in developing spatial abilities and problem-solving skills. The body of knowledge associated with the topics covered will allow students to explore a number of applications associated with design in architecture, engineering and technology generally.

An imaginative approach to problem solving is encouraged through the exploration of a variety of geometric principles and concepts. This is of particular importance when dealing with three-dimensional space in the context of descriptive geometry. This area of study will also lay the foundation for productive and creative use of computer-aided drawing and design (CAD).

B. Advantages and Disadvantages of DCG.

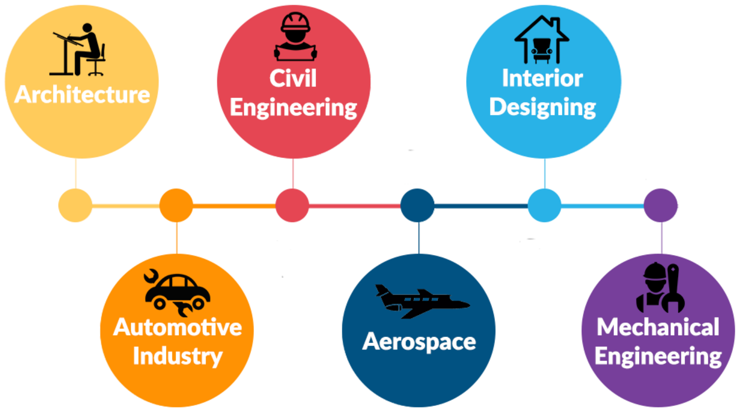
Advantages of DCG	Disadvantages of DCG
1. Easy to develop 2D &3D models quickly. 2. Less overall cost rather than building actual models.	1. Initial cost of software may be high. 2. Work can be disrupted due to a virus or a computer malfunction.

3. Designs or models can be edited quickly. 4. With training models can be made extremely realistic. 5. All measurements are available. 6. DCG Reduced storage space. 7. Corrections can be made easily. 8. Repetitive parts of the drawing can be saved and imported as part of a "DCG library." 9. DCG systems can be linked with CAM machines to produce objects straight from the drawings. 10. 3D DCG designs can be made to look realistic by using the material library for clients to see. 11. DCG designs can be easily shared between companies or department using email. 12. DCG can be used to create simulated environments to show the client.	3. Unemployment may increase as less workers are needed. 4. Workers may also need training in order to use DCG. 5. Work can be lost if the computer crashes. 6. Work could be corrupted by viruses. 7. Work could be stolen or hacked. 8. Time taken to learn how to use the software is too much. 9. Initial costs of buying a computers system are high. 10. Time and cost of training staff. 11. Continual need for updating software or operating systems. 12. DCG/CAM systems mean less people need to be employed.

C. Application of DCG.

DCG software's are used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing to produce very accurate designs.

- DCG is widely used in the area of engineering.
- Is important in chips building, aerospace industries, automotive industries, textiles industries and architectural industries.
- It is used for manufacturing, planning, computer aided analysis.
- It also helps in purchasing, manufacturing, planning and several other activities.



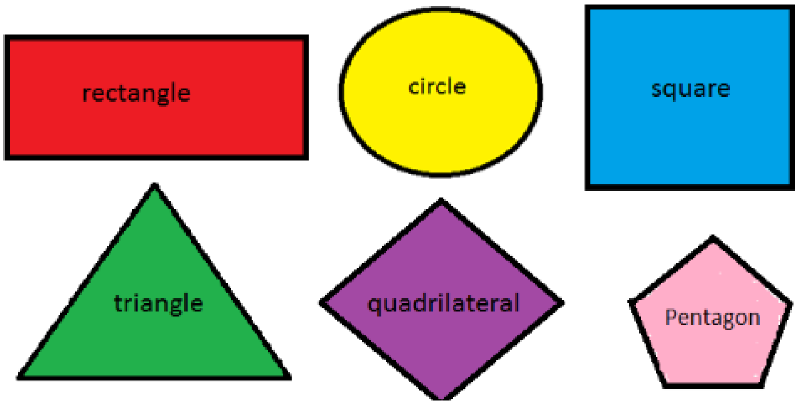
Content/Topic 2: Introduction to 2D and 3D.

The objects around us comes in various shapes and sizes. In general, we can see shapes such as triangles, squares, and circles everywhere around us. Shapes such as a sheet of paper, have only length and breadth. Thus, such shapes are 2D (two-dimensional). While other shapes such as the shape of a machine, have length, breadth, and height. Thus, such shapes are 3D (three-dimensional). Let us learn more about 2D and 3D shapes,

- **2D shapes**

In geometry, a shape or a figure that has a length and a breadth is a 2D shape. In other words, a plane object that has only length and breadth is two-dimensional. Straight or curved lines make up the sides of this shape. In addition, these figures can have any number of sides. In general, plane figures made of lines are known as polygons. For example, triangle and square are polygons.

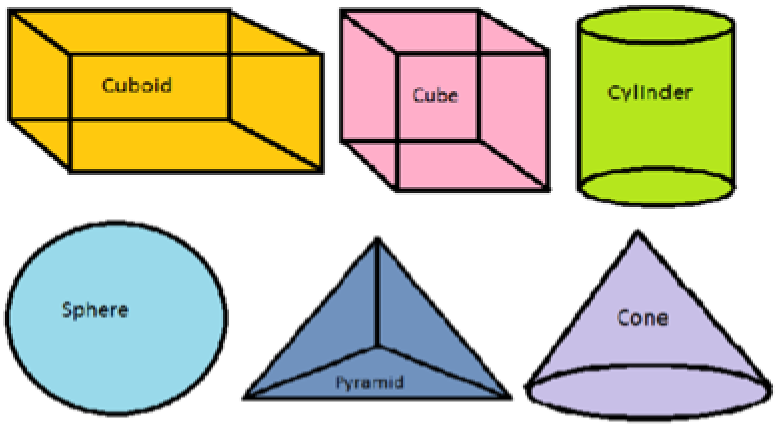
Rectangle, circle, square, triangle, quadrilateral and pentagon are some examples of 2D shapes.



- **3D Shapes**

In our day to day life, we see several objects around us which have different shapes. For example, books, ball, ice-cream cone etc. One thing common in these objects is that they all have some length, breadth and height or depth. Thus, they have three dimensions and so are known as 3D shapes. The D in 3D stands for dimensional. 3D shapes occupy space. In a world with three dimensions, you can travel forward, backward, right, left, and even up and down.

Cuboid, cube, cylinder, sphere, pyramid and cone are a few examples of 3D shapes



LO 1.2 – Select CAD Software.

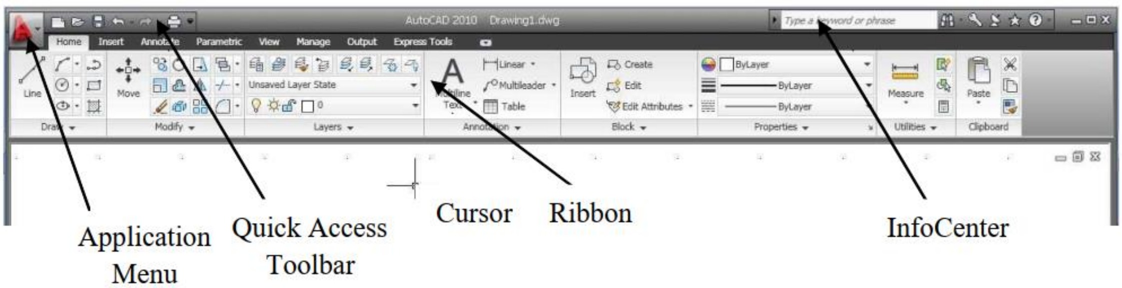
Content/Topic 1: Overview of CAD Software.

The software you should use when designing something to be 3D printed is entirely dependent on what you are trying to make, when shopping CAD software, a few features and tools stand out as key indicators of good software. During our research, we found that tools like a command line and the house wizard were included with the best CAD software. They also often had comprehensive video tutorials and a few others. tools that helped make them more useful.

A. **Autodesk:** is an American multinational software corporation that makes software services for the architecture, engineering, construction, manufacturing, media, education and entertainment industries.

B. **Auto CAD:** AutoCAD software from Autodesk was one of the first CAD software to be released on the market in 1982, making it a very established CAD software across industries.

   It is a mid-level CAD program that is easy for beginners to learn, and it doesn't cost as much as similar products. It offers 2D and 3D drawing tools and allows you to add annotations, hatching and lighting effects to your designs.



a) **Solidworks:** SolidWorks is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs on Microsoft Windows. SolidWorks is published by Dassault Systems.

Content/Topic 2: Domain of application.

A. Application of CAD Software in Construction.

There are programs designed especially for 3D modeling, or 2D drawings, but the features to accomplish both will be included with the best software.

- Architectural design requires a house wizard, and a wall tool to perform some of the work for the user.
- One of the big pieces of technology in the civil engineering field today is computer aided drafting.
- Computer aided drafting is widely used in the civil engineering field because of its ability to plan sites a lot easier then hand drawings, it can help design a lot of engineering supplies, and is constantly upgrading. Computer aided drafting makes this process faster and easier.
- It can also lay out sites, roads, sidewalks, bridges and other engineering items. There are constant upgrades to computer aided drafting being made every year to improve the system and help civil engineers.
- CAD Drawing Compared to Hand drawing in the world of construction, material, labor, equipment, time and money are some of the most important factors. A speedy well-planned site could decrease the construction cost drastically.

  Civil engineers actually have their own civil computer aided drafting program called Civil AutoCAD. With this tool, an engineer would be able to design their entire site, including access roads, car entrances, site boundaries, and contour lines (lines that connect to points of the same height below or above sea level).

B. Application of CAD Software in Mechanical: There are many applications of CAD software in mechanical engineering such us:

- Designing parts and assemblies,
- Arranging equipment in a plant,
- Creating renderings and animations of machines,
- Analyzing stress and fluid flow and much more.

AutoCAD is an old and long-established CAD application, and probably has the existing drawing files of any. It is very flexible and used in lots of different ways, not just mechanical design. However, in mechanical engineering, designing parts and assemblies is usually done in 3D CAD modeling software. AutoCAD can work well in 3D, but it’s not the best around. Parametric modelers like SolidWorks or Inventor are more modern and sophisticated, with features like assembly constraints, sheet metal, animation and content libraries.

C. Application of CAD Software in Electrical & Electronics.

In industrial contexts,

- All wires and terminals need to be individually numbered. A feature I am aware of is that AutoCAD Electrical can automatically track wire numbers (ferrule numbers) and terminal numbers, making sure these numbers are all unique and sequential.
- I would have really appreciated this on the last electrical design job I did, where we numbered all the wires and terminals by hand, with frequent mistakes.
  We have just moved across to using AutoCAD Electrical for our electrical drawings from using standard AutoCAD. The electrical component does not help much for editing the existing drawings, however when a new installation comes up. AutoCAD electrical will allow us to keep track of wire numbers, help with equipment layouts and the like.

Content /Topic3: Capabilities of CAD Software.

A. **Designing: ''**Genouvrier'' said that no need to switch from one platform to another one; a single intuitive environment provides CAD and simulation to users. The CAD and simulation applications are using the same design data for an efficient engineering workflow and making sure all users use the right data, with a single source of truth."

B. **Simulation:** Simulation is a design analysis application fully integrated with DCG Software. It provides a one-screen solution for stress analysis and enables you to solve large problems quickly using your personal computer.

   Computer-aided engineering (CAE) tools have the power to take the gut feel and rules of thumb out of the engineering world. The old guard shouting, "This is the way we always did it," will not cut it in today's market.
   Customers want cheaper, lighter, faster and stronger products that work the first time. Oh, and while you are at it, those products must look cool, too.
   To meet these demands, engineers must bring simulation early into the development cycle to drive innovation.To that end, tools like simulation in-CAD(computer-aided design) and engineering design platforms make it easier for designers and design engineers to quickly check their work and make informed decisions about how their innovative ideas will affect product performance.

C. **Program generation (G Codes):** G-code is a programming language for computer numerical controlled (CNC) machines. CNC machinists use G&M codes to:
   - Instruct CNC machines where and how to move along Cartesian coordinate (x, y and z-axis).
   - Dictates which direction the machine should move in.
   - How fast it should move.
   - How deep it should cut.

To begin with, an initial block of material will be loaded into the machine. Then, following the instructions given by the G-code, the cutting tool cuts away material from the block to produce the finished product.

G-code is one of the most widely used programming languages used to control automated machine tools. Most CNC machines execute G-code, CNC machinists can either write G-code from scratch, modify existing G-code, or generate G-code using CAM software. CAM software can generate G-code from either images or CAD files. In today's extensive CAD industry, there are also CAD editing programs that automatically convert CAD files into G-code. There are also richly featured G-code editors that can be used to simulate G-code, or to translate G-code into conversational CNC.

D. Design analysis

To choose software for a computer aided road design in order to save time and money for the company. What complex design tasks could be solved by which software products? Currently, a set of simple base functions has already ceased being the programming solution to successfully shorten a design time, improve design quality and achieve better results.

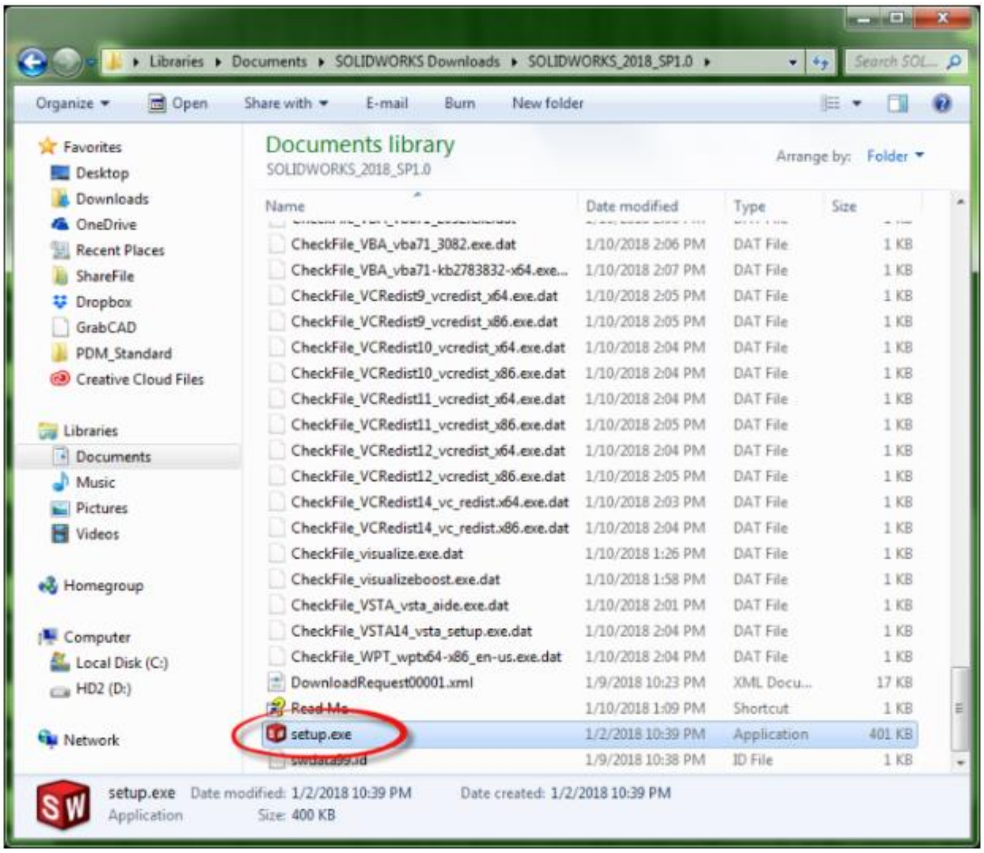
A rising key factor is the functional abilities of computer aided design tools, their correlation and integration with other subprograms, and a possibility for the designers to work together at the project in any computer network. This article analyzes the models and their abilities of the three software products most popular in the world. The analysis and the given comparison help to answer the questions raised by the designers.

LO 1.3 – Configure Software.

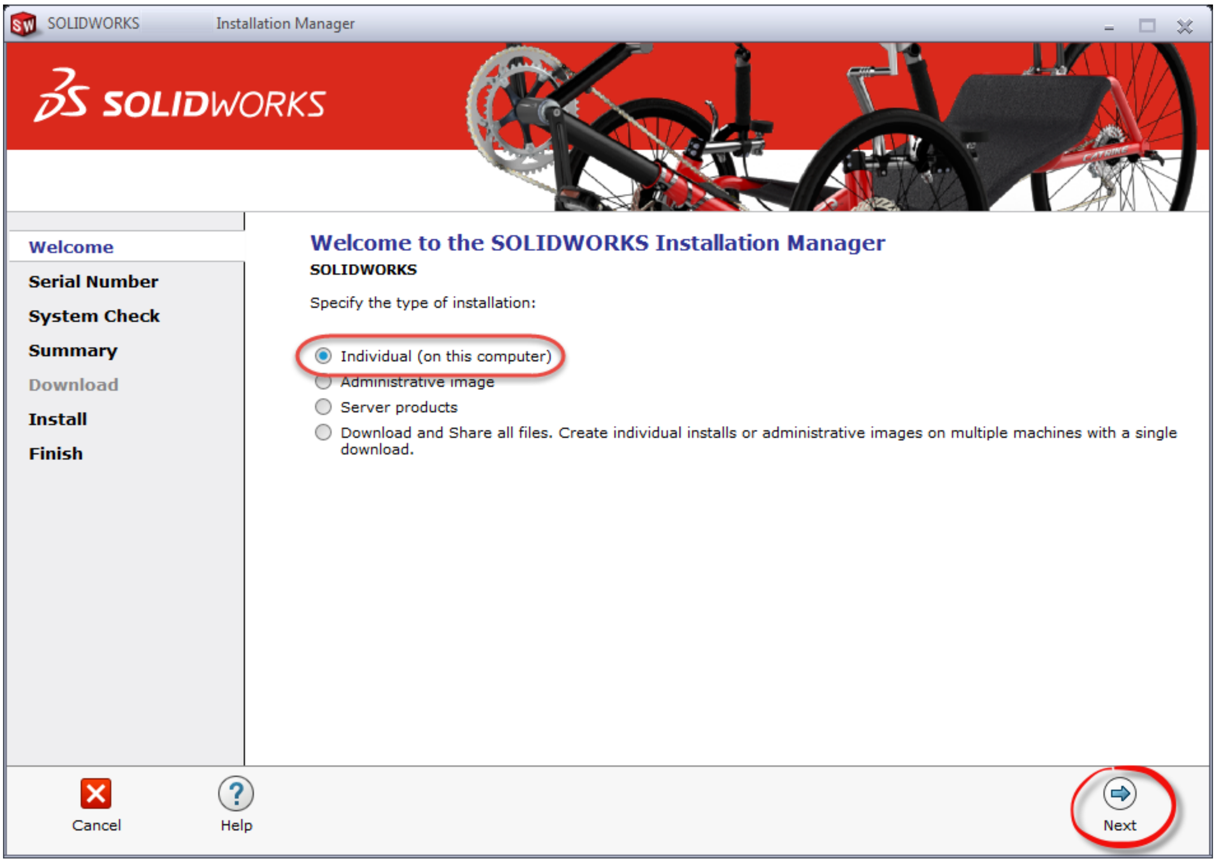
Content/Topic 1: Installation of Solid works software.

This document is a step-by-step guide covering how to install SOLIDWORKS on a local machine. Before beginning the download and installation process, make sure the computer you are planning to install SOLIDWORKS onto meets the minimum system requirements, and make sure you have a CD Software, or download it from different websites. The following are the steps to be followed when installing it,

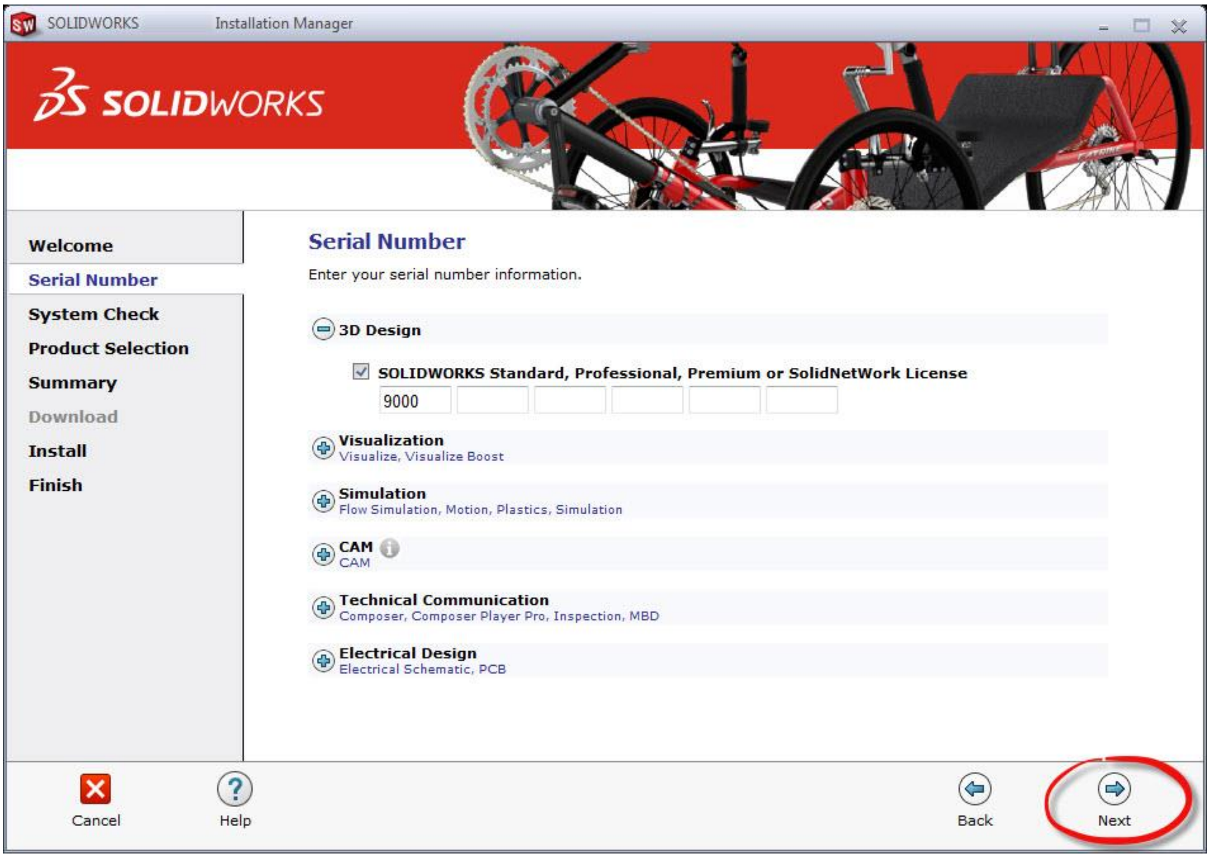
i. **Extracted Solidworks folder.**



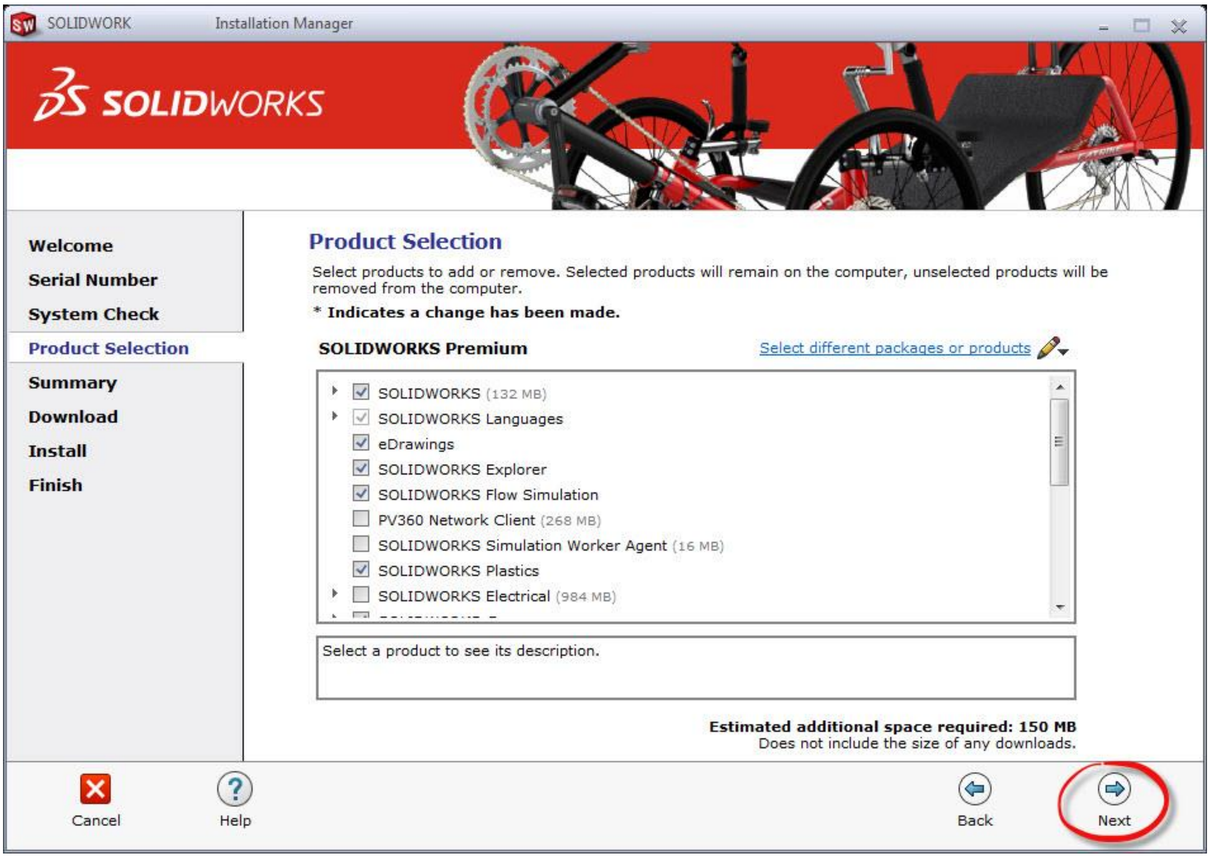
- Right-mouse click setup.exe and select “Run as Administrator”. (launches Installation Manager).
- In the Solid works, Installation Manager select “Individual installation” and click next.



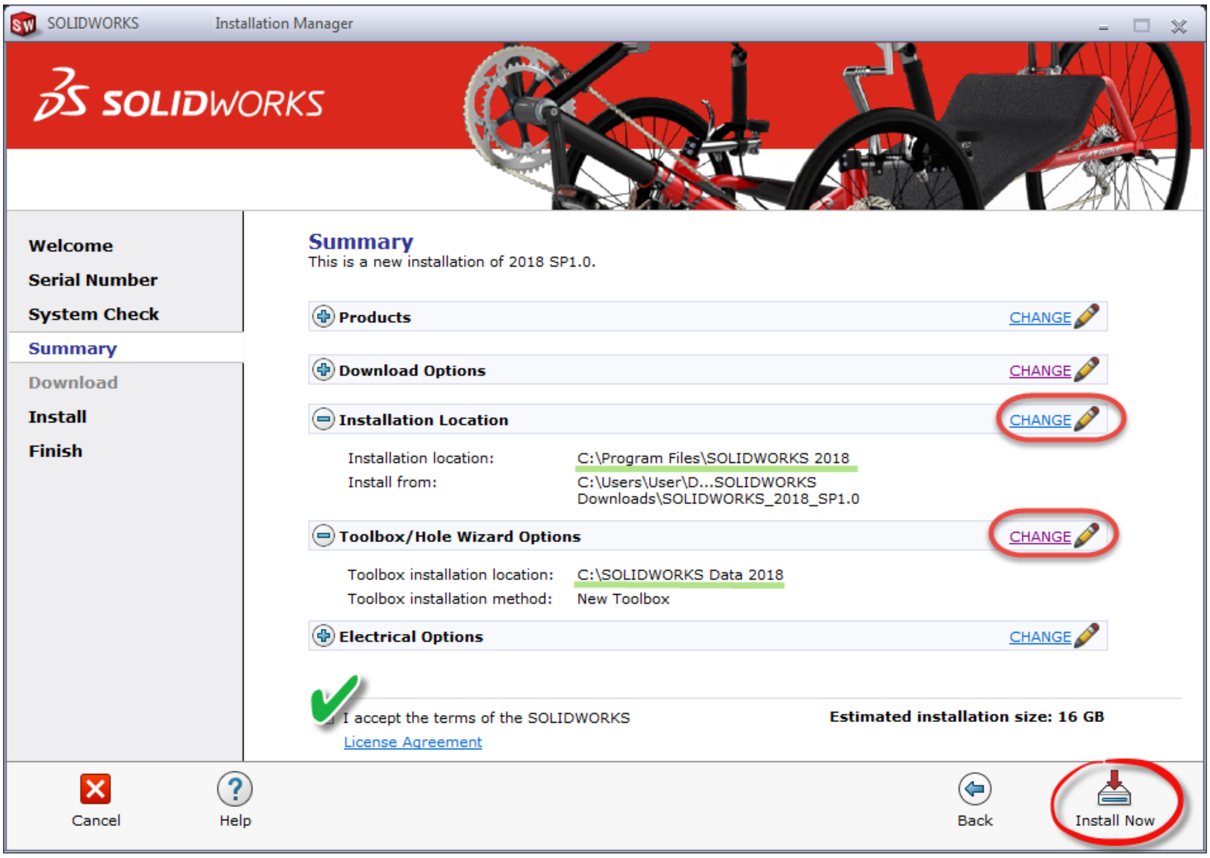
- The Serial Number screen is where you will input your serial number. Once your number is entered into the area correctly, click next.



- At the Product Selection page, you can check the software you want to install and uncheck the parts you do not need. Once done click Next.



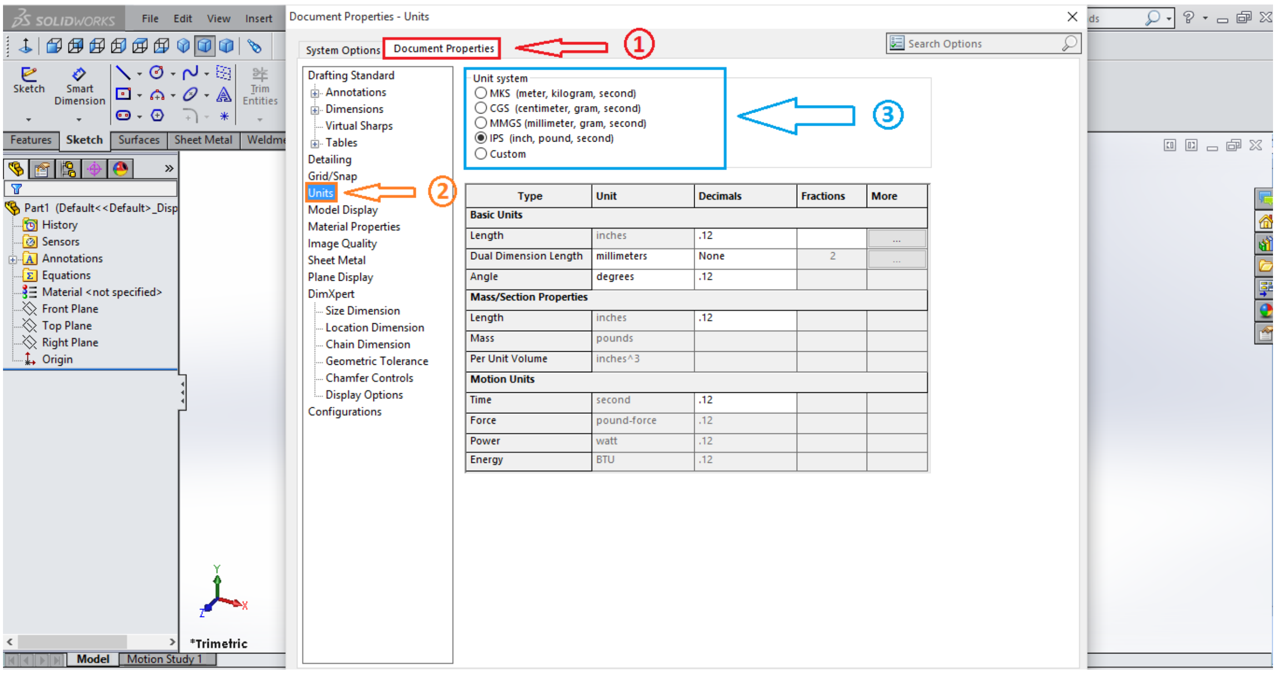
- At the Summary page you will be prompted to read and accept the License Agreement from SOLIDWORKS. This box must be checked in order to install the software.
- The Installation Location and Toolbox/Hole wizard Options location can be changed. Go Engineer suggests changing the name of the installation to reflect the SolidWorks version for future reference.
- Once this is done, click “Install Now” in the bottom-right corner. This will initiate the installation.



- After installation you restart the machine, and start using software.

A. Unity configuration: To set units options,

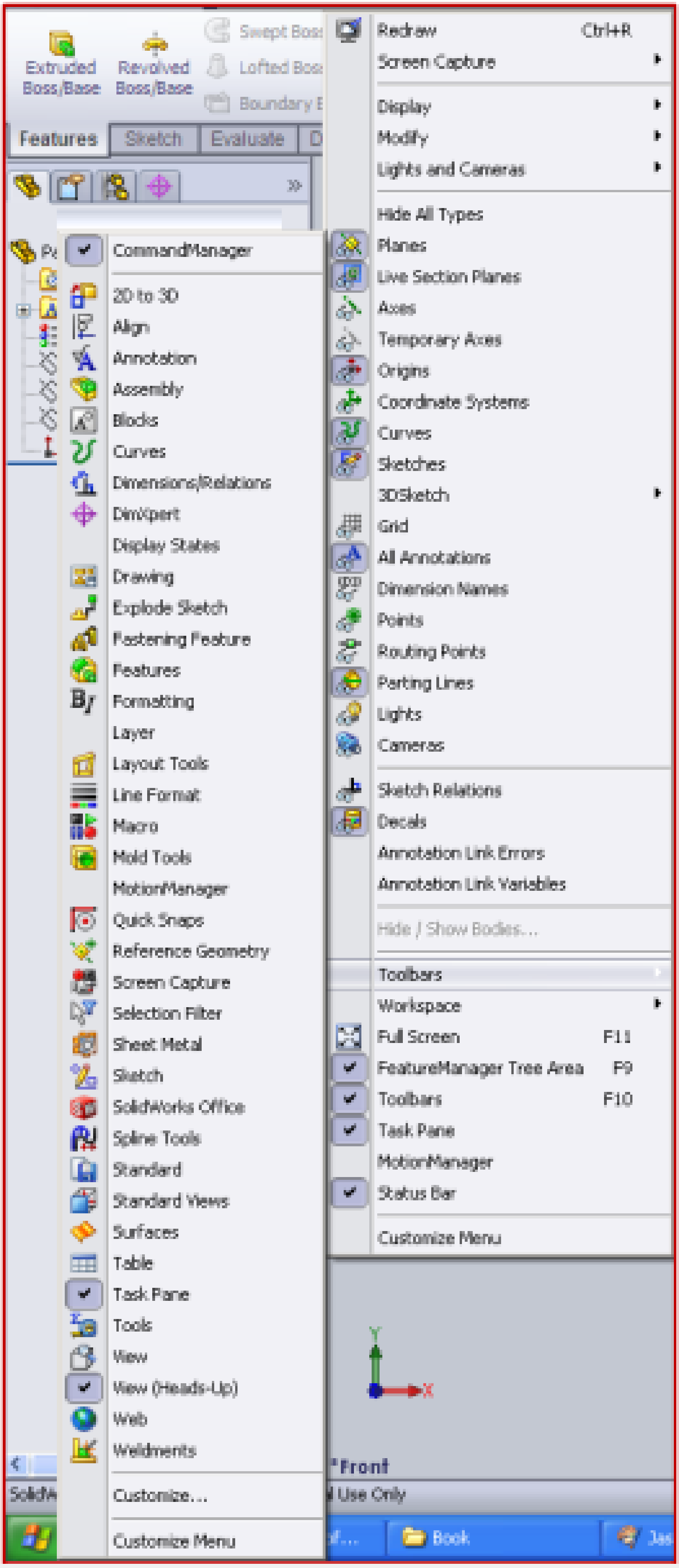
1. Click Simulation > Options. ...
2. Under **Unit** system, select SI (International System of **Units**), English (U.S. Customary **Unit** System), or Metric (gravitational system of **units**).
3. Under **Units**, select the desired **units** for Length/Displacement, Temperature, Angular velocity, and Pressure/Stress.
4. Click OK.



B. **Customization:** SolidWorks can be customized to look and workaccording to your preferences or to follow company standards.

1. Click **View→Toolbars** to see all the toolbars that are available. Toolbars that are visible have a check mark.

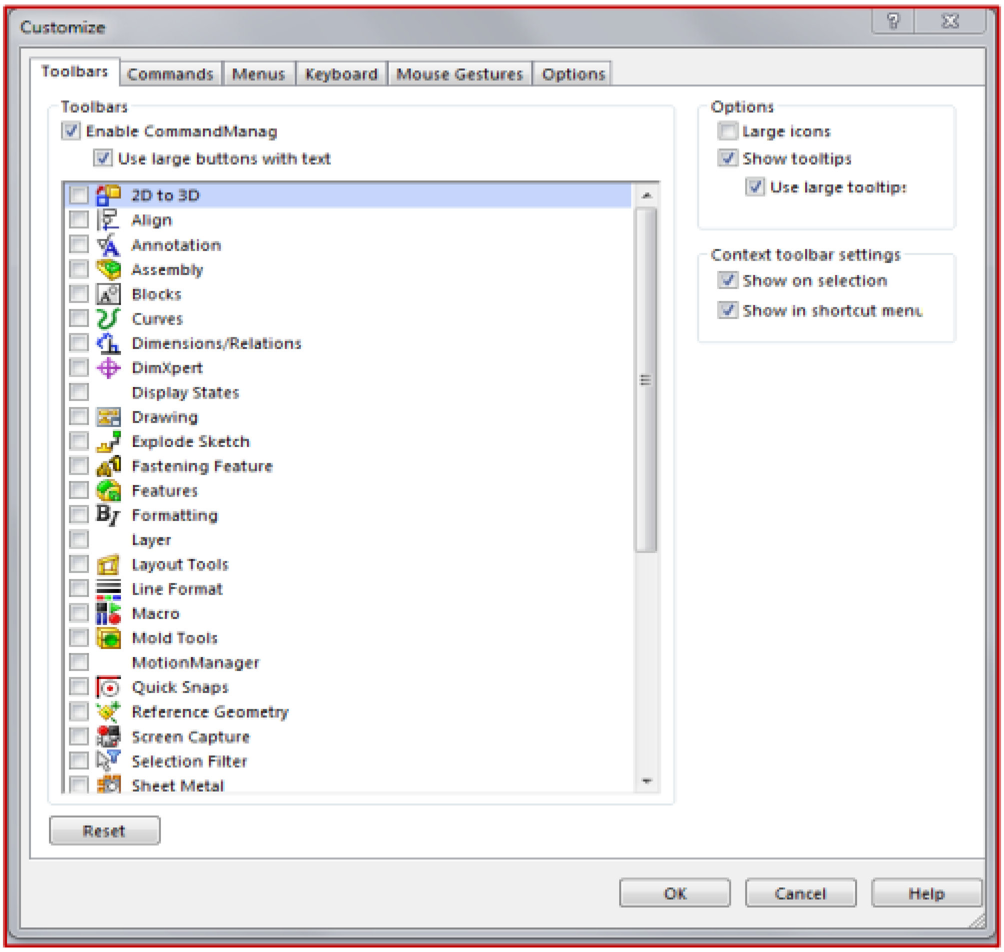
- Verify that the following toolbars are visible: **Command Manager, View (Heads-Up),** and **Task Pane.**
- Check and uncheck one or more toolbars and see what difference it makes, but remember to undo your changes before proceeding to the next step.
- All toolbars can be moved to a new location by clicking and dragging.



2. If you click **View→Toolbars→Customize**, the menu appears. It is another way of selecting which toolbars can be seen on the desktop. The commands in a toolbar can be changed. Click **View→Toolbars→Customize** toget it.it allows

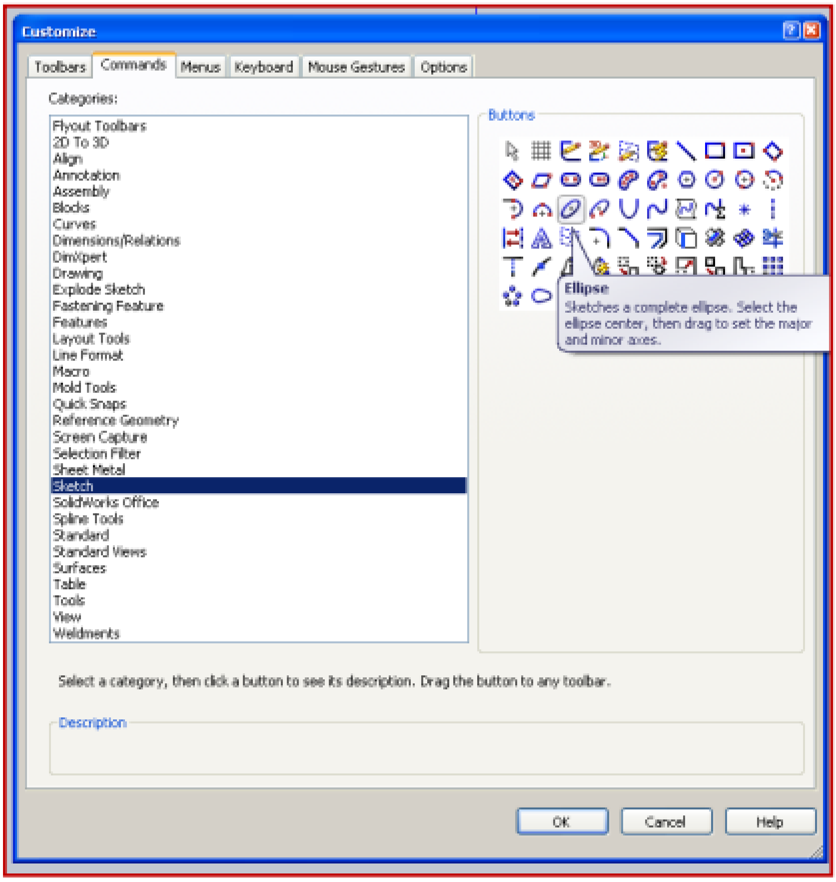
you to select which toolbars are visible. Select the **Commands** tab to get the menu, with a list of all the toolbars in SolidWorks.

They are called **Categories** on this menu. If you click a **Category**, the icons shown on the right side of the menu box are the commands that belong in the toolbar. If you place the mouse cursor overreach icon, you can see what command it represents.

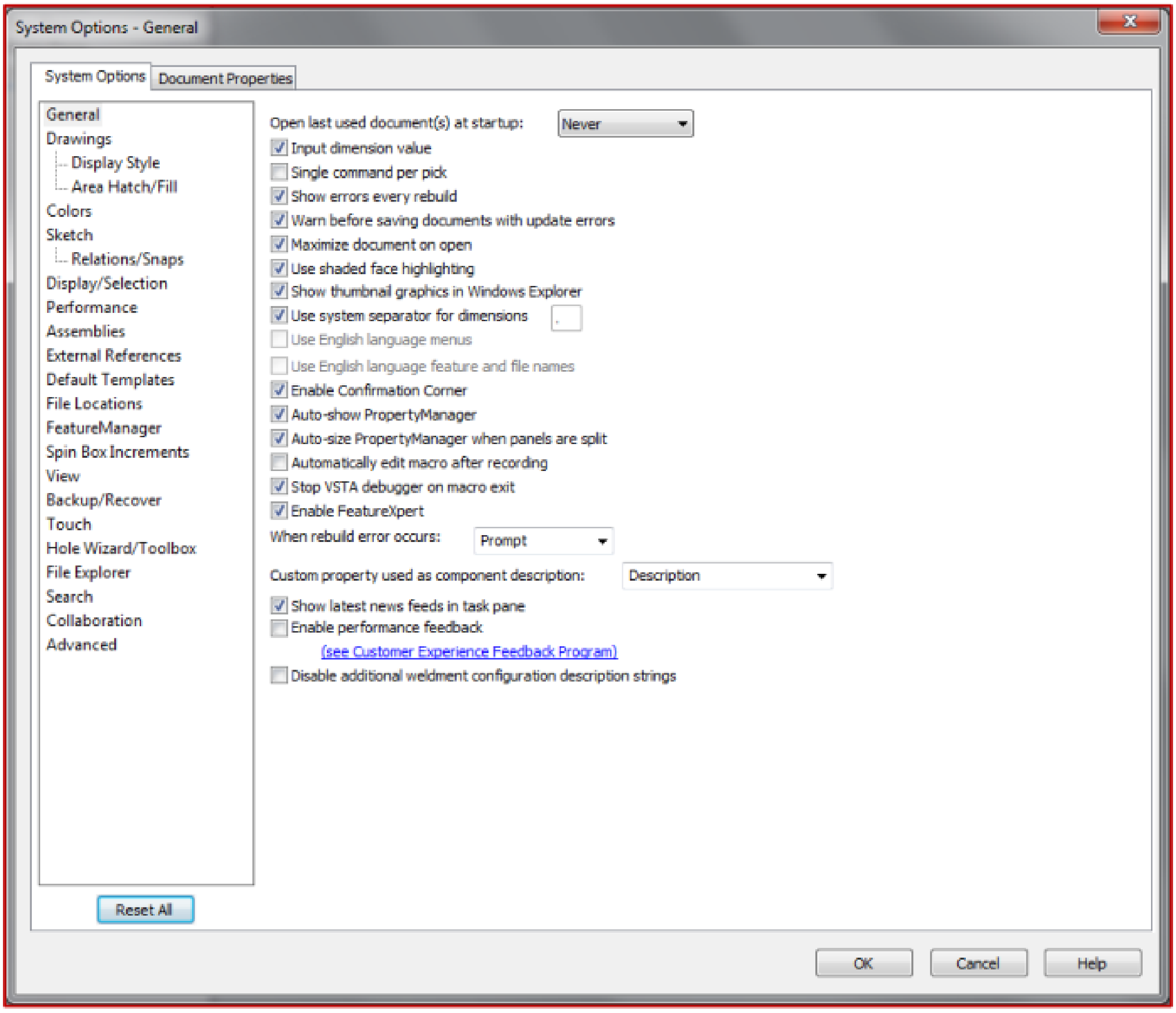


Some commands are not included in the default version of a toolbar, but can be added. To add a command, click and drag the icon to the toolbar. It will remain in the toolbar when you click OK. You can place any command in any toolbar, even if it is unrelated, but it is best to keep toolbars small. To remove a command from a toolbar, drag the icon from the toolbar to the **Customize** menu.

3. In the **Command Manager,** click the tab **Sketch** to show the sketch commands. Next, on the **Tools**→**Customize**→**Commands**→**Sketch** menu, locate the **Ellipse** tool in Figure 2.3. Click and drag it to the **Sketch** toolbar and click OK, this will add the new command.



Another way of customizing SolidWorks is by selecting **Tools→Options** on the **Main Menu**. The menu in Figure 2.4 will appear. It has two tabs, **System Options** and **Document Properties**.

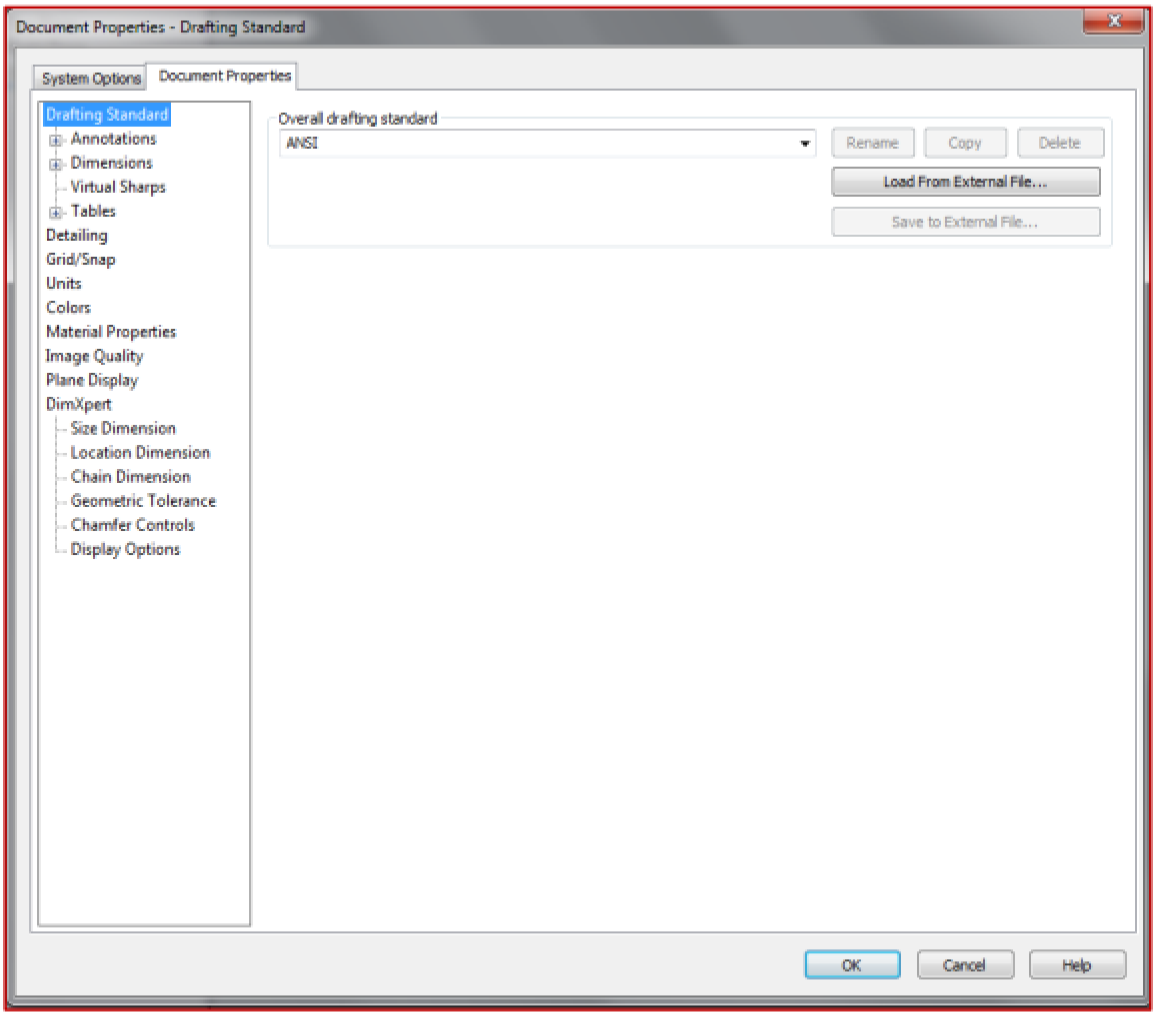


4. **System Options.**

- Select **Display/Selection** on the **System Options** tab and verify that **Projection Type for four viewports:** is **Third Angle**.
- Select **Feature Manager** and change **Design Binder** to **Show**.

5. **Document Properties.**

- Click the **Document Properties** tab and select **ANSI** in **Overall drafting standard**.
- Click **Units** and select **IPS** (inch-pound-seconds).
- Click OK.

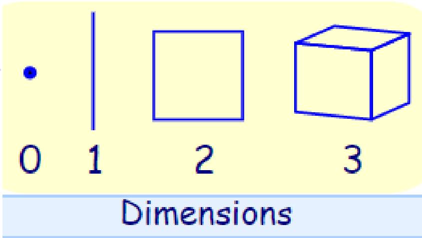

Document Properties - Drafting Standard
System Options
Document Properties
Drafting Standard
Annotations
Dimensions
Virtual Sharps
Tables
Detailing
Grid/Snap
Units
Colors
Material Properties
Image Quality
Plane Display
DimXpert
Size Dimension
Location Dimension
Chain Dimension
Geometric Tolerance
Chamfer Controls
Display Options
Overall drafting standard
ANSI
Rename
Copy
Delete
Load From External File...
Save to External File...
OK
Cancel
Help

Learning Unit 2 – Perform Plane and Descriptive Geometry.

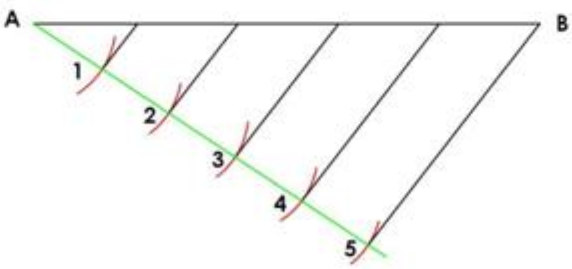
LO 2.1 – Apply Plane Geometry.

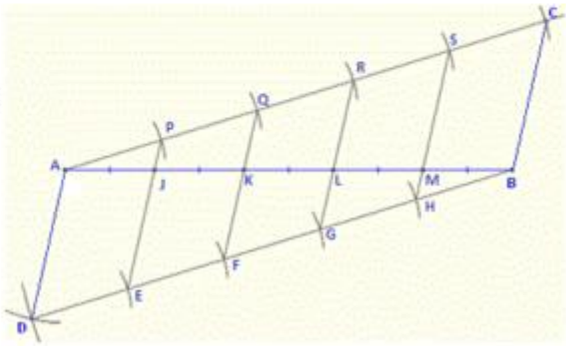
Content/Topic 1: Introduction to Plane Geometry.

A. **Definition of plane geometry:** Plane Geometry is about flat shapes like lines, circles and triangles shapes that can be drawn on a piece of paper. Plane Geometry is all about shapes on a flat surface (like on an endless piece of paper).

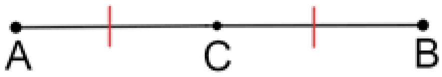


B. **Straight-line partition:** A **line** segment can be **partitioned** into smaller segments, which are compared as ratios. **Partitions** occur on **line** segments that are referred to as directed segments.



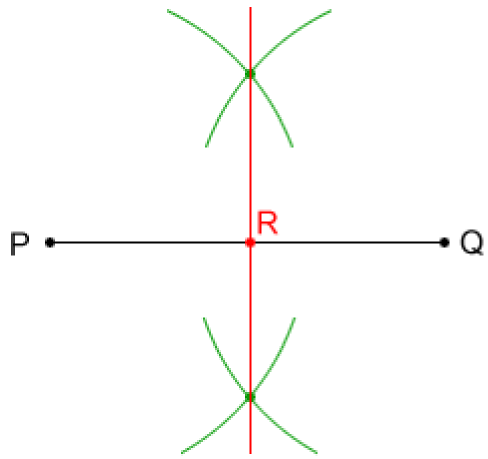


C. **Bisect a line:** To **bisect** is to divide a geometric figure into two parts that are the same size and shape.



Point C bisects line segment AB

Constructing bisectors: In geometry, it is possible to bisect many objects using just a compass and ruler. To bisect a line segment using a compass and ruler, use the following steps:

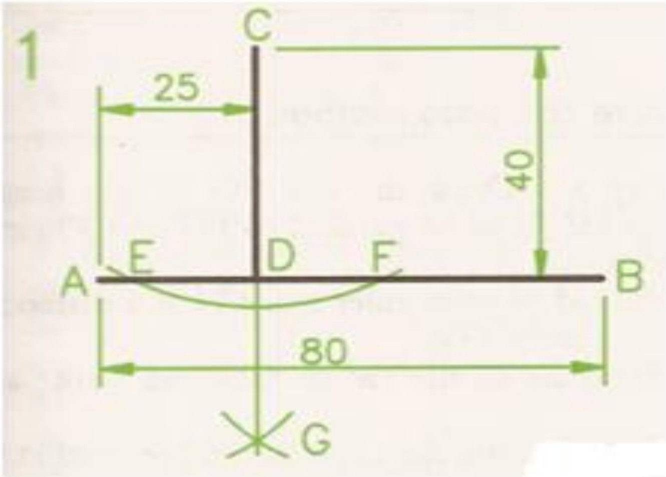


a. Place the point of the compass on endpoint P of segment PQ opening it wider than half the segment's length.
b. Draw two arcs above and below the segment. Repeat this step with endpoint Q. Make sure the arcs have the same radius and draw the arcs long enough so they intersect above and below the segment.
c. With a straight edge ruler, draw a line through the points of intersection of the arcs. The line bisects segment PQ at midpoint, R. The line is also perpendicular to segment PQ so it is also the perpendicular bisector of PQ.

D. Perpendicular lines: The **perpendicular line** is a line that crosses another line at a 90° angle. Each corner meets at a 90° angle. This is also known as a right angle.

To draw a line perpendicular to a line from a point to the line

1. Draw the line AB 80 mm long. Mark the point C 40 mm above the line and 25 mm from the left-hand end.
2. Set a compass, centered at C, to a suitable size to draw an arc, which cuts the line AB at E and F.
3. Re-set the compass and, with the compass centered at E, then at F draw the crossing arcs G.
4. Draw a line CG. The line CD is perpendicular to AB.



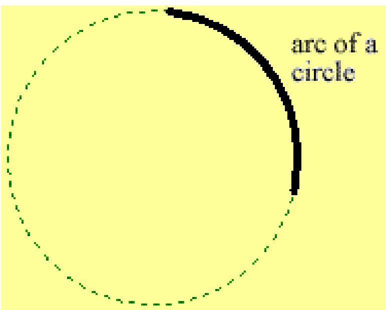
(2) To draw a line perpendicular to a line from a point on the line

1. Draw the HJ 70 mm long. Mark the point K 30 mm along HJ from J.
2. With a compass centered at K, draw arcs across the line HJ to give the points M and N.
3. Re-set the compass and, with the compass centered first at M, then at N draw the crossing arcs L.
4. Draw the line KL. The line is perpendicular to line HJ

E. Angles: An angle is the rotation required to superimpose one of two intersecting lines on the other.

Acute angle: It is an angle with degree below 90 degree
Right angle: It is an angle with 90 degree
Obtuse angle: It is an angle with degree greater than 90 degree but below 180 **degree**
Straight angle: It is an angle with 180 degree
Reflex angle: It is an angle with degree greater than 180 degree but below 360 **degree**
Full angle: It is an angle with 360 degree

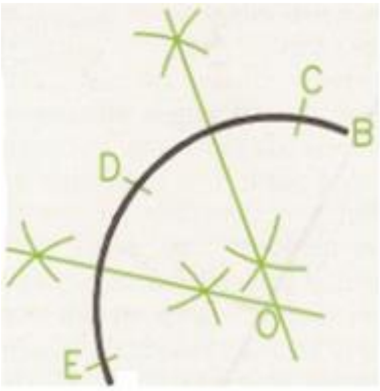
F. Arcs: A portion of the circumference of a circle is known as an arc.



Finding the center of an arc

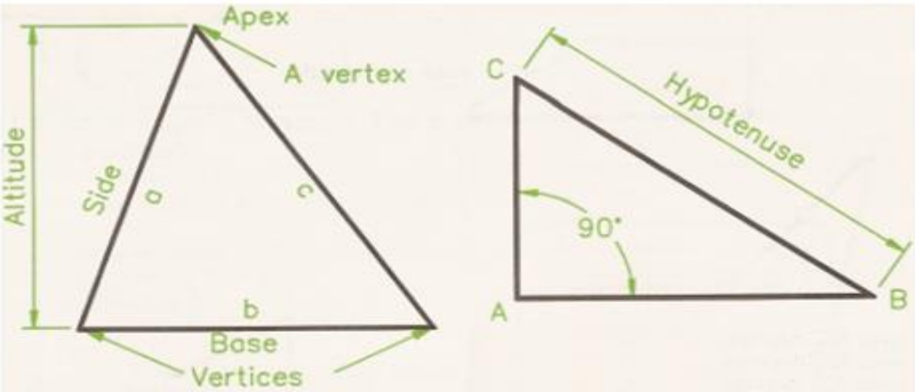
1. Draw any arc
2. Mark off any three points C, D and E on the arc.
3. Bisect the two arcs CD and DE. The bisection lines cross at O, which is the center of the arc.
4. Check that you have found the correct center by centering a compass at O and attempting to complete the circle of which the arc is a part.

The bisector of any arc passes through its center. It follows that if any two arcs of an arc or a circle are bisected, they must intersect at the center of the arc or circle.



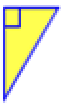
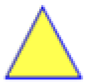
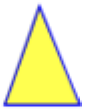
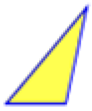
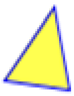
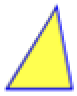
Content/Topic 2: Construction of plane figure,

A. **Triangle:** A triangle is a closed geometric figure having three sides and three angles.
    1. Triangle vertices are often lettered, using capitals, when the triangle may be, for example triangle ABC.
    2. If sides are lettered, lower case is used, e.g. **a**, **b** and **c**.
    3. The angles of triangle **ABC** are **BAC**, **ABC** and **ACB** – the middle letter being the angle where the letter is positioned.
    4. **The base** of a triangle is the side on which it is standing.
    5. **The altitude** is the vertical height above the base.
    6. The term **hypotenuse** is only used with reference to right - angle triangles.
    7. The **vertical angle** is the angle opposite the base.
    8. Note the term vertex. Its plural is vertices.



Types of triangle

Triangles are classified into the following groups, depending on various properties. Note that a given triangle can be in more than one group. For example, it could be both a right triangle and a scalene triangle at the same time.

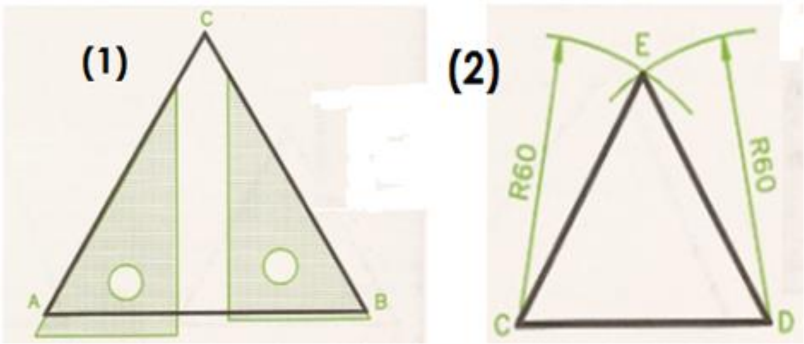
Right Triangle		One angle 90°.	Equilateral		All sides equal
Isosceles		Two sides equal	Obtuse		One angle greater than 90°
Scalene		No sides equal	Acute		All angles less than 90°

Construction of triangles

(i) Constructing an equilateral triangle

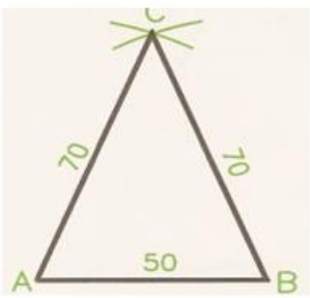
There are two methods to construct an equilateral triangle

1. With the aid of a 30, 60 set square, using the 60-degree angle. Start by drawing the base, AB, and then draw lines, meeting at C, at 60 degrees from each end of the base with the aid of the setsquare.
2. Strike off compass arcs with the compass set to the length of the side. The side length of the equilateral triangle is 60 mm. Start by drawing the base a line 60 mm long; then set a compass to 60 mm and strike arcs from each end of the base; draw lines from the ends of the base to the intersection of the two arcs.



(ii) To construct triangle ABC

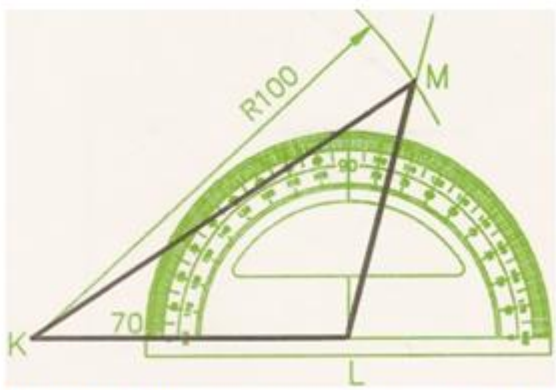
1. Draw the base AB, 50 mm long. Set a compass to 70 mm.
2. With the compass centered first at A, then at B strike intersecting arcs to give C.
3. Join AC and BC to complete the triangle.



Note: Triangle ABC is isoscele.

(iii) to construct triangle KLM

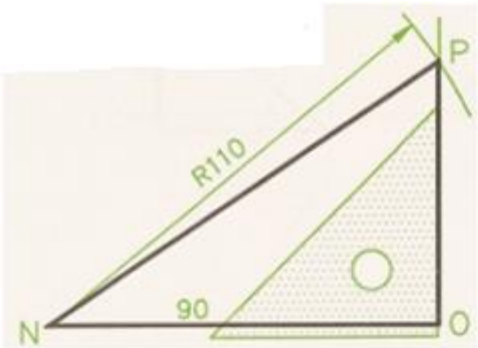
1. Draw KL 70 mm long.
2. With the aid of a protractor construct a 105-degree angle at L, and draw a line from L at that angle.
3. Set a compass to 100 mm. With the compass centered at K, strike an arc across the arm of the line at 105 degrees from L, to give M.
4. Join LM to complete the triangle.



Note: KLM is a scalene triangle, which is obtuse.

(IV) to construct triangle NOP

1. Draw NO 90 mm long.
2. Draw the angle NOP with a set square.
3. Set a compass to 110 mm. With the compass centered at N, strike an arc across the 90-degree line from O to give P.
4. Join NP to complete the triangle.



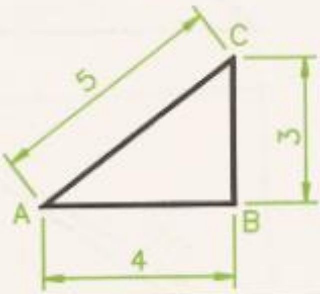
Note: Triangle NOP is a right - angle triangle

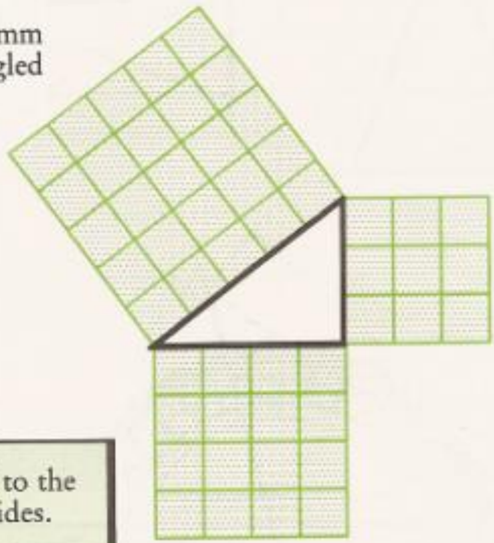
(v) Note on right angle triangle

Taking the 3: 4: 5 triangle:

a) The square on the hypotenuse = 5 × 5 = 25.
b) The square on the shortest side = 3 × 3 = 9.
c) The square on the other side = 4 × 4 = 16; and 9 + 16 = 25.

Thus: if the sides of a triangle are 30 mm, 40 mm and 50 mm long, the triangle is a right-angled one.



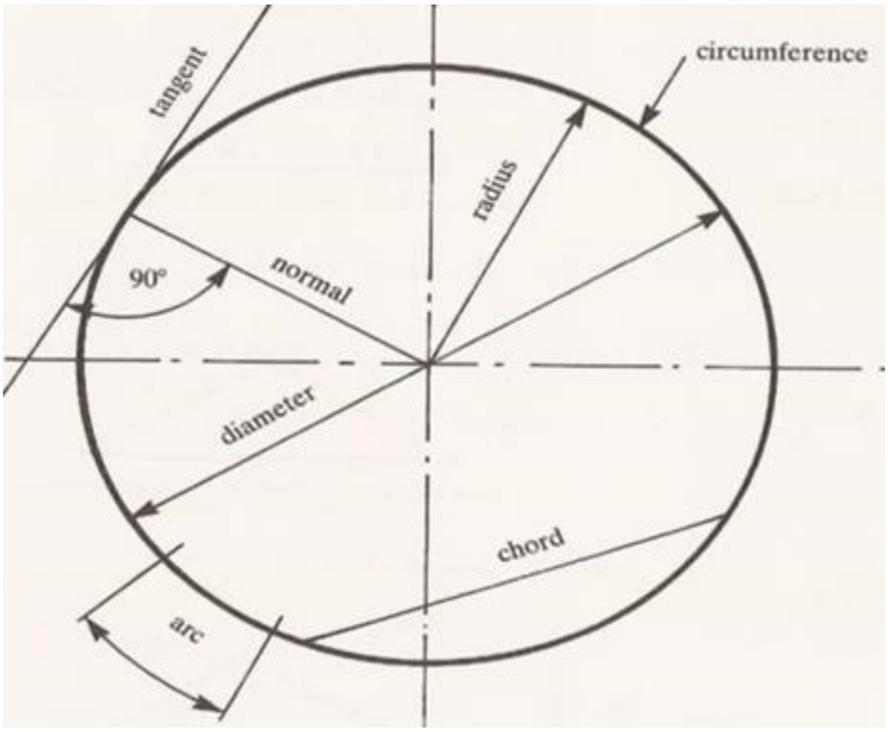


The square on the hypotenuse is equal to the sum of the squares on the other two sides.

B. Circle: A circle is a plane figure bounded by a line called the circumference, which is always equidistant from the center of the circle. The distance from the center to the circumference is called radius; the distance from one edge of the circumference to the other through the center of the circle is called the diameter.

- **An arc** is any part of the circumference.

- **A chord** is any straight line drawn across the circle meeting the circumference at both ends. Any such line passing through the center of the circle is called the **diameter**.
- **A tangent** is a straight line that touches the circumference. It is always at right angles to the radius at the point of contact. The line drawn from the point of contact to the center



C. Polygons: A polygon is a two-dimensional geometric figure that has a finite number of sides. The sides of a polygon are made of straight line segments connected to each other end to end. The line segments of a polygon are called sides or edges. The point where two line segments meet is called vertex or corners, henceforth an angle is formed.

Types of polygons

There are two main **types of polygon -** regular and irregular.
A regular **polygon** has equal length sides with equal angles between each side.
Any other **polygon** is an irregular **polygon**, which by **definition** has unequal length sides and unequal angles between sides.

According to the number of sides, a polygon has, it may be termed a pentagon (5 sides), hexagon (6), heptagon (7), Octagon (8), nonagon (9) or Decagon (10). Regular polygons have sides of equal lengths with all included angle equal.

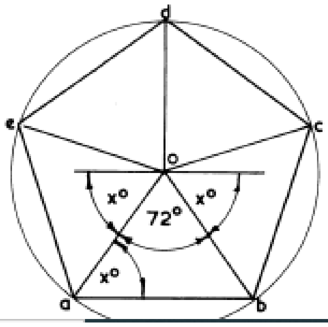
To construct a regular polygon and irregular within a circle

5. REGULAR AND IRREGULAR POLYGONS

Polygons are figures with more than four straight sides. If the sides are all the same length the figures are said to be regular polygons, if they are not all the same length the figures are irregular polygons. A polygon with

5 sides is a pentagon
6 sides is a hexagon
7 sides is a heptagon
8 sides is an octagon
9 sides is a nonagon

The sum of the interior angles of a polygon is 360° so if the figure is divided up into similar triangles as in figure 31 it is a simple task to calculate the number of degrees in the corners of the triangles. Let us take the triangle a – b – 0. The regular pentagon has five sides so angle a – 0 – b is 360 ÷ 5 = 72°. The other two angles are each (180 – 72) ÷ 2 = 108 ÷ 2 = 54°. Angles 0 – a – b and 0 – b – a are both 54°.



PENTAGON

To draw the pentagon in figure 32

1. Draw the base line a – b.
2. On the base line construct two triangles, the first with sides inclined at 45° to meet at 4, the second with sides inclined at 60° to meet at 6.
3. Bisect 4 – 6 to give point 5.
4. With centre 5 and radius 5 – a draw the circle into which the pentagon will just fit. Step off the distance a – b around the circle to give points c, d and e.

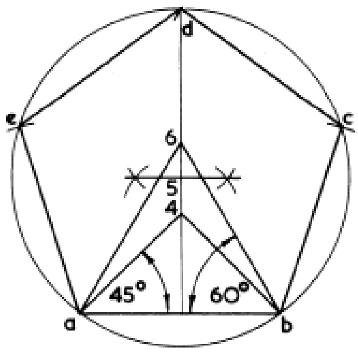


Figure 32

HEXAGON

A hexagon (figure 33) has six sides. To construct this figure:

To draw a regular polygon given the length of one side

Method 1:

Note: Point 4 is the center of the circle, radius 4A, containing a square

a. Point 5 is the center of circle, radius 5A, containing a pentagon
b. Point 6 is the center of circle, radius 6A, containing a hexagon

- To draw a hexagon, mark off point 6 as described below.
- With center at point 6, draw a circle radius 6A
- Draw the remaining sides of the polygon by putting the length=AB on the circumference of circle.

LO 2.2 – Apply Conic sections

Content/Topic 1: Introduction to Conic sections.

A. **Definition of conics:** A conic is the intersection of a plane and a right circular cone.

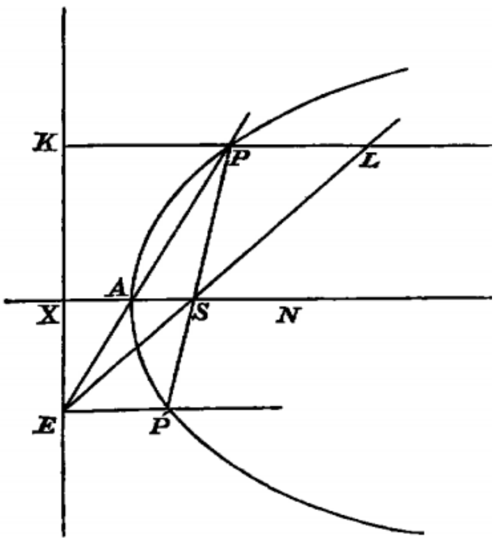
A. Conic sections are the curves obtained by intersecting a plane and a right circular cone.

B. **The Ellipse: An** ellipse is the curve traced out by a point which moves in such a manner that its distance from a given point is in a constant ratio of less inequality to its distance from a given straight line.

C. **Parabola:** A parabola is the curve traced out by a point which moves in such a manner that its distance from a given point is always equal to its distance from a given straight line.

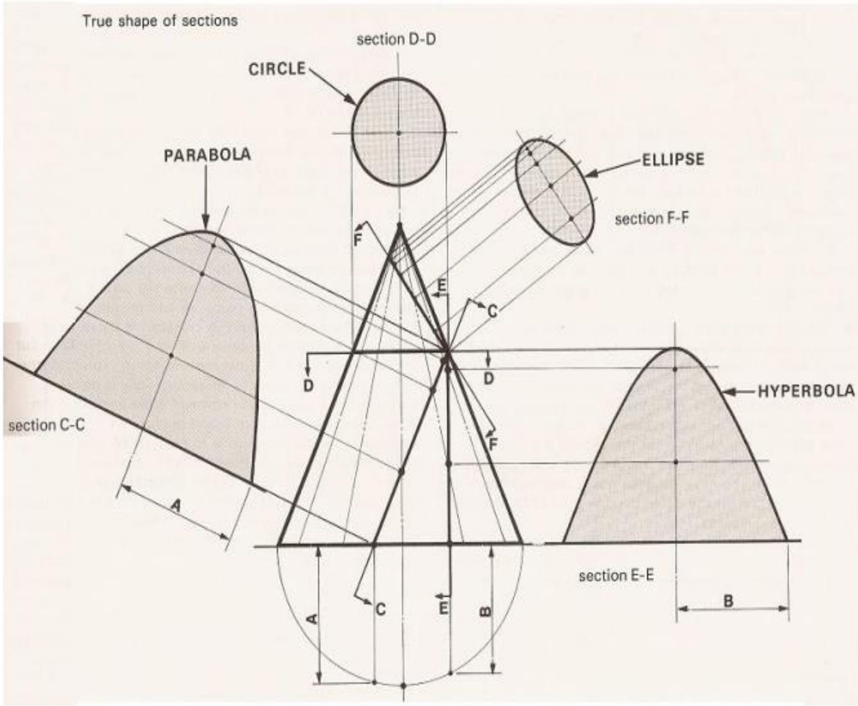
Let Us be the focus, EX the directory, and SX the perpendicular onEX. Then, bisecting SX in A, the point A is the vertex; and if, from any point E in the directrix, EAP, ESL be drawn, and from S the straight-lineSP meeting EA produced in P, and making the angle PSL equal to LSN, we obtain.

Tracing the Curve.

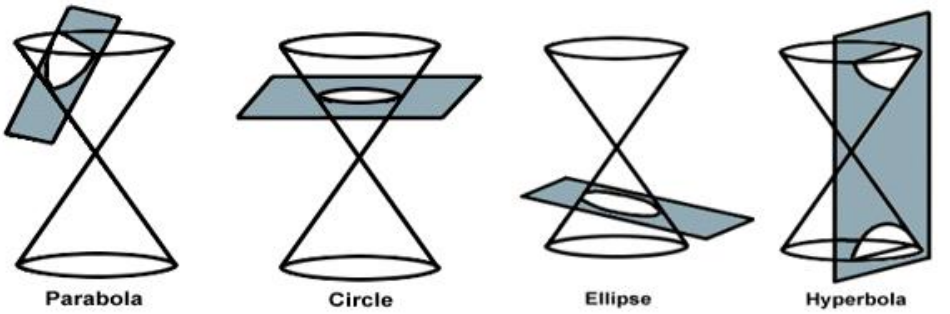


D. **Hyperbola:** A hyperbola is the curve traced by a point which moves in such a manner, that its distance from a given point is in a constant ratio of greater inequality to its distance from a given straight line.

Any number of points on the curve may be obtained by taking successive positions of E on the directrix.

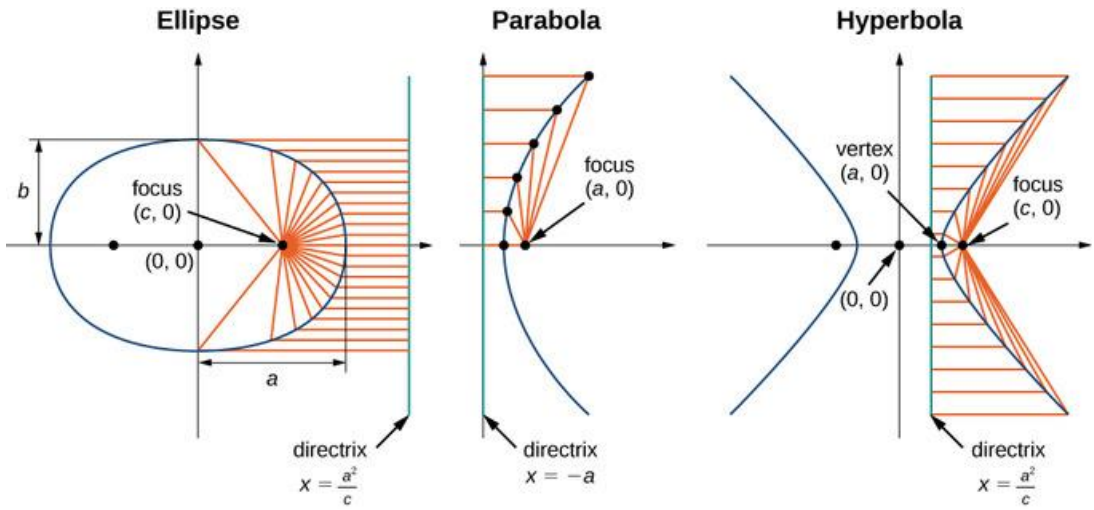


- When the ratio is one of equality, the curve is called a Parabola.
- When the ratio is one of less inequality, the curve is called an Ellipse.
- When the ratio is one of greater inequality, the curve is called a Hyperbola.

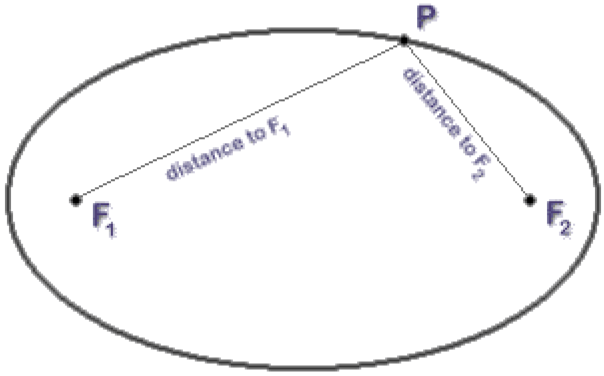


Content/Topic 2: Geometric properties of conics.

A. **Focal points (focus):** A **focus** is a **point** about which the **conic section** is constructed. In other words, it is a **point** about which rays reflected from the curve converge. A parabola has one **focus** about which the shape is constructed; an ellipse and hyperbola have two. A directrix is a line used to construct and define a **conic section**.

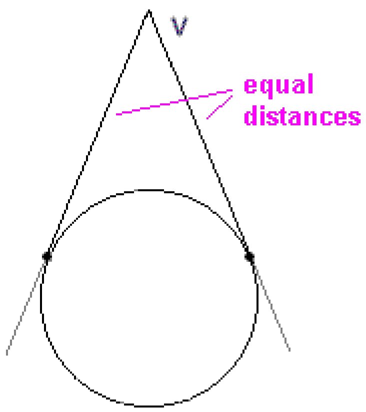


B. Focal sphere: The Dandelin spheres, which are sometimes called focal spheres, can be used to prove some important theorems; at least two. Though the theorems proved by Dandelin have been known for centuries yet Dandelin made it easier to prove them.

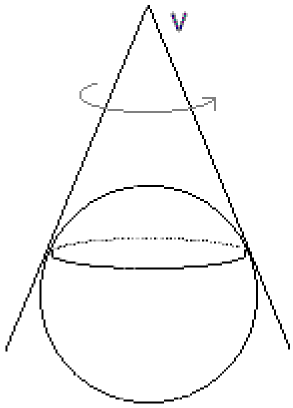


The first theorem states that a closed conic section is the locus of points such that the sum of the distances to fixed foci (that is, two fixed points) is constant.

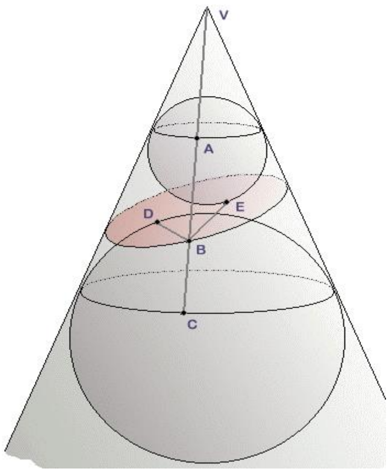
The second theorem states that for any conic section, the distance from the focus, that is, a fixed point is proportional to the distance from the directrix which is a fixed line and the constant of proportionality is called eccentricity.



As in the case of the first theorem, the second theorem has also been known to the Ancient Greek mathematicians such as Apollonius of Perga but the Dandelin spheres made the proof easier. However, the focus of this article is the first theorem and we shall try to make the proof clearer for easy understanding.



An ellipse as a conic section is the intersection of a cone and a plane such that the angle it made to the vertical is larger than that which the generator of the cone made. In other words, it is the curve resulting from a plane slicing through one of the nappes of the cone and an ellipse has two Dandelin spheres touching the same nappe of the cone (see the diagram below).

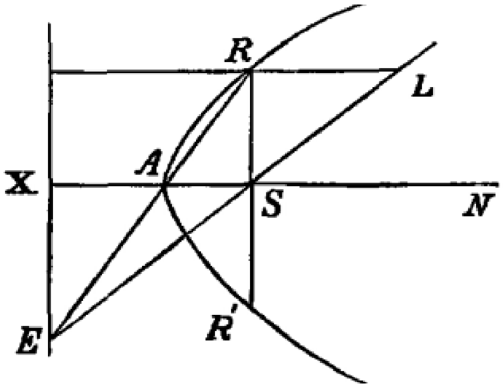


C. **Eccentricity:** The eccentricity, denoted **e**, is a parameter associated with every conic section. It can be thought of as a measure of how much the conic section deviates from being circular.

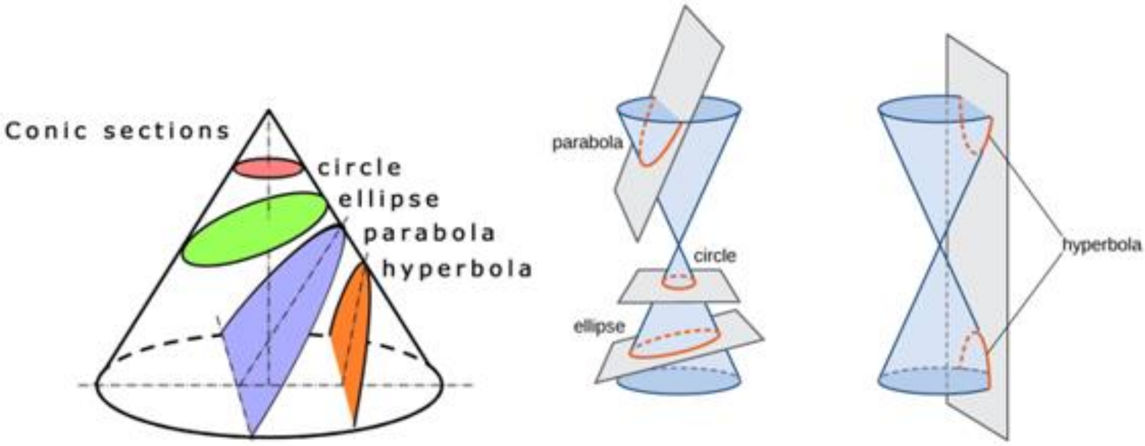
The eccentricity of a conic section is defined to be the distance from any point on the conic section to its focus, divided by the perpendicular distance from that point to the nearest directrix. The value of **e** is constant for any conic section. This property can be used as a general definition for conic sections. The value of **e** can be used to determine the type of conic section as well:

- If $e=1e=1$, the conic is a parabola
- If $e<1e<1$, it is an ellipse
- If $e>1e>1$, it is a hyperbola

The eccentricity of a circle is zero. Note that two conic sections are similar (identically shaped) if and only if they have the same eccentricity.

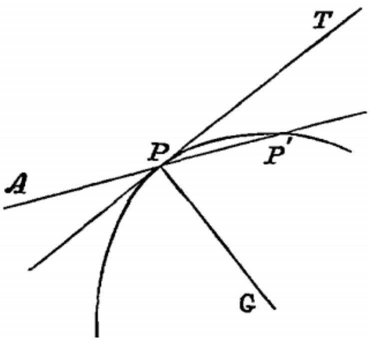


D. Conic curves: a conic section (or simply **conic**) is a **curve** obtained as the intersection of the surface of a cone with a plane. The three types of **conic section** are the hyperbola, the parabola, and the ellipse; the circle is a special case of the ellipse, though historically it was sometimes called a fourth type.



E. Tangents to conics: If a straight line, drawn through a point P of a curve, meet the curve again in P_0, and if the straight line be turned around the point P until the point P_0a approaches indefinitely near to P, the ultimate position of the straight line is the tangent to the curve at P.

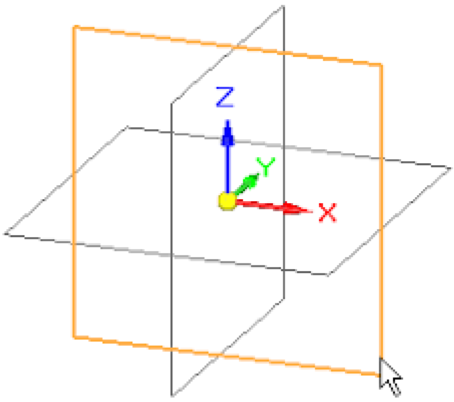
Thus, if the straight line APP0 turn around P until the points P and P0 coincide, the line in its ultimate position PT is the tangent at P.



LO 2.3 – Apply projection systems.

Content/Topic 1: Orthographic projection.

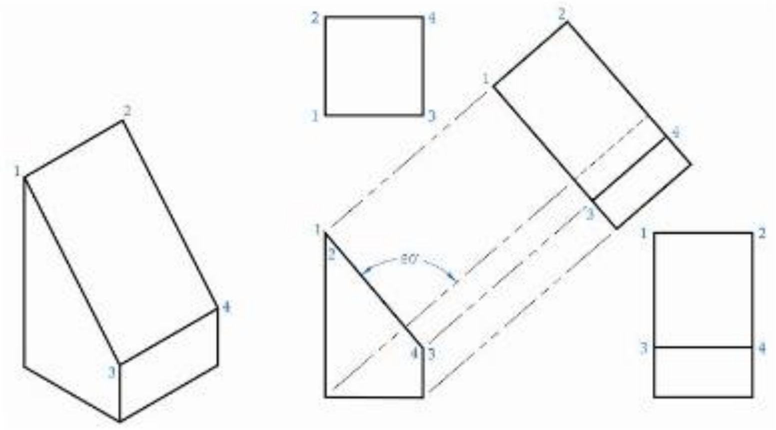
A. **Definition of a Plane: A** plane is the two-dimensional analogue of a point (zero dimensions), a line (one dimension) and three-dimensional space.
B. **Principal Planes:** may be defined as the **plane** at which there is zero shear stress. The stresses that act on a **principal plane** are called **principal** stresses.
C. **Reference plane:** is a **plane** in 3D space used as the workspace for drawing and the basis for other interactive actions. The initial **reference plane** is the XY **plane** (or ground **plane**). The **reference plane** may be one of the three Cartesian **planes** (XY, YZ, ZX), or it may be a custom **plane**.



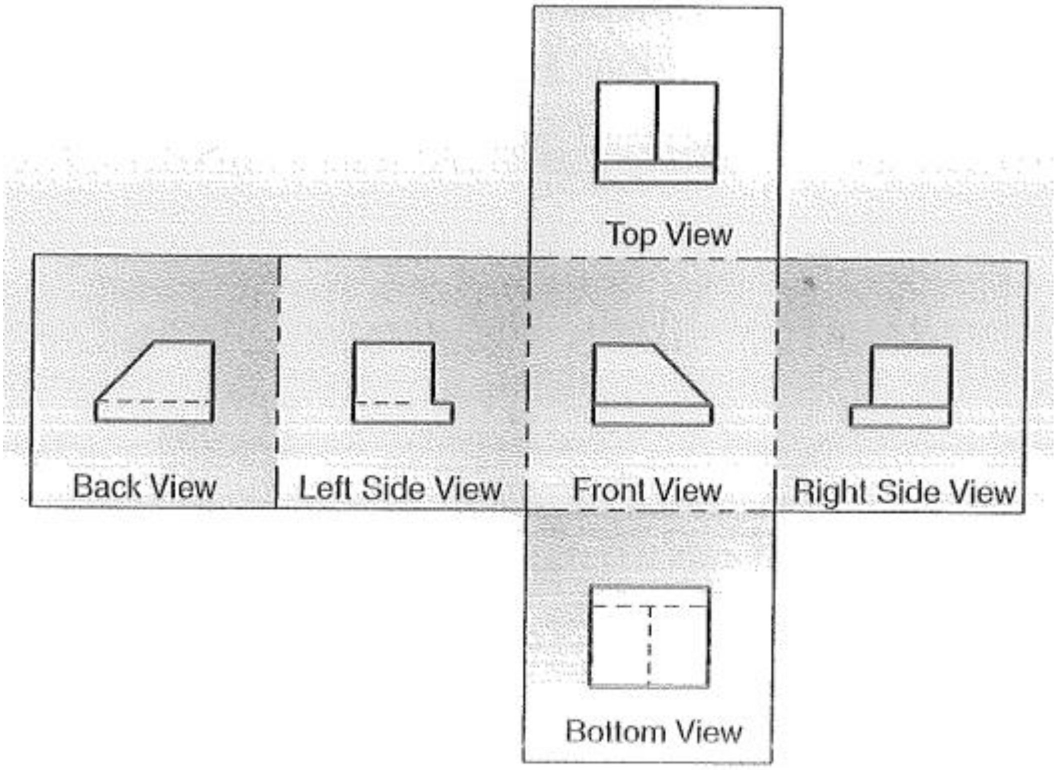
Content/Topic 2: Projection of right and obliques solids.

An auxiliary view is an orthographic view taken in such a manner that the lines of sight are not parallel to the principal projection planes (frontal, horizontal, or profile). There are an infinite number of possible auxiliary views of any given object.

A. **Auxiliary Views:** An auxiliary view is simply a "helper" **view**, which shows the slanted part of the object as it actually is. It turns, or projects, the. object so that the true size and shape of the surf ace (or surfaces) are seen as they actually are. **Auxiliary views** are:
   - Front view.
   - Top view.
   - Side view.



Third angle of projection



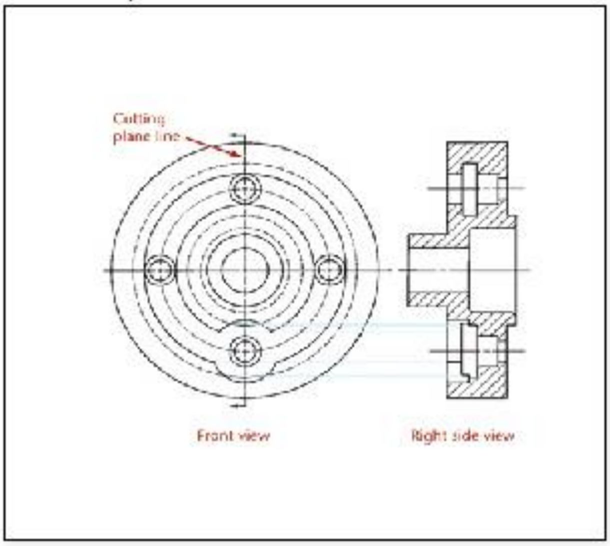
B. **Sectional Views:** The view obtained by cutting an object with an imaginary cutting plane is called **Sectional View**.
The surface produced by cutting the object by the section plane is called **Section**. It is indicated by thin section lines uniformly spaced, generally at an angle of 45'. As already imagined, a sectional view is a view seen when a portion of the object nearest to the observer is imagined to be removed by means of a cutting plane or planes, thus revealing the interior construction. The other views are not affected in any way always represent the entire object.

B.1. Types of Sectional Views

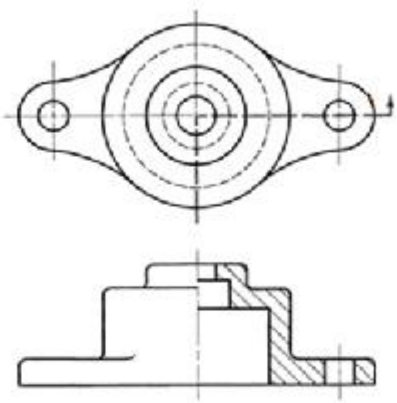
The sectional views are of mainly two types. These are dependent upon the number of cutting planes cutting the object.

1. Full Sectional View.
2. Half Sectional View.

1. **Full Sectional View:** The view obtained after removing the front half portion of an object is called a Full Sectional Views or **Front Sectional Views** or **Simply Sectional Elevation**.
   When the cutting plane cuts the object lengthwise, full sectional front view is obtained. It is also called longitudinal section. It may be noted that the top view or the slide remain unaffected, that means top view is drawn full not half



2. **Half sectional view:** The view obtained after removing the front quarter i.e. one fourth portion of an object by means of two cutting planes at right angle to each other is called **Half Sectional View** or **Half Sectional Elevation**. It may be observed that the plane or top view also remain unaffected i.e. full side view is drawn.



3. **Auxiliary section:** Auxiliary sections may be used to supplement the principal views used in orthographic projections. A sectional view projected on an auxiliary plane, inclined to the principal planes of projection, shows the cross-sectional shapes of features such as arms, ribs and so on. In Fig. 4.5, auxiliary cutting plane X-X is used to obtain the auxiliary section X-X.

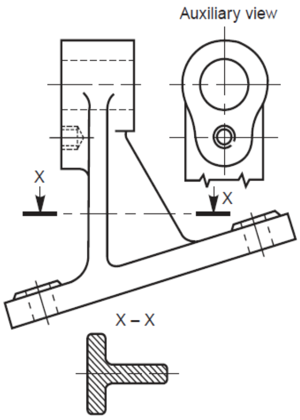


Fig. 4.5 Auxiliary section

How you obtain some view

a) **View from the front:** The view from the front of an object is defined as the view that is obtained as projection on the vertical plane by looking at the object normal to its front surface. It is the usual practice to position the object such that its view from the front reveals most of the important features. Figure 3.1 shows the method of obtaining the view from the front of an object.

b) **View from Above:** The view from above of an object is defined as the view that is obtained as projection on the horizontal plane, by looking the object normal to its top surface. Figure 3.2 shows the method of obtaining the view from above of an object.

c) **View from the side:** The view from the side of an object is defined as the view that is obtained as projection on the profile plane by looking the object, normal to its side surface. As there are two sides for an object, viz., left side and right side, two possible views from the side, viz., view from the left and view from the right may be obtained for any object. Figure 3.3 shows the method of obtaining the view from the left of an object.

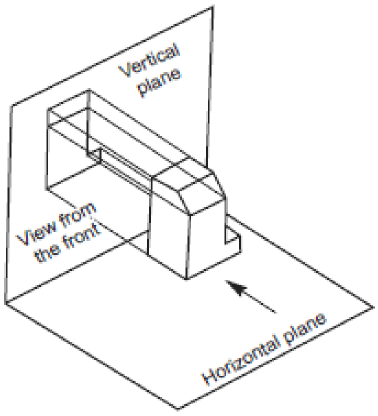


Fig. 3.1 Principle of obtaining the view from the front

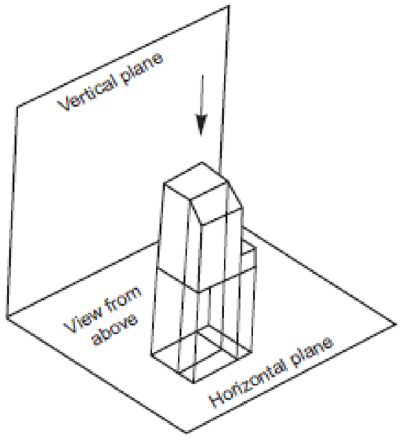


Fig. 3.2 Principle of obtaining the view from above

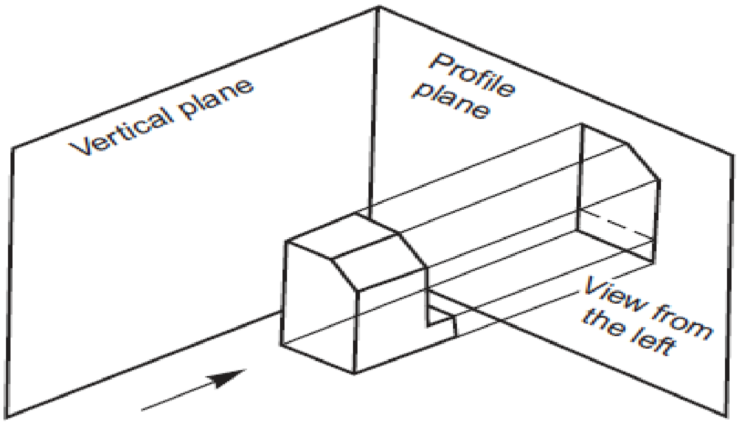
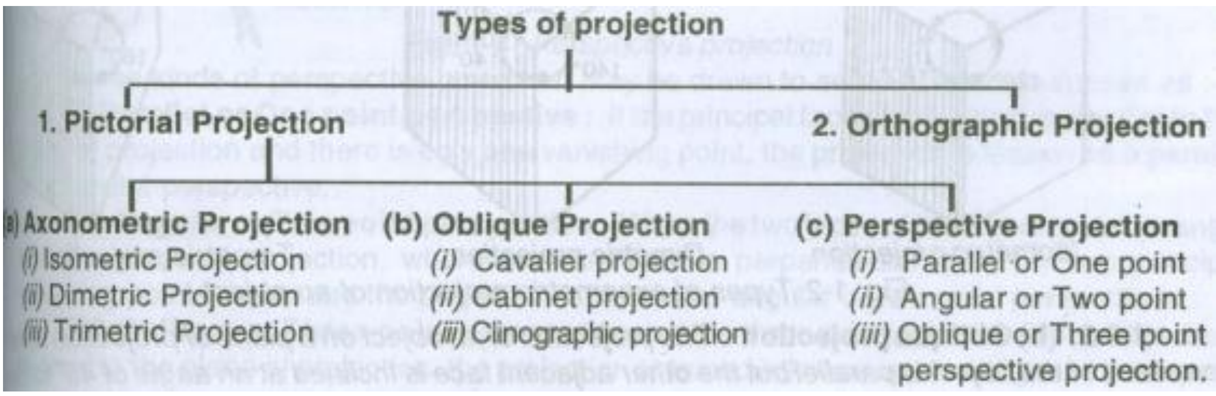


Fig. 3.3 Principle of obtaining the view from the left

Content /Topic3: Pictorial drawing.

In engineering practice, the followings are the common types of projections:

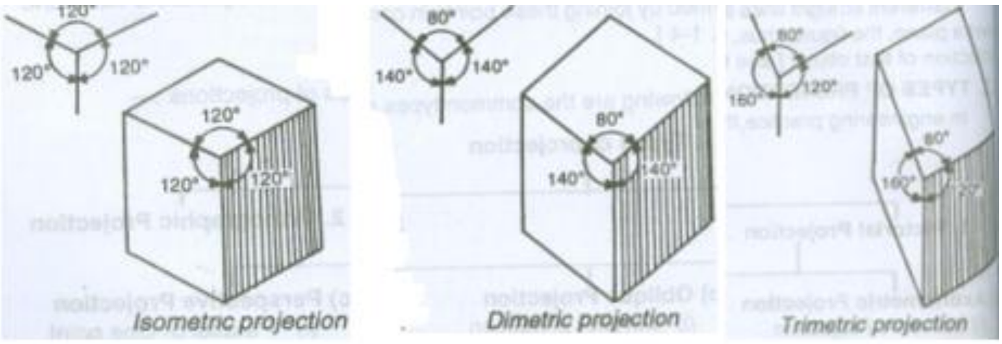


The projection in which the length, breadth and height of an object are shown in one view is known as pictorial projection. This type of projection has the advantage of conveying an immediate impression of the general shape of the object, but does not necessarily show the exact dimensions.

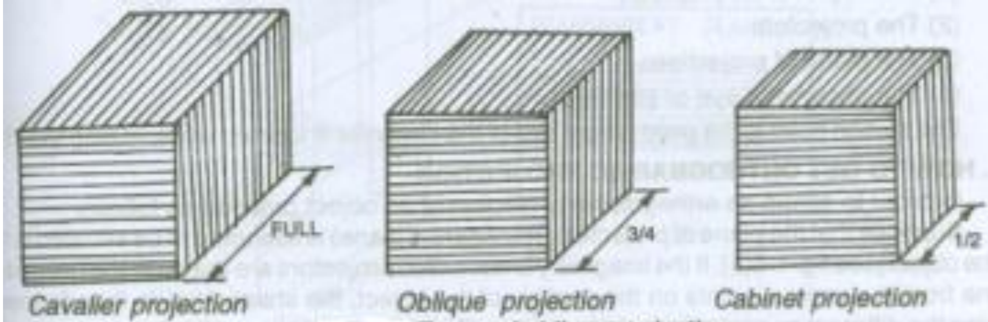
The pictorial projection is made in:

- axonometric projection,
- oblique projection,
- and perspective projections.

i. **Axonometric projection**If the object is turned and then tilted so as that three faces are inclined to the plane of projection; the resulting projection is a special type of orthographic projection known as axonometric projection. There are three subdivisions of axonometric projection:
    1. **Isometric:** Three sides of the object are shown on one projection plane and are equally inclined.
    2. **Dimetric:** Three sides of the object are shown on one projection plane and two of the three sides are equally inclined
    3. **Trimetric:** Three sides of the object are shown on one projection plane and are inclined differently.



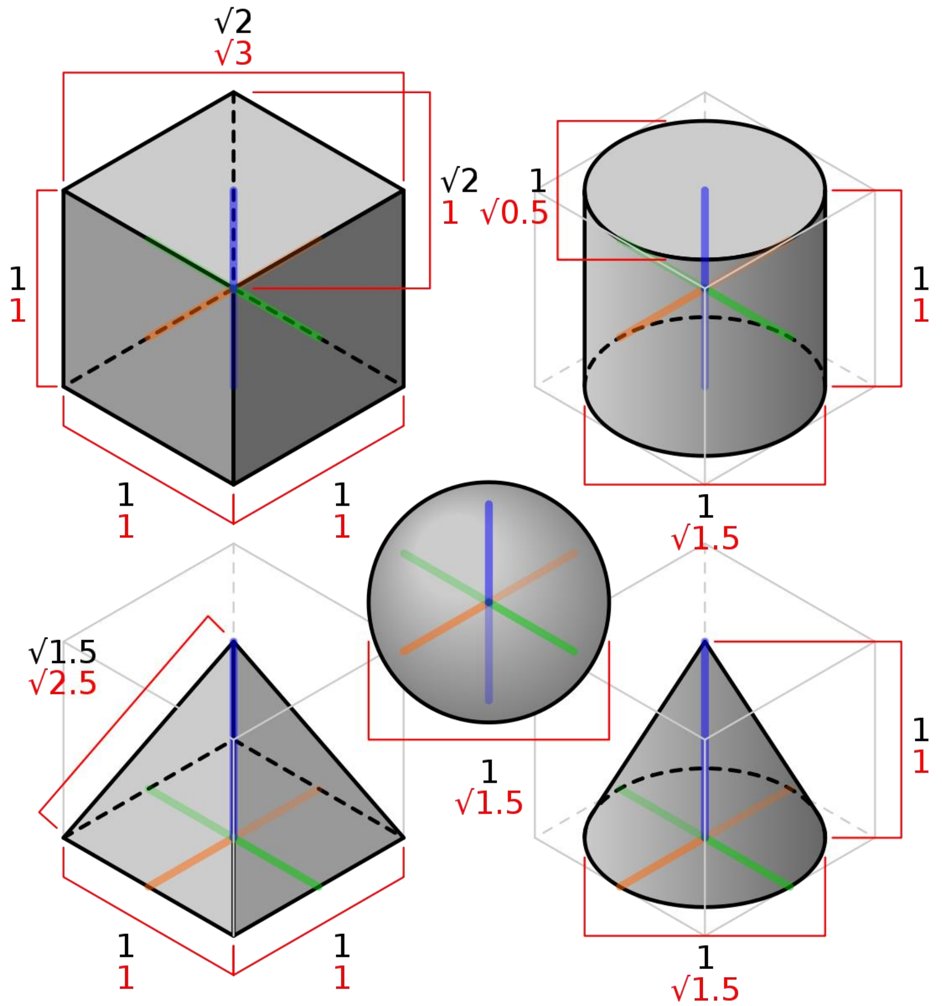
ii. **Oblique projection:** Another form of one plane projection is the oblique projection. This is not an orthographic projection because, although one face is imagined to be parallel to the plane of projection, the projectors are not perpendicular to it. Oblique projection provides an easy way of turning an existing orthographic view into a pictorial view. The oblique projection is further discussed as under:
    1. **Cavalier projection:** when the projection lines make angle of 45^0 with the plane of projection, the projection is called a cavalier projection.
    2. **Cabinet projection:** When the angle that the projecting lines make with the plane of projection is such that the scale on the reading axis in the drawing is about one half as long as the two axes, the result is called a cabinet projection.
    3. **Clinographic projection:** In cavalier and cabinet projections the principal face of the object is made parallel to the plane of projection. For some cases it may be desirable to turn the object at an angle with respect to the plane of projection and is known as Clinographic projection.



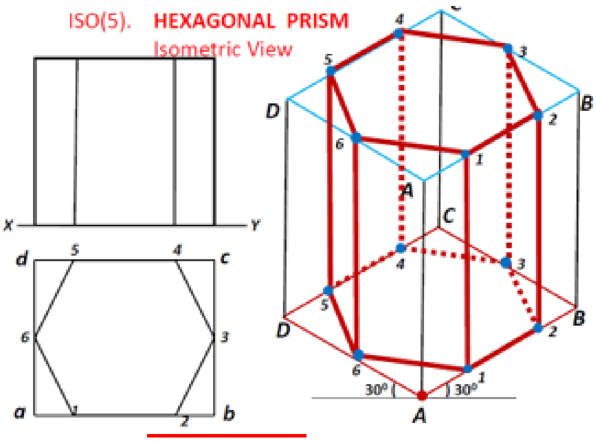
Types of oblique projection

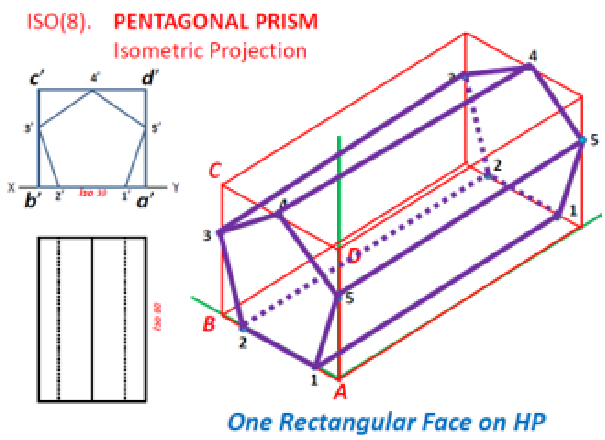
iii. **Perspective projection:** The projection obtained on a plane when the projectors converge to a point is known as perspective projection. There are three kinds of perspective projections:
   1. **Parallel or one-point perspective projection**: if the principal face of the object is parallel to the plane of projection and there is only one vanish point; the projection is known as parallel or one-point perspective projection.
   2. **Angular or two-point perspective projection**: When the two faces of the object are at an angle with plane of projection, where the third face is perpendicular to it, the two principals vanish points occur and the projection is known as angular or two-point perspective projection.
   3. **Oblique or three-point perspective projection:** If the three principal faces of the object are inclined to the plane of projection, the projection obtained is known as an oblique or three-point perspective projection.

A. Isometric drawing of solids: An **isometric drawing** combines the three views in one. The object is drawn so that the front, one side and the top views of the solid are all visible to the person viewing the drawing. This is called the isometric drawing of the solid. The isometric drawing of the house on the previous page is shown above.

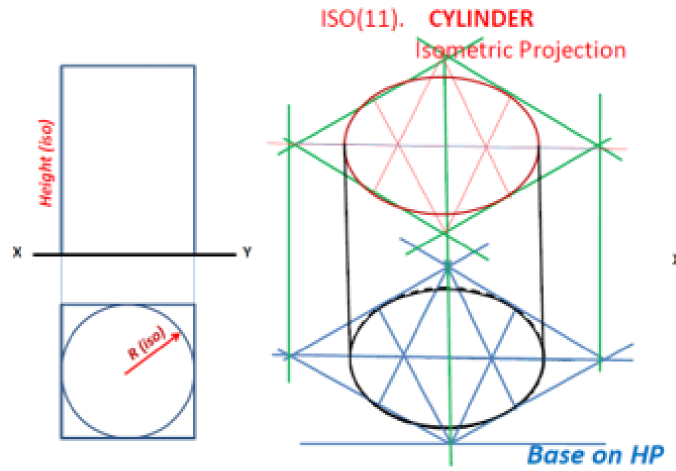


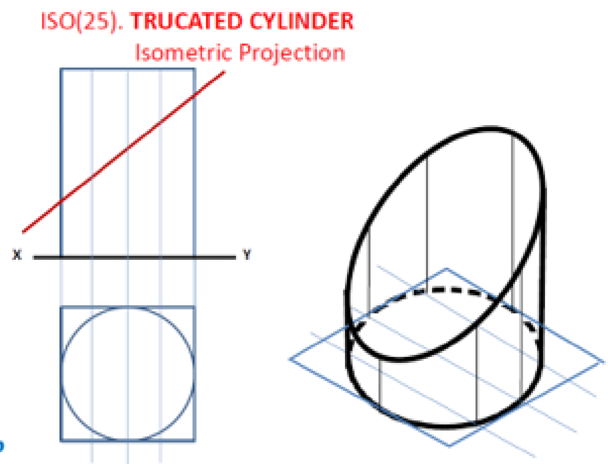
1. **Prism:** a prism is a polyhedron comprising an n-sided polygonal base, a second base which is a translated copy of the first, and **n** other faces joining corresponding sides of the two bases.



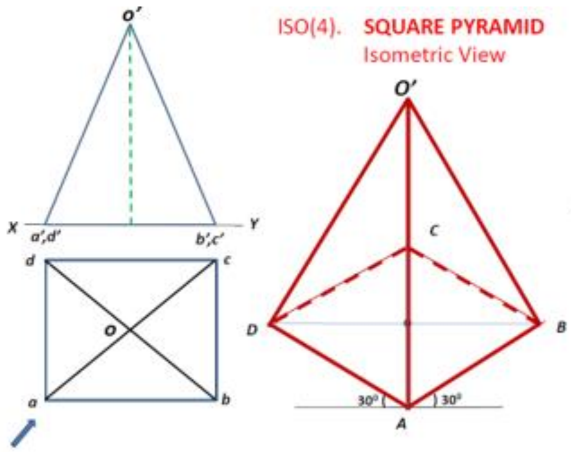


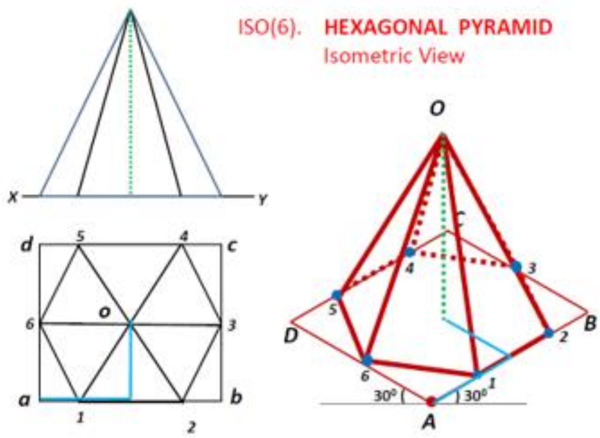
2. **Cylinder:** A cylinder is one of the most basic curved geometric shapes, with the surface formed by the points at a fixed distance from a given line segment, known as the axis of the cylinder. The shape can be thought of as a circular prism. Both the surface and the solid shape created inside can be called a cylinder.

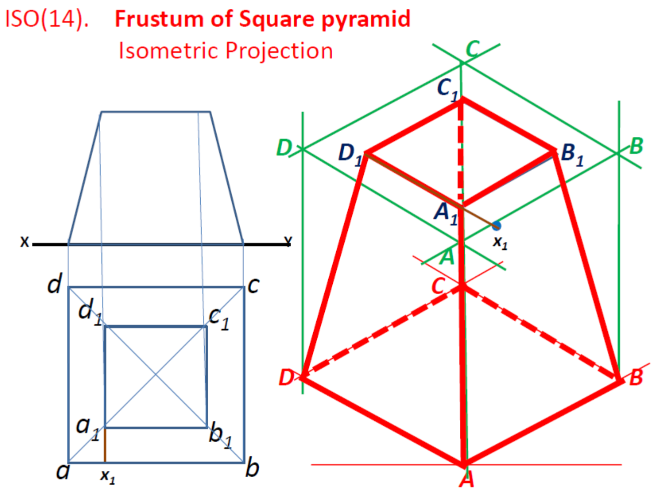




3. **Pyramid:** a square pyramid is a pyramid having a square base. If the apex is perpendicularly above the center of the square, it is a right square pyramid, and has C_{4v} symmetry. If all edges are equal, it is an equilateral square pyramid.

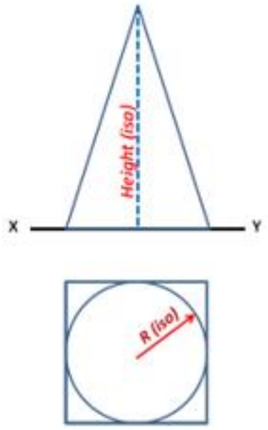


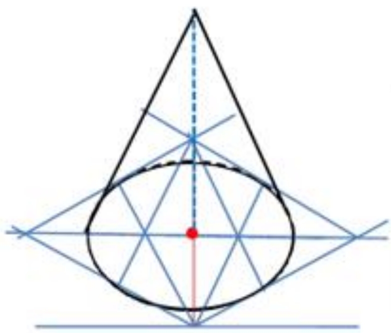




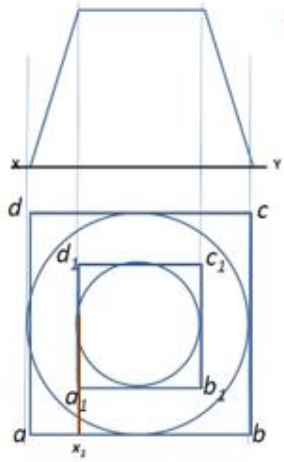
4. **Cone:** A cone is a three-dimensional geometric shape that tapers smoothly from a flat base to a point called the apex or vertex. A cone is formed by a set of line segments, half-lines, or lines connecting a common point, the apex, to all of the points on a base that is in a plane that does not contain the apex.

ISO(12). **CONE**
Isometric Projection
Base on HP

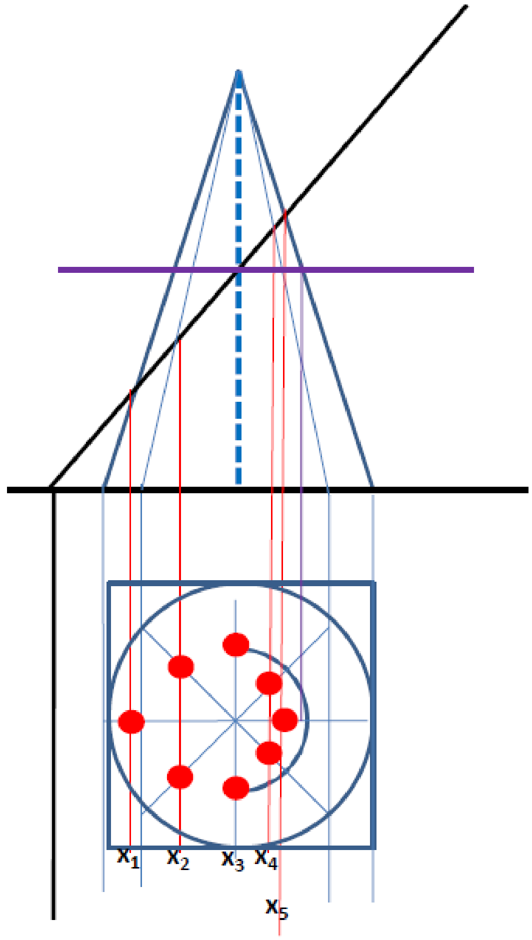


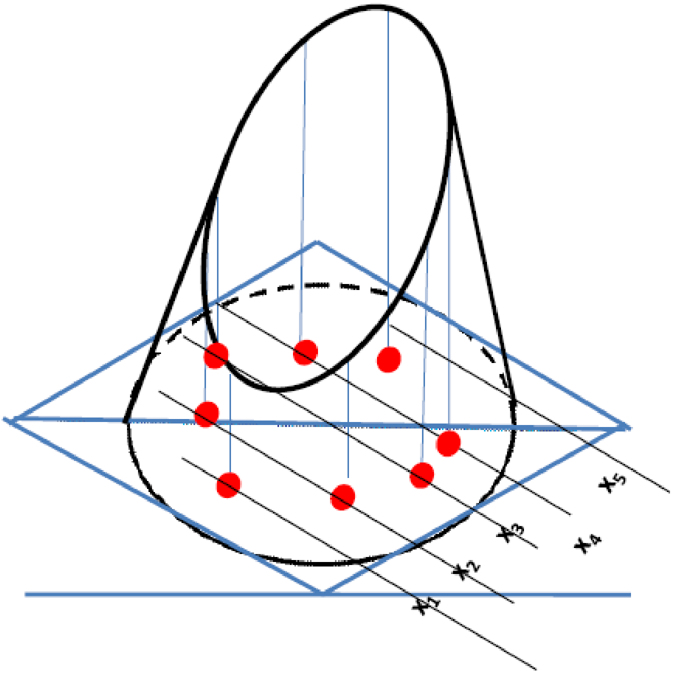


ISO(15). **Frustum of Cone**
Isometric Projection

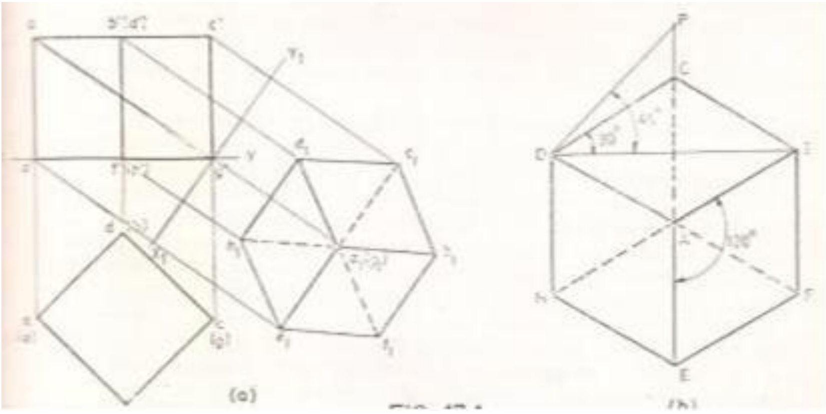


ISO(23). **TRUCATED CONE**
Isometric Projection



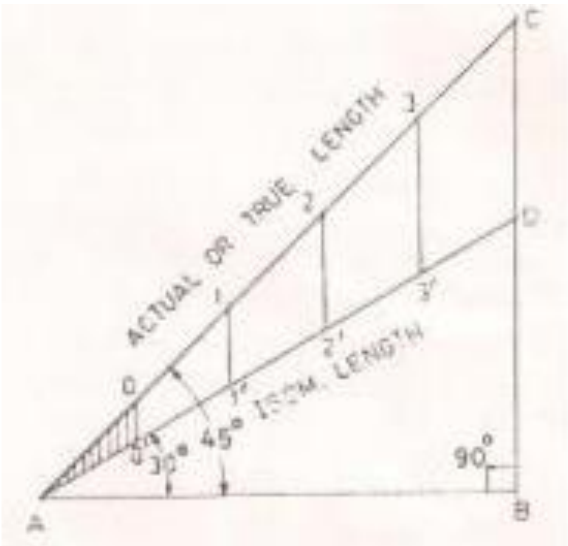


B. Construction and application of the isometric scale: When a solid is resting in its simple position, the front or top view, taken separately, gives an incomplete idea of the form of the object. When the solid id tilted from its simple position such that its axis is inclined to both H.P. and V.P., the front view or the top view or sometimes both, give a fair idea of the pictorial form of the object, i.e., all the surfaces are visualized in a single orthographic view.



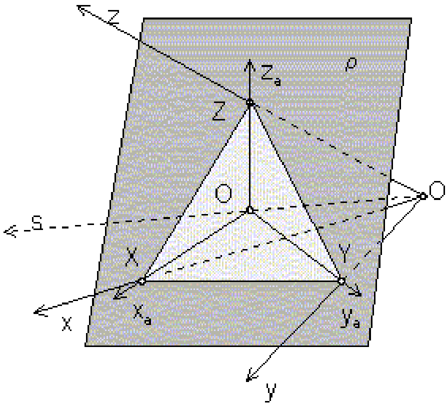
B.1. Construction of Isometric Scale:

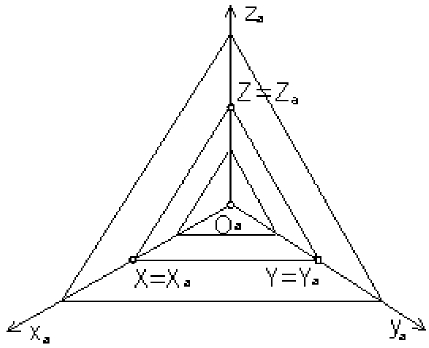
- Draw a horizontal line AB.
- From A draw a line AC at 45 degrees to represent actual or true length and another line AD at 30 degrees to AB to measure isometric length.
- On AC mark the points 0, 1, 2 etc. to represent actual lengths.
- From these points draw verticals to meet AD at 0', 1', 2' etc. The length A1' represents the isometric scale length of A1 and so on.



C. The axonometric plane and axes: Axonometric projection is a type of orthographic projection used for creating a pictorial drawing of an object, where the lines of sight are perpendicular to the plane of projection, and the object is rotated around one or more of its axes to reveal multiple sides.

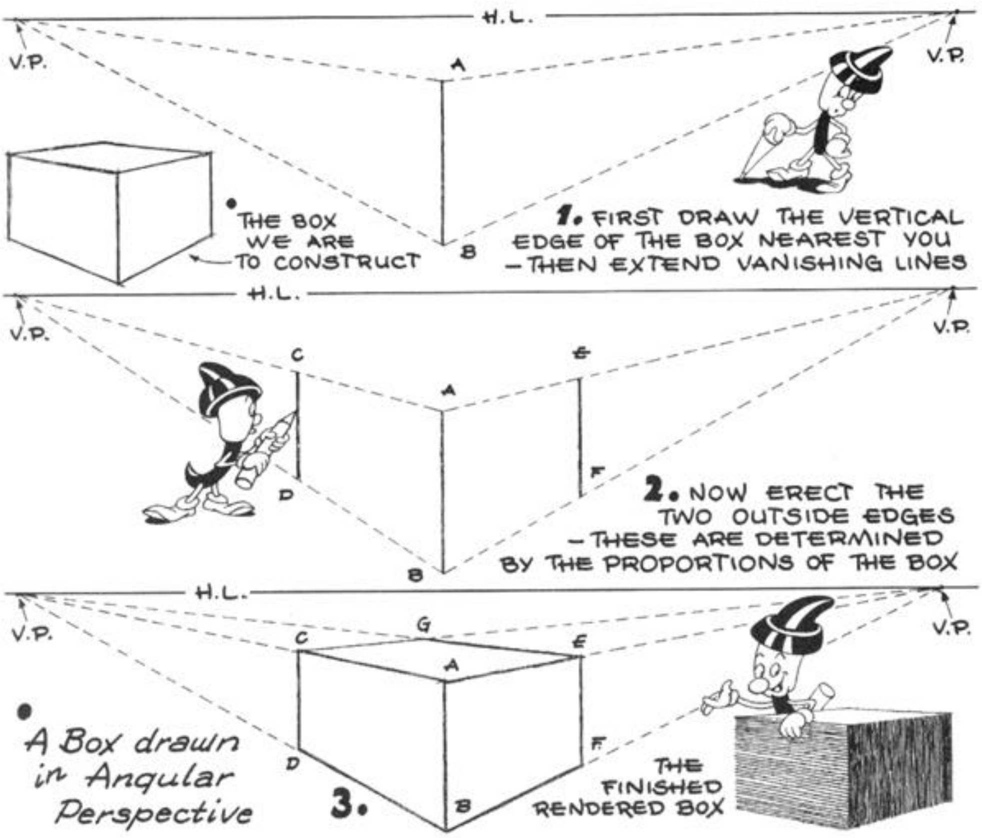
D. Principles of orthogonal axonometric projection: Axonometry is a parallel projection onto one image plane - **axonometric image plane** r, which does not coincide to any of the coordinate planes p, n, m. Space figures can be mapped onto the axonometric image plane, together with their orthographic views to the coordinate planes, and the entire coordinate trihedron $Ox^+y^+z^+$. The direction of projection s can be perpendicular to the axonometric image plane r, and then we speak about orthogonal axonometry.



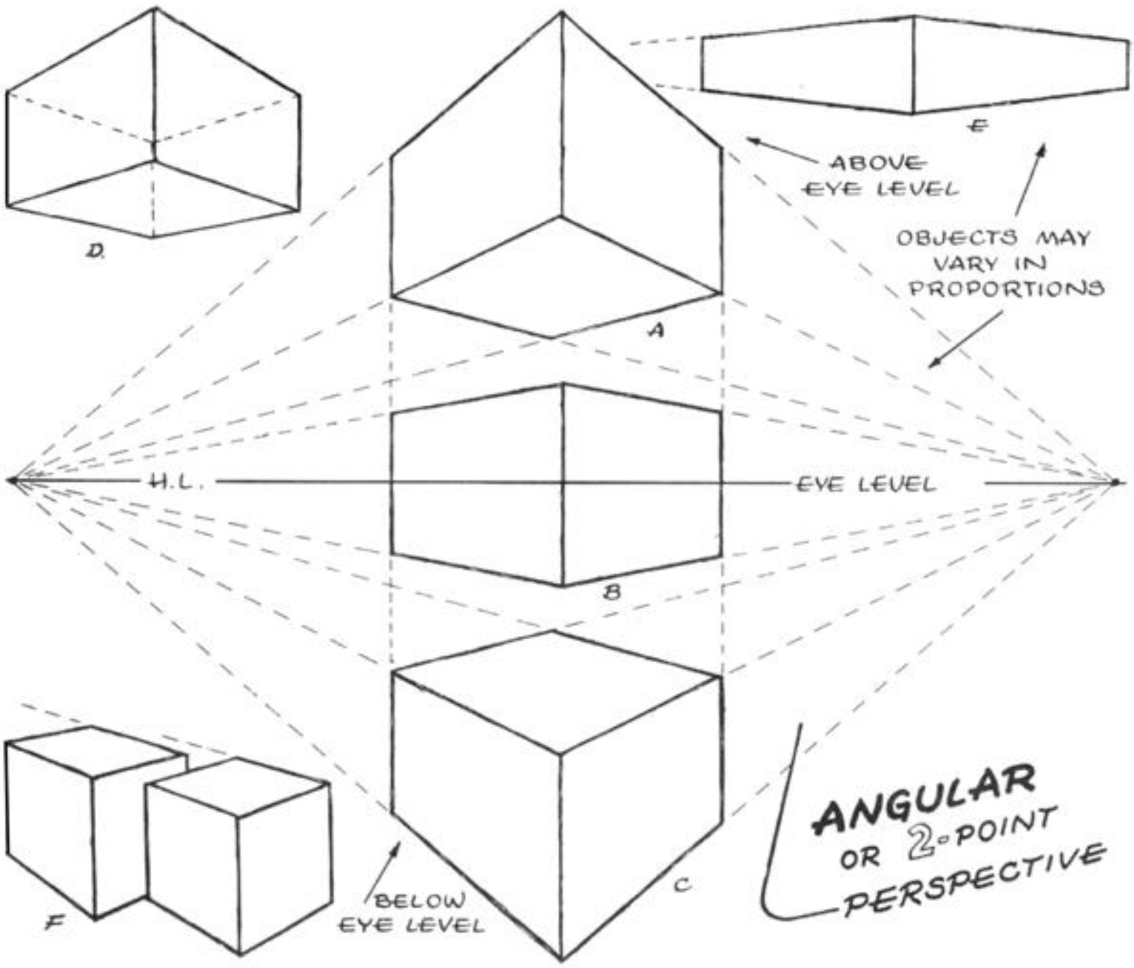


E. Principles of pictorial perspective drawing

1. **Parallel and angular perspective:** Up to this point we have been concerned only with objects which have been parallel to our line of sight, or what we know as parallel or one-point perspective. Instead of seeing one face of the object parallel to our line of vision (as in true parallel perspective), we shall now learn how to draw objects which are viewed at an angle. Whether the top or bottom of the object may be seen is determined by its relationship to the horizon line. Thus, when objects are viewed at an angle we term this angular perspective. In as much as we are now concerned with two sides – an individual vanishing point is needed on the horizon line for the perspective construction of each side. Therefore, to repeat, in angular perspective we use two vanishing points to draw our sides.

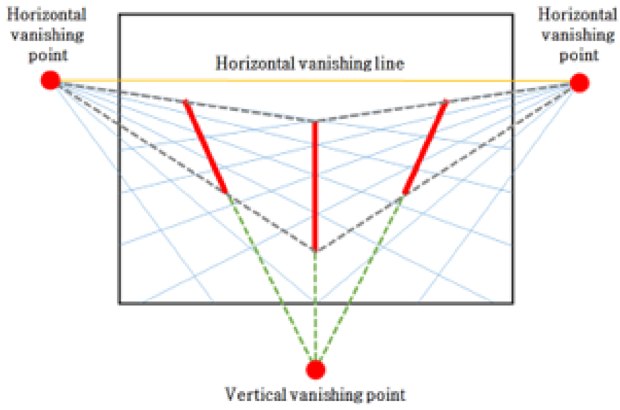


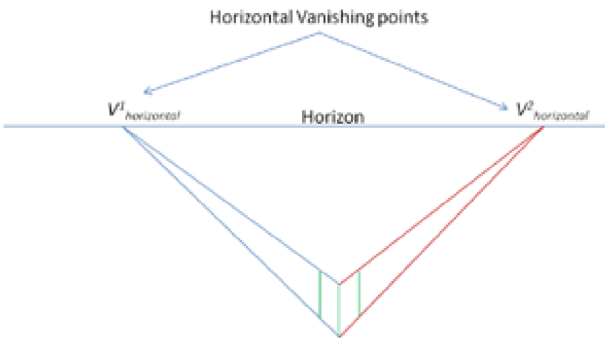
In the above diagram the horizon line is drawn first. The two vanishing points are then established in any relationship on this line preferably at a reasonable distance from each other. If the two vanishing points are too close together the object, while basically correct, appears distorted. Now proceed to construct the box as demonstrated.



In the further study of drawing objects at an angular view, we shall learn how a box is observed in relationship to its horizon line.

2. **Vanishing points for horizontal lines: In** two-**point** perspective, two sets of **horizontal lines** run toward two different **vanishing points**. All verticals are perpendicular to the ground. In three-**point** perspective, you use your left and right **vanishing points**, as in two-**point**, but you add a third **vanishing point** in the sky.



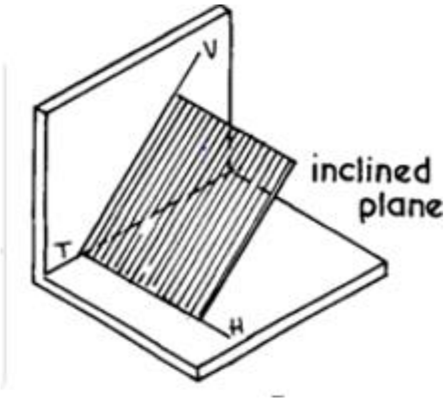


LO 2.4 – Apply descriptive geometry of lines and Planes.

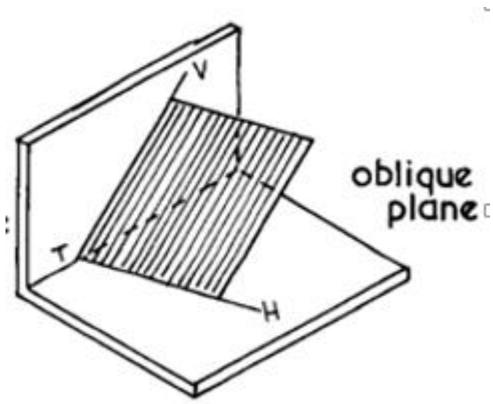
Content/Topic 1: Introduction to plane geometry.

. **plane** is a flat, two-dimensional surface that extends infinitely far. A **plane** is the two-dimensional analogue of a point (zero dimensions), a line (one dimension) and three-dimensional space.

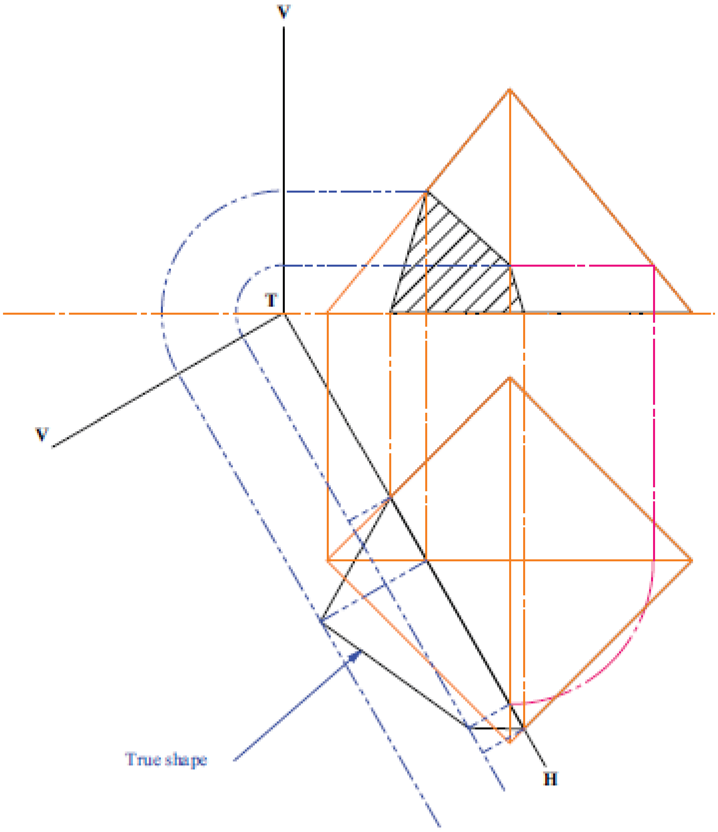
A. **Simply Inclined plane:** a plane surface that makes an oblique angle with the plane of the horizontal.



B. **Oblique plane**: are all the possible meanings and translations of the word oblique plane



A pyramid is cut by a simply inclined plane as sh**own.** Complete the elevation and show the true shape of the cut section.



A. **Determination of oblique Planes: Determine** the inclination of the **oblique plane** to the horizontal plane. (c) Hence, or otherwise, **determine** the true shape of the cut surface

B. **True shape and inclinations of planes to principal planes of reference**

A plane is usually represented by its lines of intersection with the principle planes of reference. These lines are called the **traces** of the plane. The line of intersection between the plane and the vertical plane is called the **vertical trace** and the line of intersection between the plane and horizontal plane is called the **horizontal trace**.

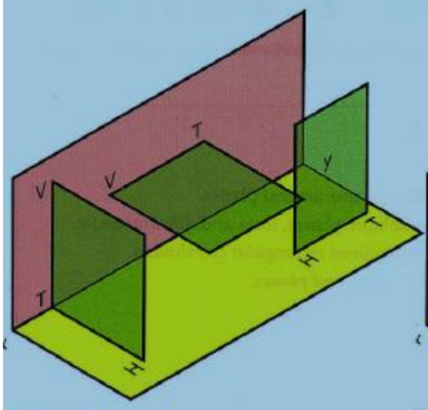


Fig. 9.1

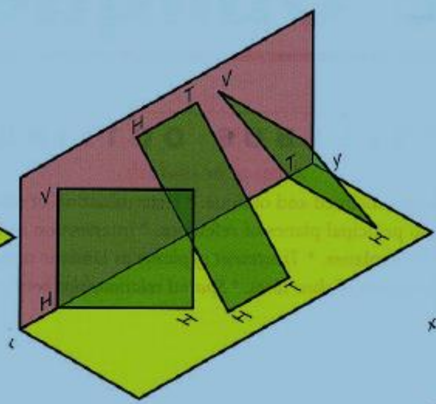


Fig. 9.2

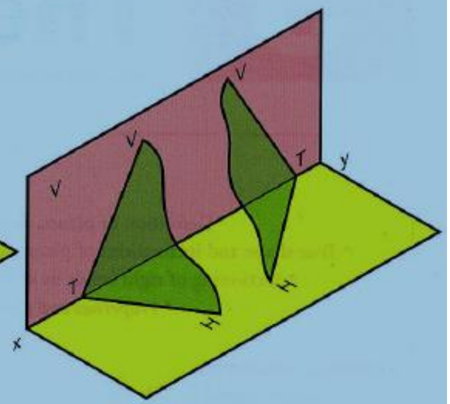


Fig. 9.3

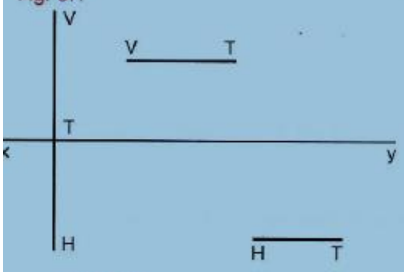


Fig. 9.1a

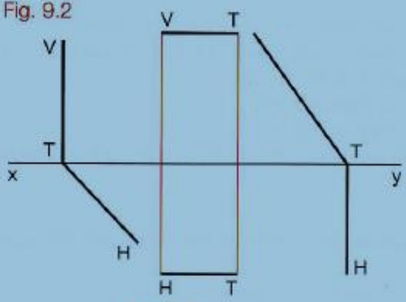


Fig. 9.2a

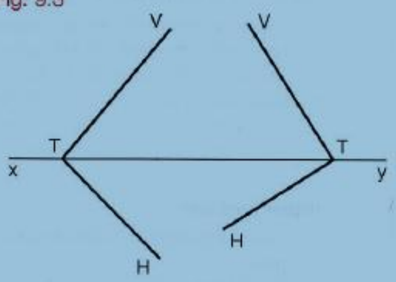


Fig. 9.3 a

To find the true inclination of an oblique plane to the HP. Fig. 9.14

To find the true angle, insert a half cone underneath the plane and tangential to it. The base angle of this cone will be the true angle of the plane to the horizontal plane.

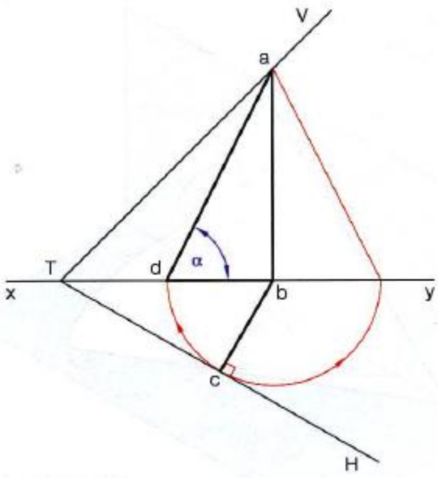


Fig. 9.14

(1) Draw a vertical line ab in elevation.

(2) From b on the xy line, draw a perpendicular to the HT finding c.

(3) Line bc equals the radius of the cone. Draw the half cone in plan.

(4) Draw the elevation of the cone. The base angle of the cone is the true angle of the plane to the horizontal plane, Fig. 9.15.

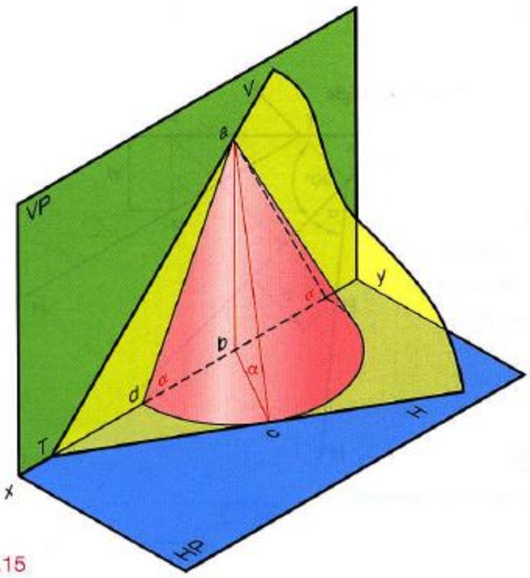
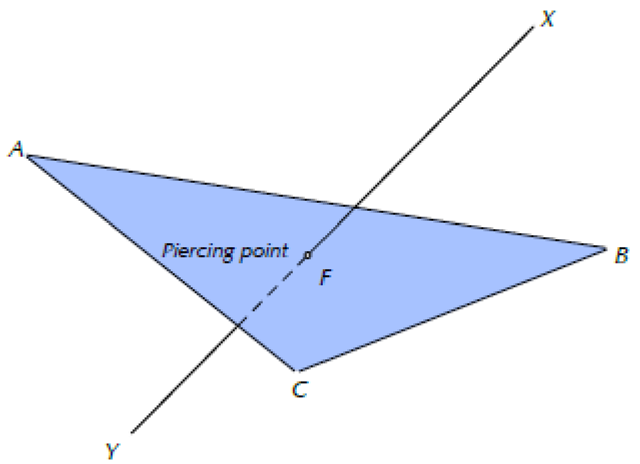
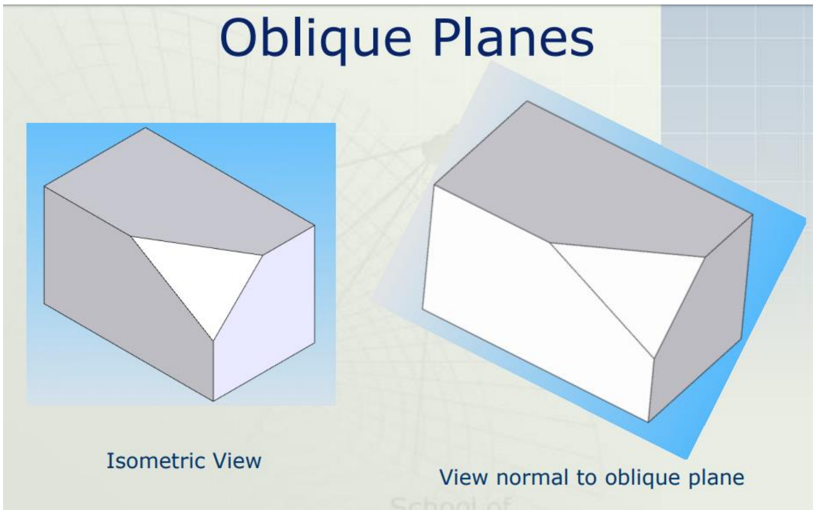


Fig. 9.15

C. Intersection of oblique planes and lines: When a line neither on nor parallel to a plane intersects that plane, it does so at a point called the piercing point.



Content/Topic 2: Sectioning of right solids by obliques plane.



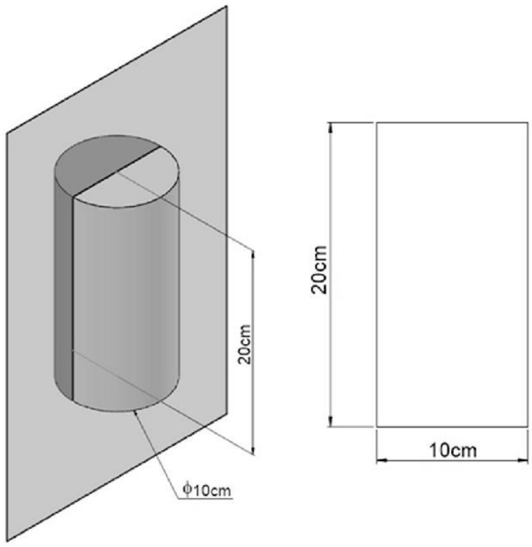
A. Types of section views

- **Full Section**: If the imaginary cutting plane passes through the entire object, splitting the drawn object in two with the interior of the object revealed, this is called a "full **section**." A full **section** is the most widely-used **sectional view**.
- **Half View**.: In this view, the cutting plane is assumed to bend at a right angle and cuts through only half of the represented object, not the full length. When the quarter of the object that was cut is removed, the remainder is called a "half section." A half section view is effective only on symmetrical objects, and its main purpose is to show an object's internal and external construction in the same drawing.

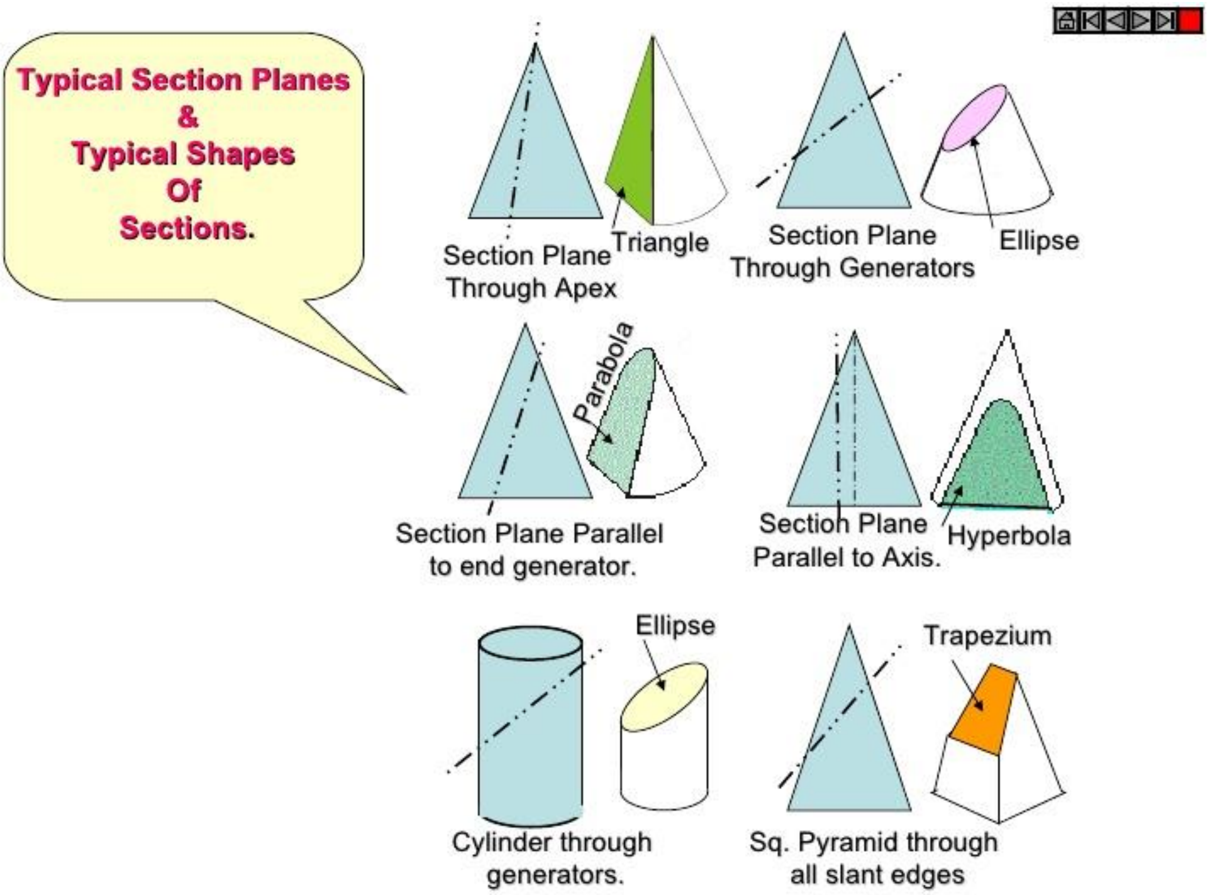
- **Offset View:** When specific features of an object that need highlighting are not located on the straight line of the cutting plane, an irregular-shaped cutting plane is imagined cutting the object, revealing the desired components. This is called an "offset view," and is effective on complex objects. The bends in the imaginary cutting pane are always 90 degrees.
- **Revolving View:** A "revolving view" is effective for elongated objects or the elongated section of an object. In this view, the cross-sectional shape of ribs, spokes, and other projections of the object are featured. The cutting plane cuts the object at an angle, but the drawing is rotated for a better view by the observer.
- **Broken View:** When only a small part of the object needs viewing, the cutting plane is not used. An irregular cut line removes a section of the object at the desired depth, leaving a "broken view." A broken view is helpful when only specific interior details in a certain part of the object need featuring.

B. Representation of cutting plan: Engineers use cutting plane lines on the plans they are drawing up to differentiate what is inside an object and what lies outside it. The cutting plane line bisects the object and provides a view of its interior features. Cutting plane lines and the interior features of the object they bisect are never in the same color as the rest of the plan.

Engineers may manually draw cutting plane lines on their designs by using paper, pencil or pen, a straight edge ruler, or T-Squares. Today, most cutting plane lines are done electronically, with engineers using computer aided design to create them.



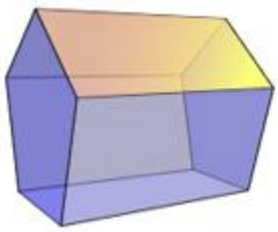
C. Examples of cutting plane and sectioning of different solids

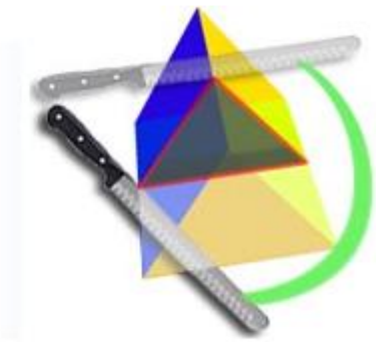


LO 2.5 – Intersect and develop surfaces.

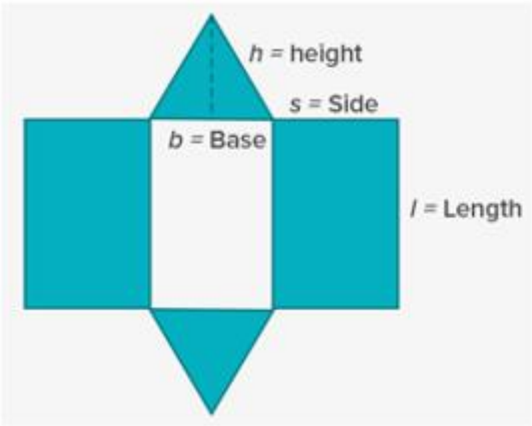
Content/Topic 1: Surface development and envelopment of right solids.

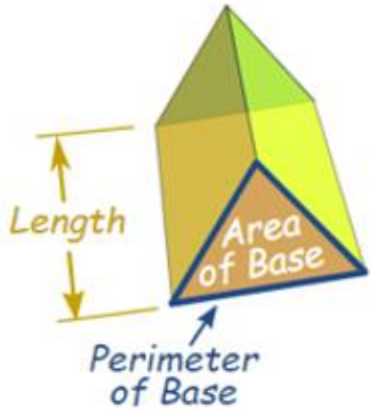
A. **Development of prism:** A prism is a solid object with: identical ends, flat faces and the same cross section all along its length.





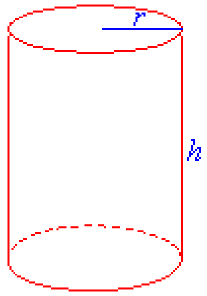
A cross section is the shape made by cutting straight across an object.
The cross section of this object is a triangle, it has the same cross section all along its length so it's a triangular prism.

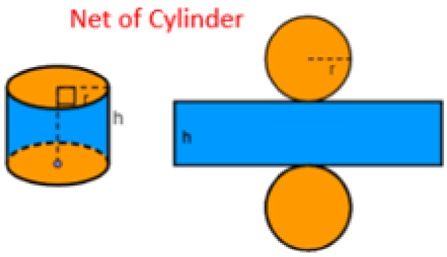




B. Development of cylinder

A cylinder is a solid with two congruent circles joined by a curved surface.

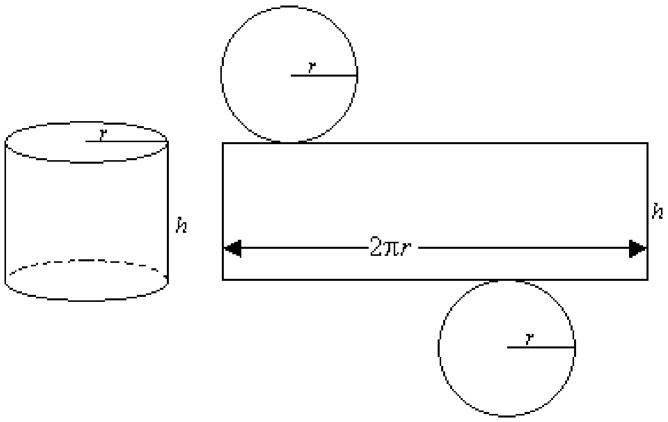




In the above figure, the radius of the circular base is r and the height is h. The volume of the cylinder is the area of the base × height.

$$\text{Volume of cylinder} = \pi r^2 h$$

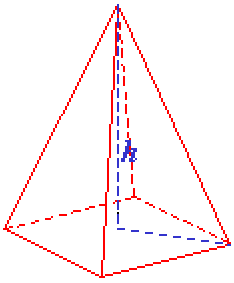
The net of a solid **cylinder** consists of 2 circles and one rectangle. The curved surface opens up to form a rectangle.



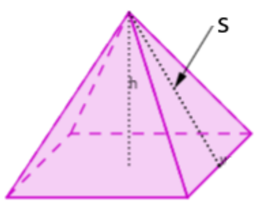
Surface area = 2 × area of circle + area of rectangle

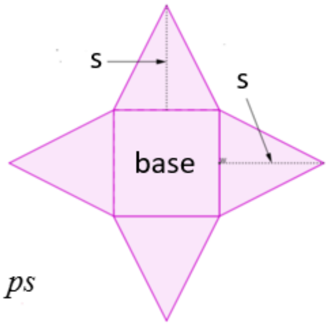
Surface area of cylinder = $2\pi r^2 + 2\pi rh = 2\pi r\,(r + h)$

C. **Development of pyramid:** A pyramid is a solid with a polygon base and connected by triangular faces to its vertex. A pyramid is a regular pyramid if its base is a regular polygon and the triangular faces are all congruent isosceles triangles.



Surface area of a Pyramid: The following diagrams show how to find the surface area of a pyramid.



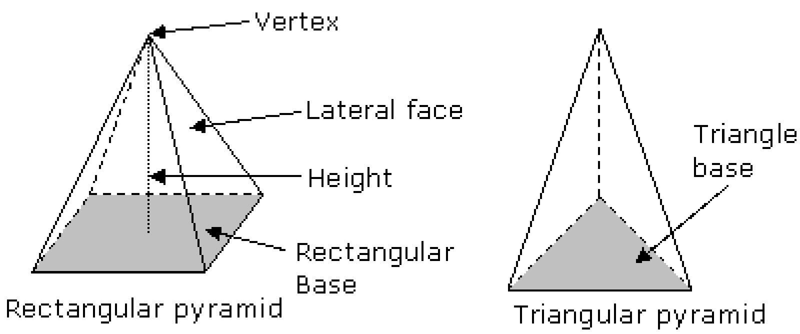


Surface Area = $A + \frac{1}{2}ps$

A = Area of base
p = perimeter of base
s = slant height

A pyramid is a solid with a polygonal **base** and several triangular **lateral faces**. The lateral faces meet at a common **vertex**. The number of lateral faces depends on the number of sides of the base. The **height** of the pyramid is the perpendicular distance from the base to the vertex.

A regular pyramid has a base that is a regular polygon and a vertex that is above the center of the polygon. A pyramid is named after the shape of its base. A rectangular pyramid has a rectangle base. A triangular pyramid has a triangle base.

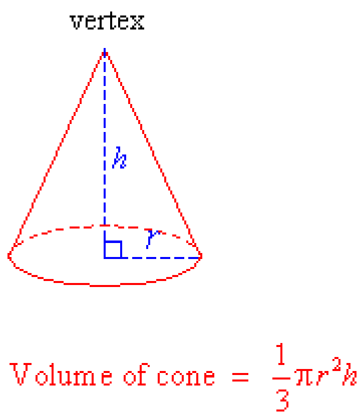


We can find the surface area of any pyramid by adding up the areas of its lateral faces and its base.**Surface area of any pyramid = area of base + area of each of the lateral faces** If the pyramid is a regular pyramid, we can use the formula for the surface area of a regular pyramid.

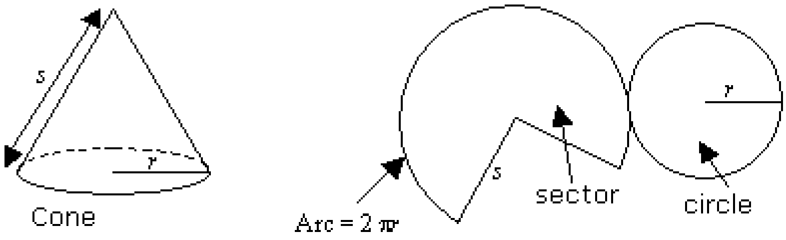
Surface area of regular pyramid = $\mathbf{area\ of\ base} + \frac{1}{2}\mathbf{ps}$**,** where p is the perimeter of the base and s is the slant height.If the pyramid is a square pyramid, we can use the formula for the surface area of a square pyramid.

Surface area of square pyramid = $\mathbf{b^2 + 2bs}$ **,**where b is the length of the base and s is the slant height.

D. **Development of cone: A** circular cone has a circular base, which is connected by a curved surface to its vertex. A cone is called a right circular cone, if the line from the vertex of the cone to the center of its base is perpendicular to the base.



The net of a solid **cone** consists of a small circle and a sector of a larger circle. The arc of the sector has the same length as the circumference of the smaller circle.



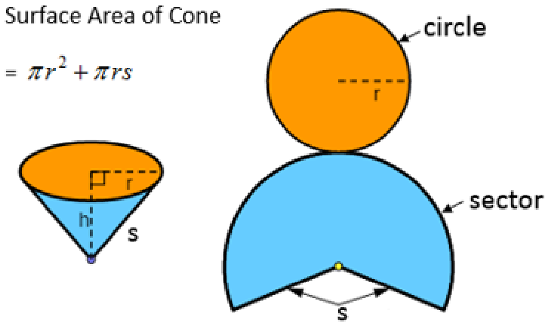
Surface area of cone = Area of sector + area of circle= $\pi rs + \pi r^2 = \pi r(r + s)$

Surface Area of a Cone

A cone is a solid with a circular base. It has a curved surface which tapers (i.e. decreases in size) to a vertex at the top. The height of the cone is the perpendicular distance from the base to the vertex.

The net of a solid cone consists of a small circle and a sector of a larger circle. The arc of the sector has the same length as the circumference of the smaller circle.

The following figures show the formula for surface area of a cone. Scroll down the page if you need more examples and explanations.

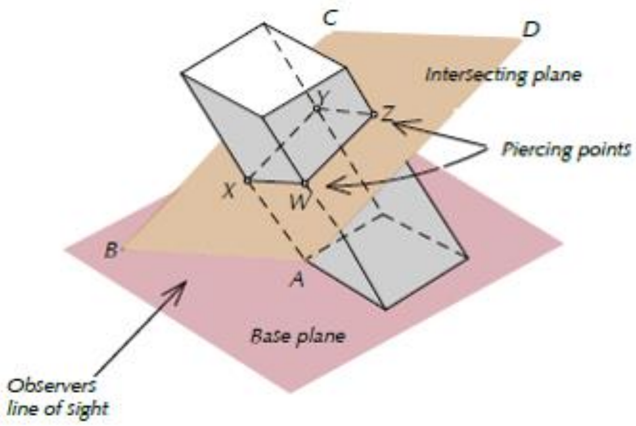


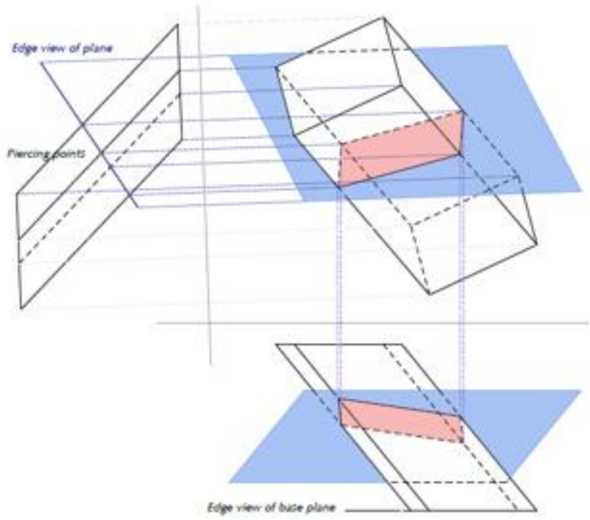
Surface area of cone = Area of sector + area of circle $= \pi rs + \pi r^2 = \pi r(r+s)$

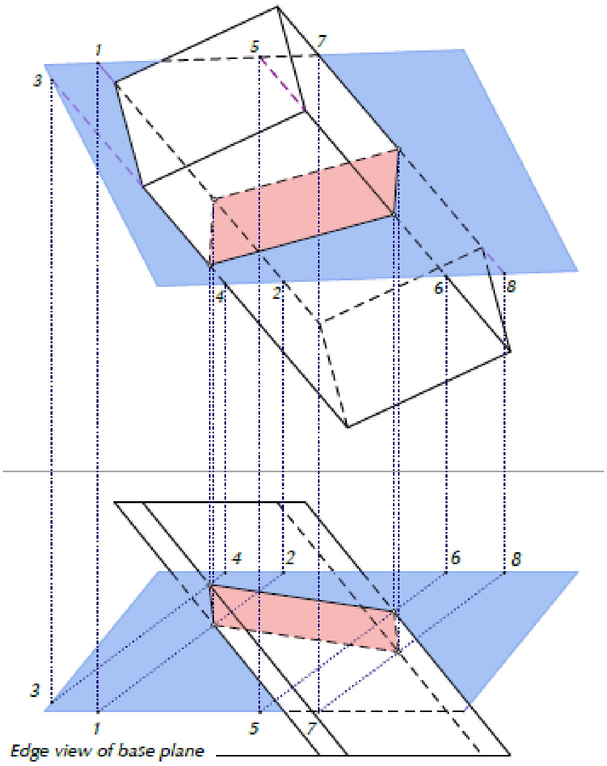
Content/Topic 2: Intersection of surfaces and development.

A. **Prisms:** The intersection of two flat surfaces is a line. Therefore, when a plane surface intersects the face of a prism it does so in a line.

The individual lines of intersection between the plane and faces of the prism form the complete lines of intersection between the plane and the prism. In Figure 6-13 plane ABCD intersects the prism along lines WXYZ.

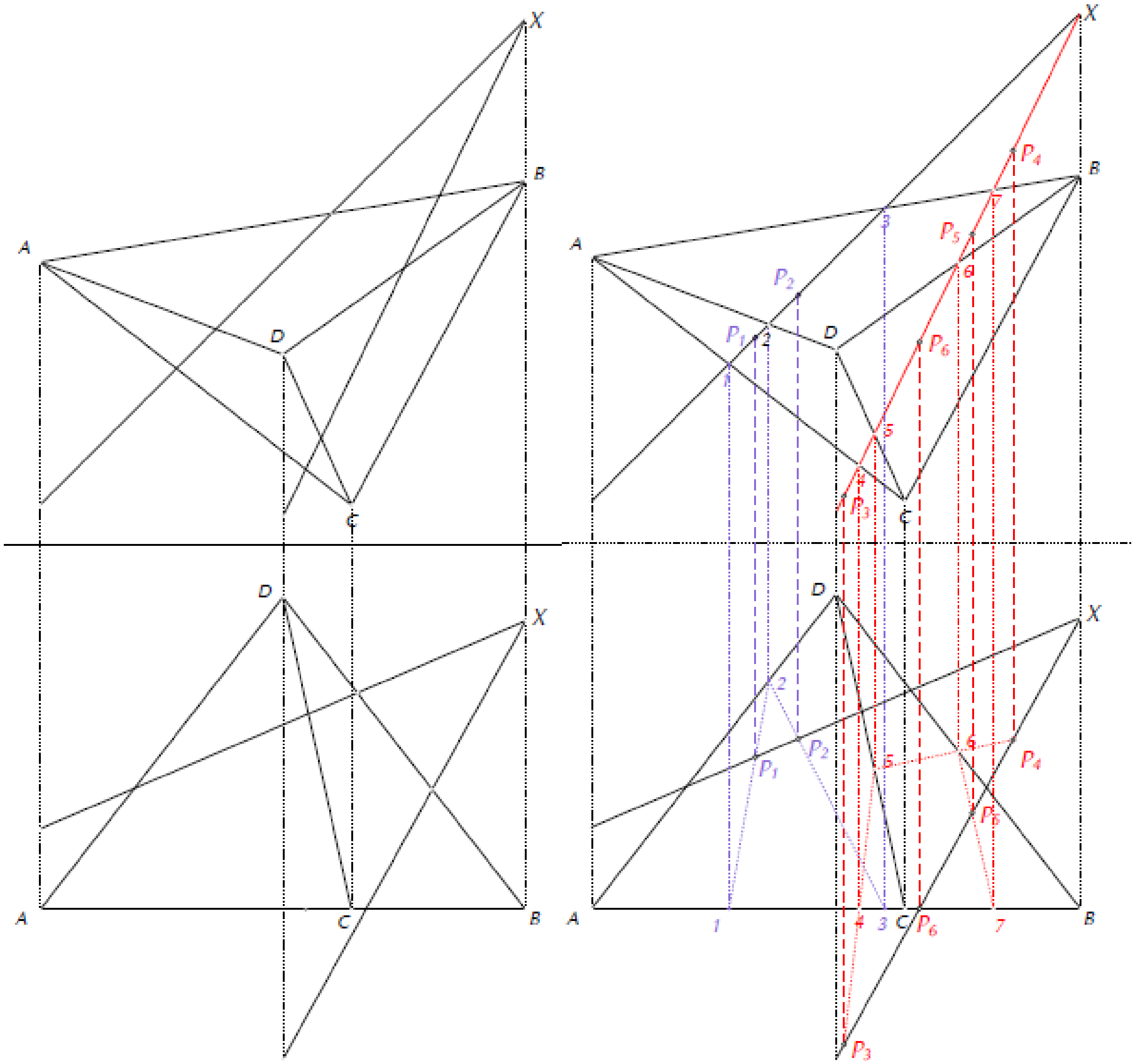




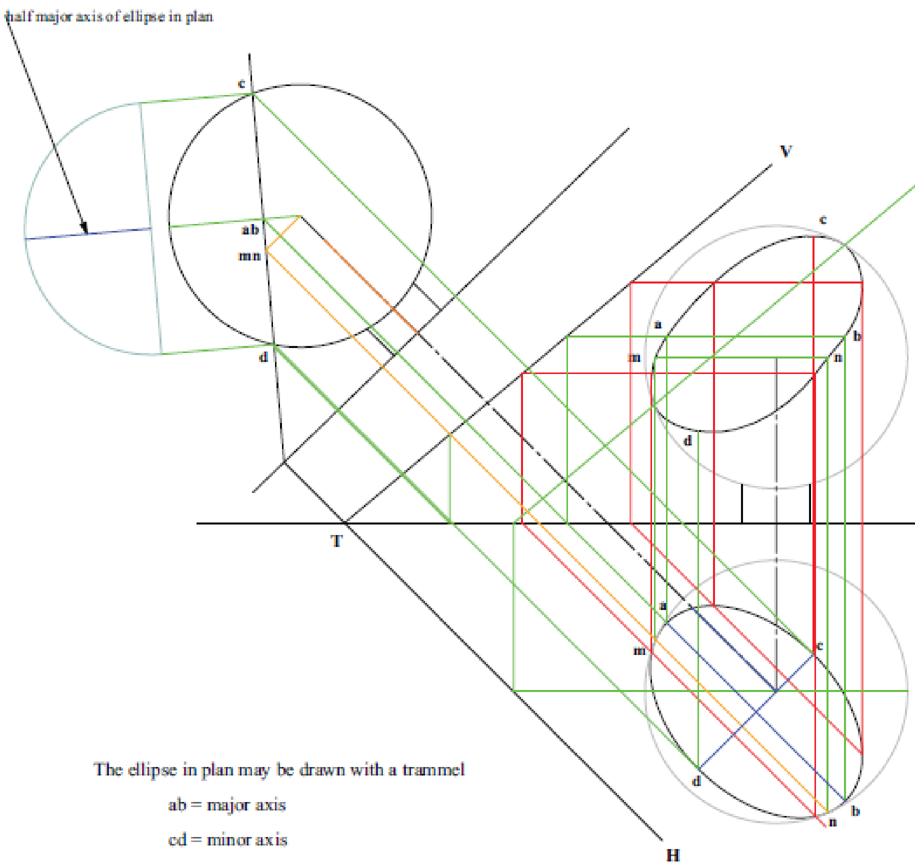


B. Pyramids: We are given a pyramid and two lines emanating from the same point Determine whether the two lines intersect the pyramid and if so, where. The steps to the problem are straightforward. For each line from X, we determine the piercing points by constructing the traces of the cutting plane. The traces 12 and 23determine the piercings points P1 and P2. Likewise, traces 45 and 56 determine (apparent) piercing points P3 and P4, which lie outside the pyramid.

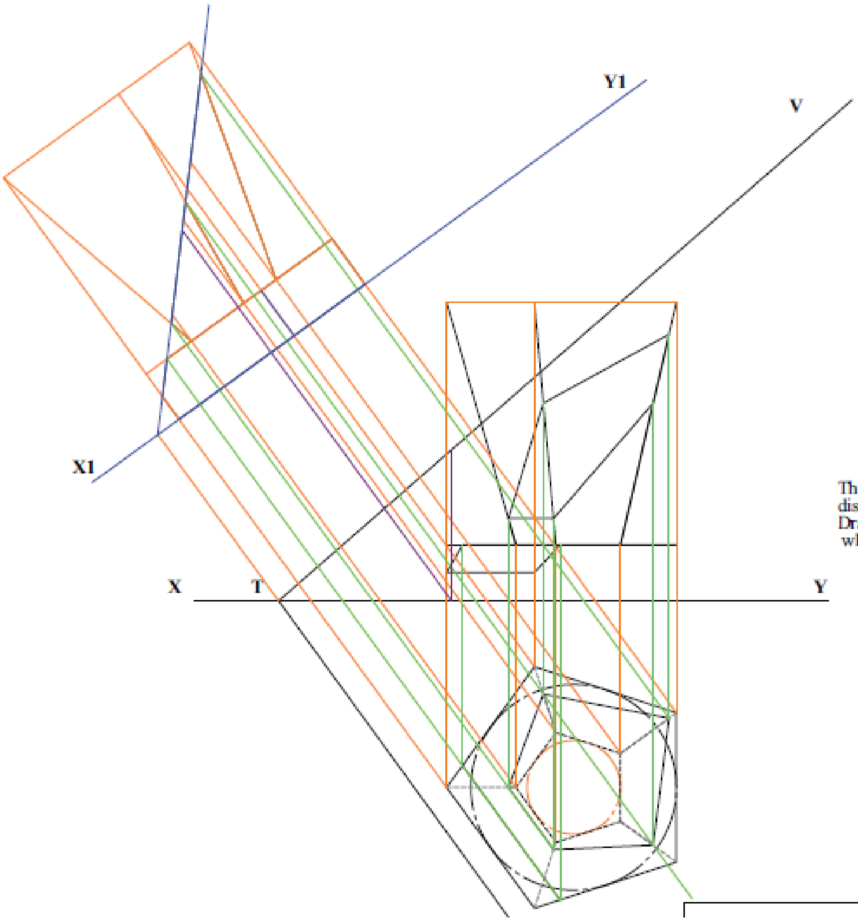
Trace 67 determines the piercing point P5. Trace 47 determines the piercing point P6, which intersects the base of the pyramid.

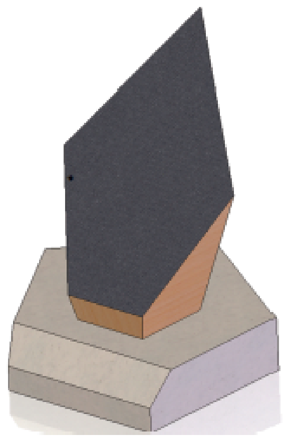


C. Spheres: The elevation and plan of a sphere that is to be cut by the oblique plane VTH is given. Complete the plan and elevation of the sphere showing the cut section.



D. Composite Solids





The partial elevation and plan of a jewellery display stand is shown.
Draw the projections of the jewellery stand when cut by the oblique plane VTH.

Learning Unit 3 – Perform Design Communication and Computer Graphics.

LO 3.1 – Apply graphics in communication.

Content/Topic 1: Drawing from a historical perspective.

A. **Design strategies:** is the term used to describe the nexus between corporate strategy and design thinking. Corporate strategy is the traditional method that businesses and other similar entities use to identify, plan, and achieve their long-term objectives and goals. Design Thinking is a methodology that provides a solution-based approach to solving problems by engaging the end-users.

B. **Reflection on process of design:** In Design Study Jason Dykes, City, University of London Mariah Meyer, University of Utah Abstract Visualization design study research methodologies emphasize the need for reflection to generate knowledge. And yet, there is very little guidance in the literature specifying what reflection in the context of design studies actually involves. We initiated a community discussion on this topic through a panel at the 2017 IEEE VIS Conference -- this report documents the panel discussion. We analyze the panel content through the lenses of our own reflective experiences and propose several priorities for ongoing thinking on reflection in applied visualization research. Introduction In 2012 Sedlmair et al. proposed a design study methodology, laying out a call to the visualization community to take a more structured and methodical approach to design-focused applied visualization research [1].

   While some guidance in the methodology is specific to design studies, there are many ideas that cross-cut applied visualization research more generally. One of these is the role of reflection in generating and validating knowledge from highly situated research settings. The paper notes that "reflection is where research emerges from engineering", and provides this guidance for reporting on design study research: "a careful selection of decisions made, and their justification, is imperative for narrating a compelling story about a design study and are worth discussing as part of the reflections on lessons learned." Best practice according to the paper might involve "reflecting on lessons learned from the specific situation of study in order to derive new or refined general guidelines [, which] typically requires an iterative process of thinking and writing." This limited guidance is the extent of existing advice in the visualization literature on the role of reflection, and what it might entail for applied visualization research. In our own research groups, we use reflection throughout the process of designing new visualization techniques and systems, as well as when we try to understand the broader implications of the applied research that we do. The specifics of our reflective practices, however, are not always the same. Furthermore, we do not actually know how we should be reflecting or even how we could be reflecting the limited discussion in our literature is not enough. What works, what doesn't, and how certain are we about any of this?

C. **Design appraisal:** Appraisal of conceptually new engineering solutions, if fundamentally new engineering solutions are used, as well as for the purpose of feasibility studies, tenders, etc., the Register may conduct an appraisal of terms of,

- reference,
- technical proposal,
- tender documentation, conceptual design and other documentation that is characterized by a high degree of novelty. According to the appraisal results, a Conclusion Letter is sent to the Customer.

Content/Topic 2: Interpretation of design.

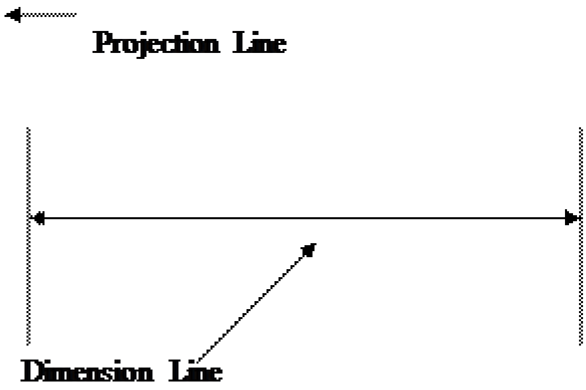
A. **Ideas sketching:** I used drawing as a primary language for capturing thoughts, exploring ideas, and then sharing those ideas. Teachers and mentors encourage people, helping to sustain sketching as a key skill throughout school and into professional career. Good fortune has to ignite passion to become a sketch advocate, helping others rediscover sketching as a powerful problem-solving and communication tool.

B. **Design problem solving:** Design thinking is a process by which designers approach **problem solving**. It incorporates analytical, synthetic, divergent and convergent thinking to create a wide number of potential solutions and then narrow these down to a "best fit" **solution.**

LO 3.2 – Apply Design Communication.

Content/Topic 1: Introduction to Design Communication

A. **Drawing conventions, symbols and standards:** In the construction industry all drawings are carried out to a British Standard (BS 1192). This ensures that every drawing produced within Ireland and the UK relating to a building project will follow the same standard principles. Dimensions should be shown as follows:



The conventions relating to dimensions are as follows:

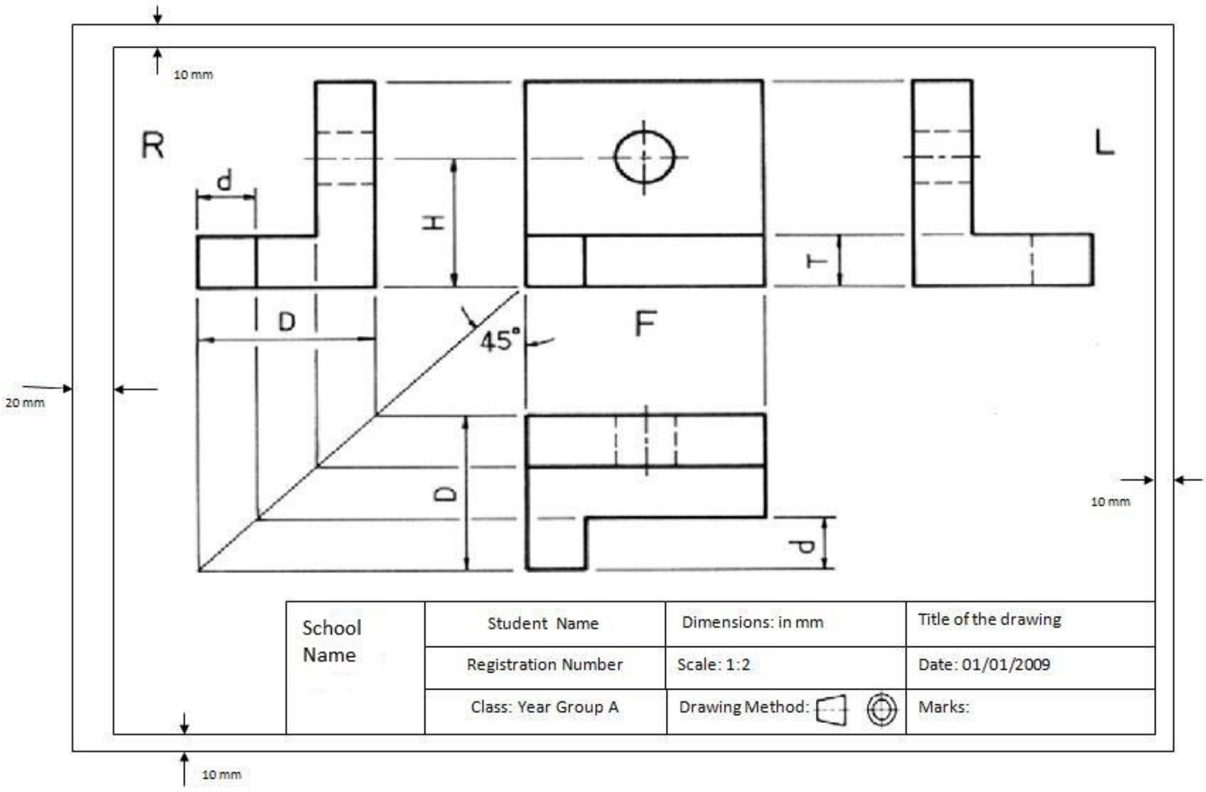
- State dimensions once only.
- Place in the most appropriate view.
- Keep related dimensions on the same view.
- Select the functional dimensions.
- Avoid redundant dimensions.

Give metric dimensions to the least number of significant figures, for example;2.5 not 2.50 3 not 3.0 Dimensions less than 1 are expressed with a zero preceding the decimal point; 0.5 not 5.

❖ **letters and numbers:** All drawings require some form of lettering and numbers. The principles to remember are:

- They should be legible and clear – especially numbers, as they often have to be read on their own.
- They should be of a suitable size and not less than 3mm tall. Title blocks and relative information are usually larger.
- They should be correctly spaced and positioned. Notes and captions should be placed so that they can be read in the same direction as in the title block. In other worlds, it should not be necessary to turn a drawing on its side to read the information.
- Notes should be grouped together and not spread over the drawing.
- Underlining is not recommended.

❖ **Borders and title blocks:** One of the most important features of any drawing is the border and title block. The border (or margin) is a line that follows the outer edge of the drawing and is usually 10 or 20mm inside it. This margin is very important because everything inside it forms part of any contract. The 'Title Block' is locked within the boarder and contains information such as:



- **Scales:** A scale can be used to increase the detail of a small object or to accurately represent a large object on a smaller piece of paper. The majority of scaled work done in the construction industry is to reduce objects to a smaller more suitable size that will fit on a sheet of paper.

- **Graphical symbols and abbreviations:** In order to read a drawing properly, and to understand what is happening, an agreed set of graphical symbols and abbreviations are used. All the different trades have a set of symbols pertaining to their respective works. The works of the plumber is often referred to as the "Mechanical Services". The Mechanical Services includes:

  - Hot and Cold-Water Services.
  - Central Heating Installations.
  - Air Conditioning Pipe-work.
  - Compressed Air Lines.
  - Oil and Gas Supply Lines.
  - Above and Below Grounds Drainage.
  - Medical Gas Services.
  - Sheet Metal Roof Coverings.

❖ **Abbreviations for Pipe Rises/Drops**

TA To Above

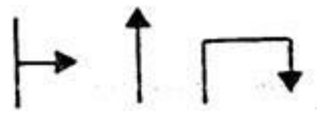
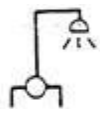
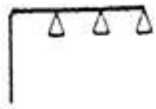
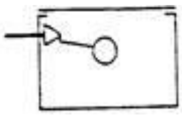
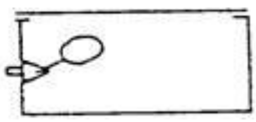
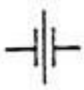
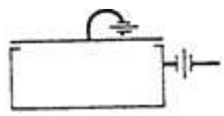
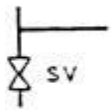
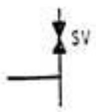
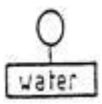
FB From Below

RTA Rise to Above

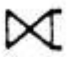
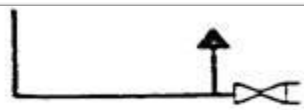
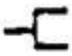
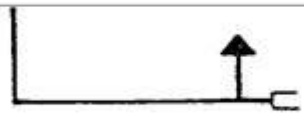
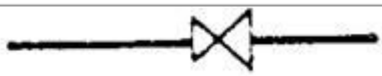
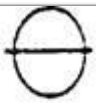
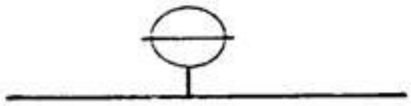
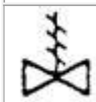
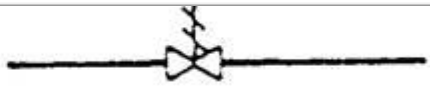
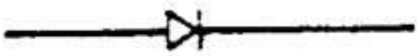
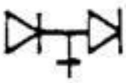
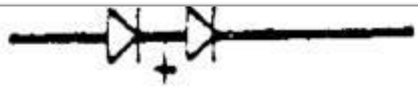
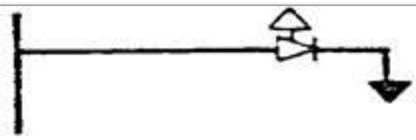
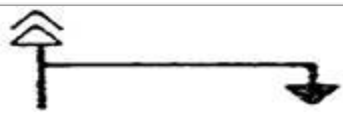
DTB Drop to Below

To identify individual services some of the following abbreviations may be used.

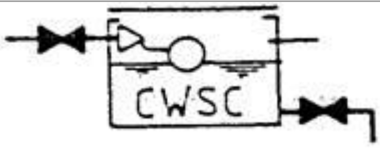
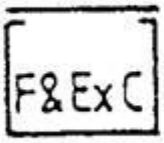
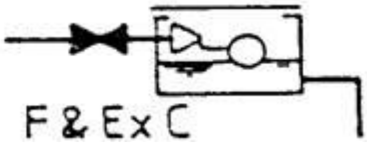
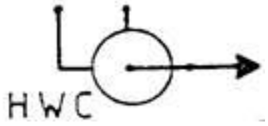
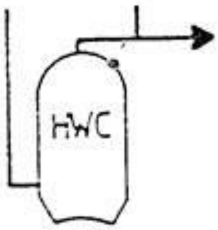
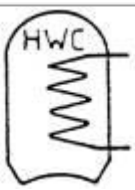
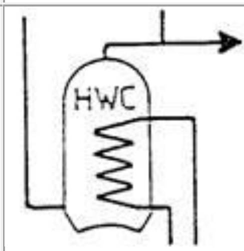
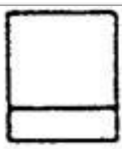
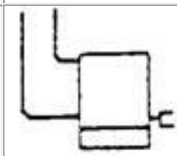
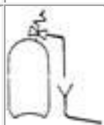
- British Standards Institution Symbols
- BSI Symbols

Symbol	Description	Application
	Draw-off tap	
	Shower head	
	Sprinkler head	
	Float-operated valve	
	Float switch (Hydraulic type)	
	Float switch (Magnetic type)	
	Filter or screen	
	Supply stop valve (SV)	
	Servicing valve (SV)	
	Water meter	

- **BSI Symbols**

Symbol	**Description**	**Application**
	Draining valve (BS 1192) (Drain valve) (drain cock)	
	Draining valve (Abbreviated version used in this book)	
	Line Strainer	
	Pressure reducing valve (Small end denotes high pressure)	
	Expansion vessel	
	Pressure relief valve (Expansion relief valve)	
	Check valve or non-return valve (NRV)	
	Double check valve assembly	
	Combined check and anti-vacuum valve (check valve and vacuum breaker)	
	Air inlet valve	

- **BSI Symbols**

Symbol	Description	Application
	Cold water storage cistern (Storage and feed cistern) (Feed Cistern)	
	Feed and expansion cistern	
	Hot water storage cylinder or tank (plan)	
	Hot water storage cylinder or hot store vessel (Direct types) (elevation)	
	Hot water storage cylinder or hot store vessel (indirect types) (elevation)	
	Boiler (elevation)	
	Temperature relief valve	
	Tundish	

Content/Topic 2: Presentation methods of drawing

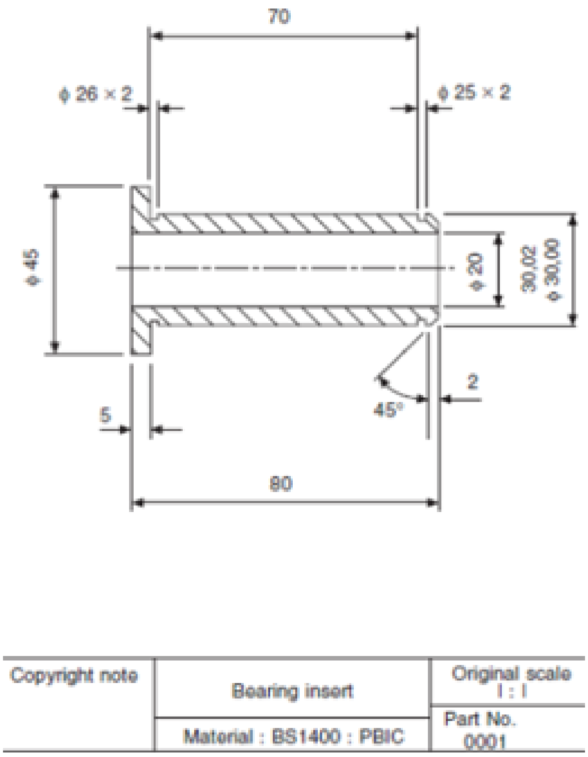
A. Single-part drawing: A single-part drawing should supply the complete detailed information to enable a component to be manufactured without reference to other sources. It should completely define shape or form and size, and should contain a specification.

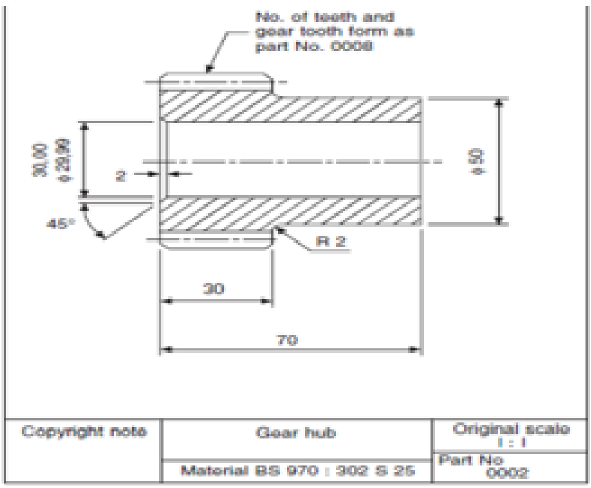
The number of views required depends on the degree of complexity of the component. The drawing must be fully dimensioned, including tolerances where necessary, to show all sizes and locations of the various features. The specification for the part includes information relating to the material used and possible heat-treatment required, and notes regarding finish.

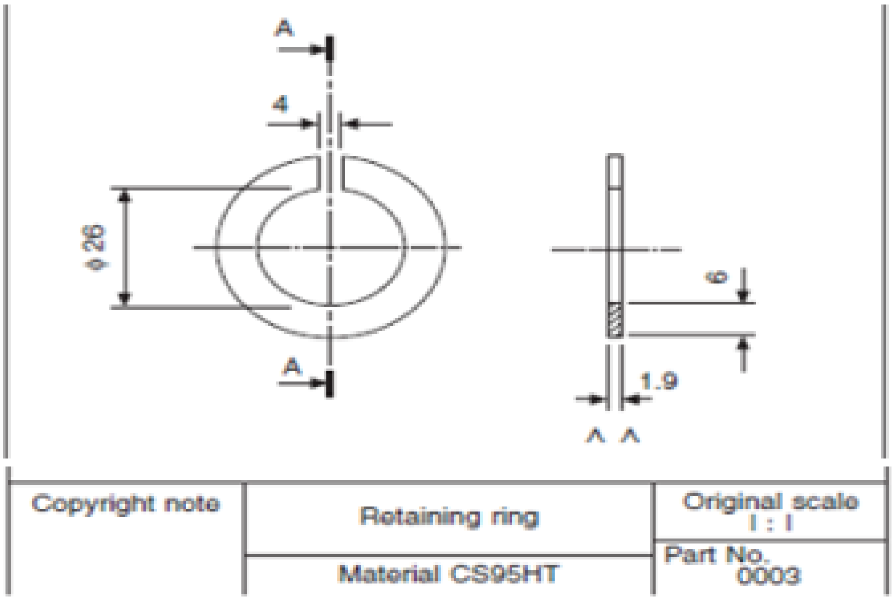
The finish may apply to particular surfaces only, and may be obtained by using special machining operations or, for example, by plating, painting, or enameling.

More than one drawing may also be made for the same component. Consider a sand-cast bracket. Before the bracket is machined, it needs to be cast; and before casting, a pattern needs to be produced by a patternmaker it may therefore be desirable to produce a drawing for the patternmaker, which includes the various machining allowances, and then produce a separate drawing for the benefit of the machinist, which shows

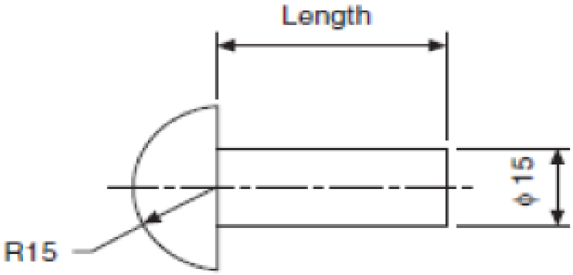
Only dimensions relating to the surfaces to be machined and the size of the finished part. The two drawings would each have only parts of the specification which suited one particular manufacturing process







B. Collective single-part drawings: The following figures shows a typical collective single-part drawing for a rivet. The drawing covers 20 rivets similar in every respect except length; in the example given, the part number for a 30 mm rivet is S123/13. This type of drawing can also be used where, for example, one or two dimensions on a component (which are referred to on the drawing as A and B) are variable, all others being standard.



Part No.	Length	Part No.	Length
S123/1	6	/11	26
/2	8	/12	28
/3	10	/13	30
/4	12	/14	32
/5	14	/15	34
/6	16	/16	36
/7	18	/17	38
/8	20	/18	40
/9	22	/19	42
/10	24	/20	44

Copyright note	Rivet	Standard No. S 123
	Material EIC-0	

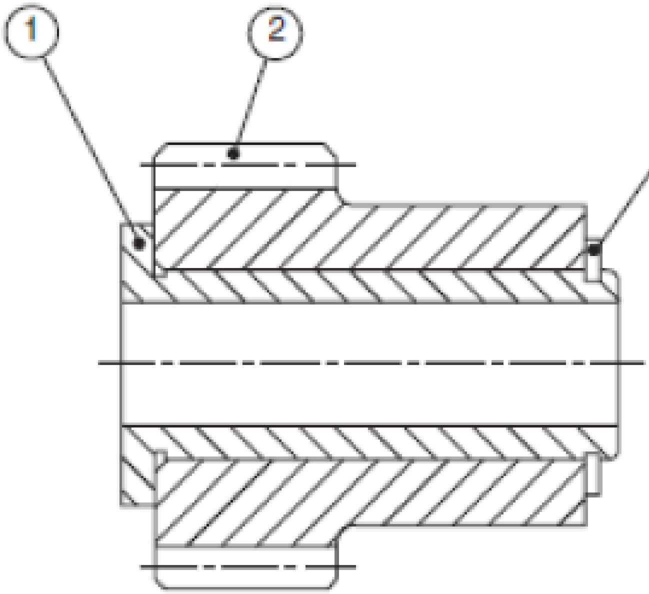
C. Assembly drawings: Machines and mechanisms consist of numerous parts, and a drawing which shows the complete product with all its components in their correct physical relationship is known as an assembly drawing.

A drawing, which gives a small part of the whole assembly, is known as a sub-assembly drawing. A sub-assembly may in fact be a complete unit in itself; for example, a drawing of a clutch could be considered as a sub-assembly of a drawing showing a complete automobile engine. The amount of information given on an assembly drawing will vary considerably with the product and its size and complexity.

If the assembly is relatively small, information which might be given includes a parts list. The parts list, as the name suggests, lists the components, which are numbered. The parts list will also contain information regarding the quantity required of each component for the assembly, its individual single-part drawing number, and possibly its material.

Parts lists are not standard items, and their contents vary from one drawing office to another.

The assembly drawing may also give other information, including overall dimensions of size, details of bolt sizes and center's where fixings are necessary, weights required for shipping purposes, operating details and instructions, and also, perhaps, some data regarding the design characteristics

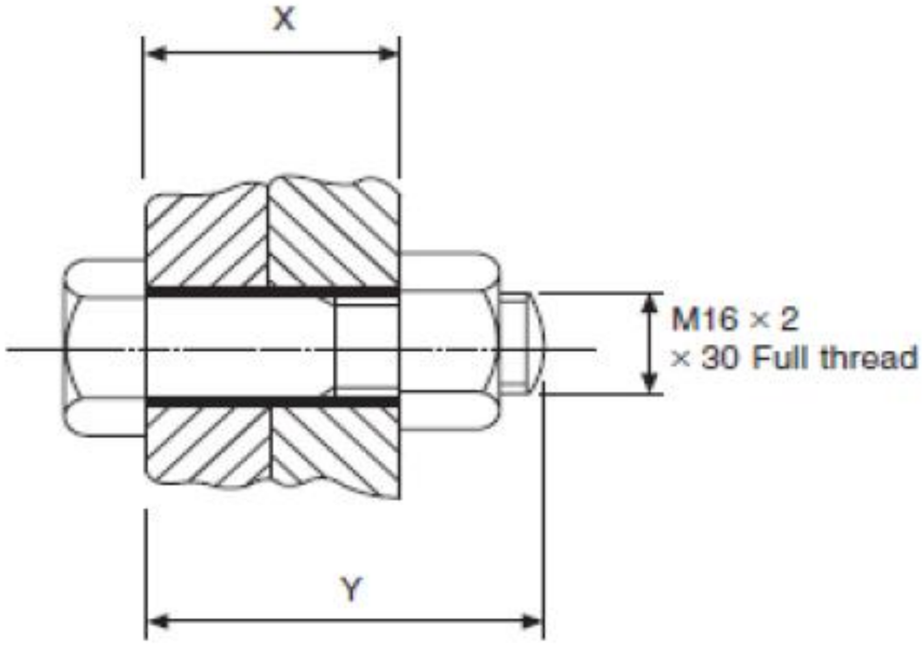


Item No.	Title	No. off	Part No.
1	Bearing insert	1	0001
2	Gear hub	1	0002
3	Retaining ring	1	0003

Copyright note	Assembly of gear and bearing	Original Scale I : I
	Material ———	Part No. 0004

C.1.Collective assembly drawing

This type of drawing is used where a range of products which are similar in appearance but differing in size is manufactured and assembled. Figure 3.4 shows a nut and-bolt fastening used to secure plates of different combined thickness; the nut is standard, but the bolts are of different lengths. The accompanying table is used to relate the various assemblies with different part numbers.

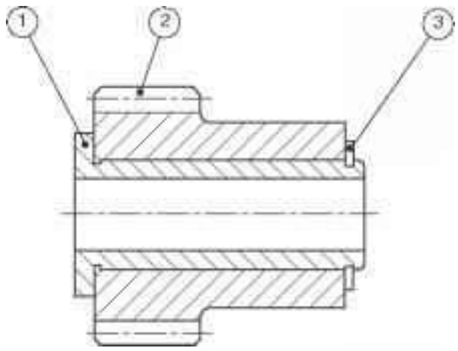


Part No.	X	Y	Part No.	X	Y
S456/1	40	60	/6	90	110
/2	50	70	/7	100	120
/3	60	80	/8	110	130
/4	70	90	/9	120	140
/5	80	100	/10	130	150

Copyright note	Fastener assy. Material: M.S.	Standard No. S 456

Content /Topic 3: Design layout drawings

A. **Combined detail and assembly drawings :**Combined detail and assembly drawings is sometimes convenient to illustrate details with their assembly drawing on the same sheet. This practice is particularly suited to small 'one-off' or limited-production-run assemblies. It not only reduces the actual number of drawings, but also the drawing-office time spent in scheduling and printing. Figure 7.5 shows a simple application of an assembly of this type.

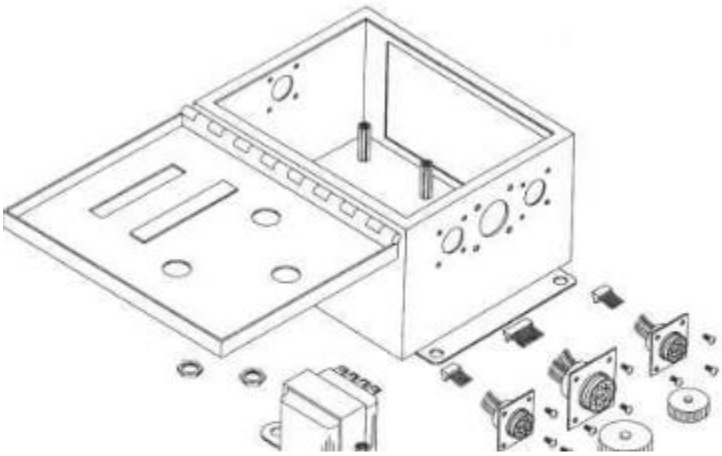


B. Exploded assembly drawings: An exploded view separates the components in an assembly to facilitate viewing. Exploded views include many options such as which components to include, what distances to use, and in which direction to display the exploded components. The exploded view is saved with a configuration of the assembly or subassembly.

C. Simplified drawings: Simplified draughting conventions have been devised to reduce the time spent drawing and detailing symmetrical components and repeated parts. Figure below shows a gasket, which is symmetrical about the horizontal centerline. A detail drawing indicating the line of symmetry and half of the gasket is shown, and this is sufficiently clear for the part to be manufactured.

If both halves are similar except for a small detail, then the half which contains the exception is shown with an explanatory note to that effect, and a typical example

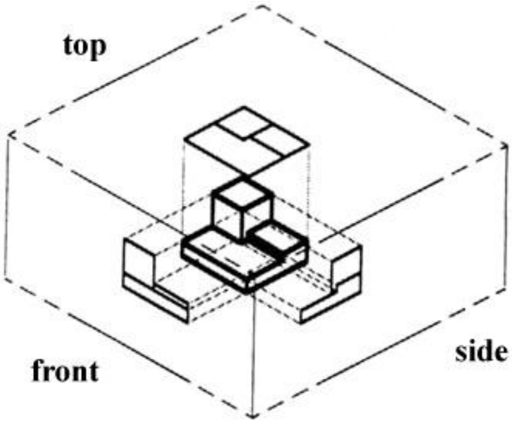
The figure below illustrates the accepted conventions for straight and diamond knurling.



Content /Topic 4: Design drawings and associated processes

A. **Pictorial and orthographic working and assembly drawings:** The Orthographic Projection is a kind of representation by which an object is presented by the means of line drawing on a projection plane. The plane is perpendicular to the parallel projection.

   The term Orthographic drawing means the representation of the exact shape of an object. It is represented in two or more views in which the objects are seen perpendicular to the objects' surface.



There are two methods in obtaining views in an orthographic drawing; these are the

- Natural Method and the
- Glass Box Method.

By looking in the perpendicular side of the object, the Natural method is used to obtain the natural image. By placing the planes of projection parallel to the principal faces of the objects, the Glass Box method is used to obtain the image or views of the object.

There are three (3) Planes of projection in an Orthographic Drawing; these are the

- Frontal Plane,
- the Horizontal Plane and the

- Profile plane.

The Frontal Plane is the projection plane that projects the front view of an object.
The Horizontal Plane is the projection plane that projects the top view of an object.
The Profile Plane is the projection plane that projects the side views of the objects.
The Pictorial Drawing is easy to be read even by those who are not skilled in the works of drafting. This drawing is considered as one of the widely used drawing because it shows several faces of illustrations.
There are three (3) types of pictorial drawing; these are the

- Axonometric,
- Oblique, and
- Perspective drawings.

The axonometric drawing is based upon the rotation principles; these are further classified into three (3) kinds, these are

- Isometric,
- Diametric and Trimetric.

The Isometric shows the axis of revolution perpendicular to the horizontal plane. In here, the drawing or the object projects or shows two faces; the objects front as well as the view in the right side.
The Diametric shows or projects two faces of views; the objects' top view as well as its left side view.
The Trimetric shows or projects three faces or angles; the top view, the left and the right-side view.
In the Oblique drawing, one face of the object is parallel in the plane of projection. Like the isometric drawing, the Oblique drawing also uses three axes.
The two of these axes are placed in perpendicular to each; while the third axis is placed in any angle that is convenient to the horizontal.
There are two (2) types of Oblique drawing; these are the Cavalier drawing and the Cabinet drawing.
In the Cavalier drawing, the receding lines usually are at thirty (30) degrees or it is at forty-five (45) degrees to the horizontal axis. In the Cabinet drawing, the object is presented as it appears to a particular position in where the observer positioned relative to the object. This drawing presentation looks like the objects actually appear to the eyes of the viewer.
The Perspective Drawing represents the objects, as it would actually appear to the observer from a particular place. This is also another kind of pictorial drawing in which objects are presented as they actually appear to the viewer's eyes.
There are different kinds of pictorial drawing; the Parallel or One-Point Perspective, the Angular or Two Point Perspective and the Three Point Perspectives.

Content /Topic 5: Balloon extraction detailing

Manually ballooning drawings gives you more control over how SOLIDWORKS Inspection adds balloons to drawings.

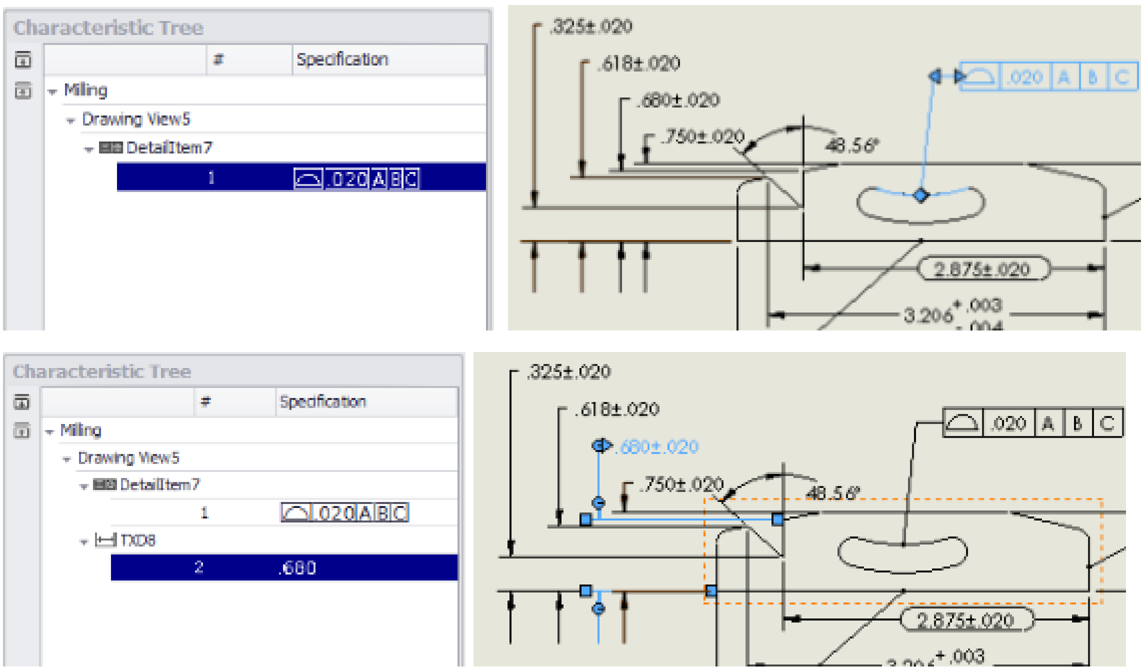
When you select automatic ballooning, the software balloons all characteristics in the drawing, using the specified sort order (clockwise or counter-clockwise).

If you select manual ballooning, the software:

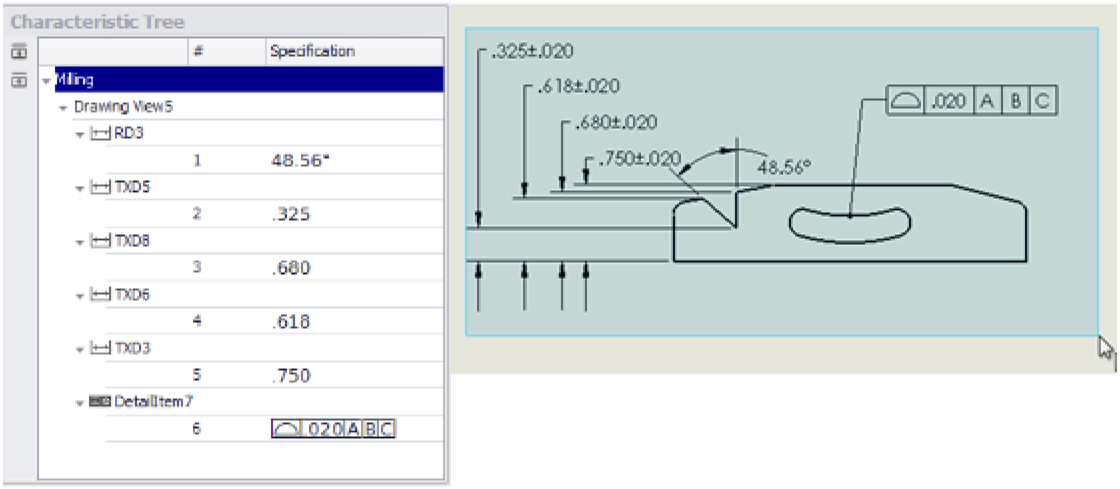
- Balloons only the specific characteristics you identify.
- Orders the balloons based on the order in which you select them.

To manually balloon drawings:

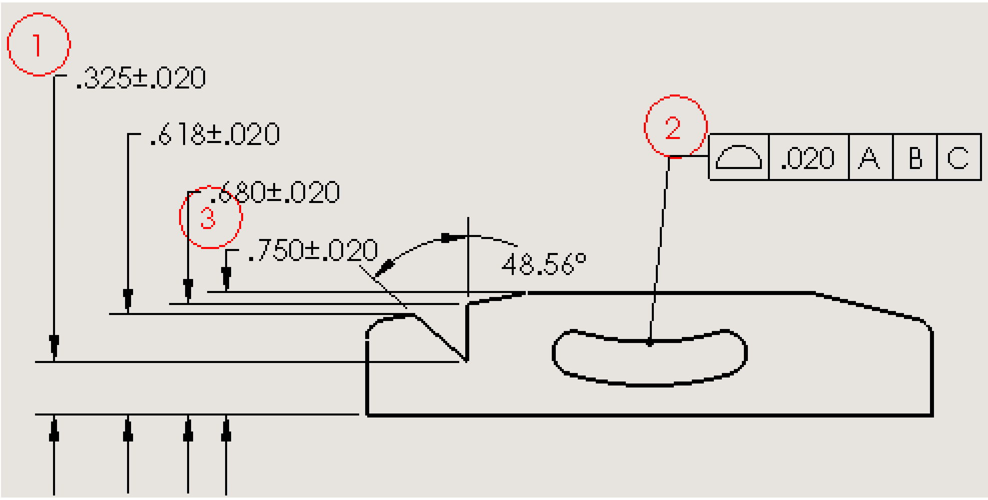
1. Click New Inspection Project (SOLIDWORKS Inspection command Manager).
2. Select a project template.
3. On the General Settings tab of the Create Inspection Project Property Manager, under Characteristic Info, for Extraction, select Manual.
4. Click to validate the project settings.
5. Click Add Characteristic (SOLIDWORKS Inspection command Manager).
6. In the graphics area, use one of the following techniques to select the characteristics to balloon:
   - Select individual characteristics.
     The characteristics are added to the Characteristic Tree in the order in which you select them.



   - Box select a set of characteristics. All the characteristics within the box are added to the Characteristic Tree.

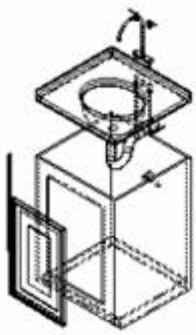


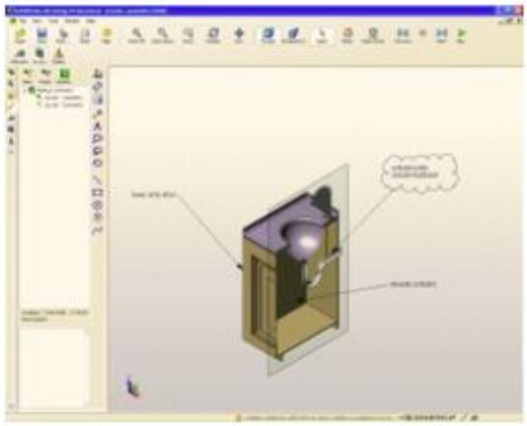
7. To remove a characteristic, click it in the graphics area.
8. If you want to balloon most but not all characteristics, you can box select the entire drawing and then remove characteristics you do not want to balloon.
9. Click Add/Edit Balloons (SOLIDWORKS Inspection Command Manager). The software creates balloons for the characteristics you selected, in the order in which you selected them. This step is not needed if you selected Auto Balloon in the Inspection Project Settings.



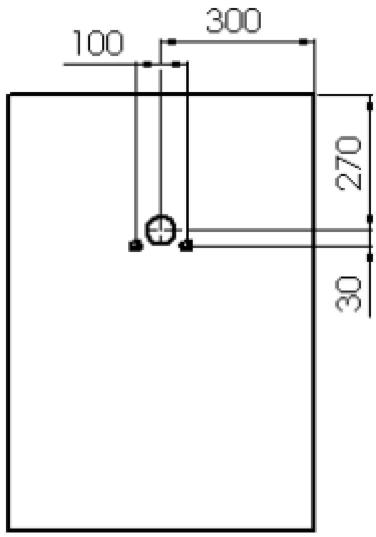
A. Exploded pictorial views: Exploded views are versions of named views defined in configurations in the assembly document. This drawing contains an exploded view of the vanity assembly. The drawing also contains an isometric named view of the complete assembly, unexploded, at the lower left.

Save SolidWorks exploded view information and see the exploded views in the drawings Viewer.





B. Dimensioning and notation: The back view on the Vanity Cabinet sheet is included to show the dimensions of the holes in the cabinet for the supply and waste pipes. Reference dimensions help you to locate the holes. You can choose whether to enclose reference dimensions in parentheses automatically. Other types of reference dimensions include baseline dimensions and ordinate dimensions. For example, you might add ordinate dimensions to the front view of the cabinet as shown. You can dimension to edges, vertices, and arcs. The dimensions jog automatically to avoid overlapping. You can display ordinate dimensions without the chain (the arrows between the dimension extension lines).



notations : In addition to dimensions, you can add other types of annotations to your models and drawings to convey manufacturing information:

Notes

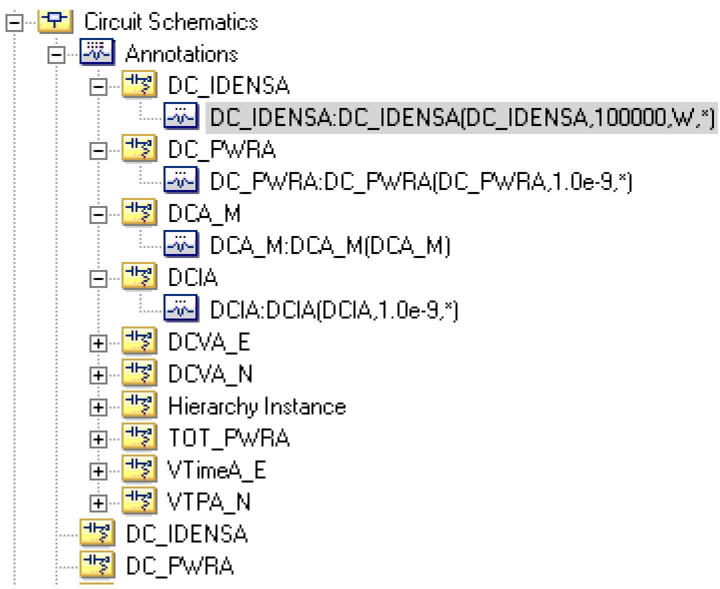
- Geometric tolerance symbols
- Datum feature symbol
- Center marks
- Surface finish symbols
- Datum target symbols
- Weld symbols
- Balloons and stacked balloons

- Blocks
- Multi-jog leaders
- Area hatches
- Dowel pin symbols

Most annotations can be added in part and assembly documents and inserted automatically into drawings in the same way that dimensions are inserted into drawings. Some annotations (center marks, multi-jog leaders, hole callouts, area hatch, and dowel pin symbols) are available in drawings only.

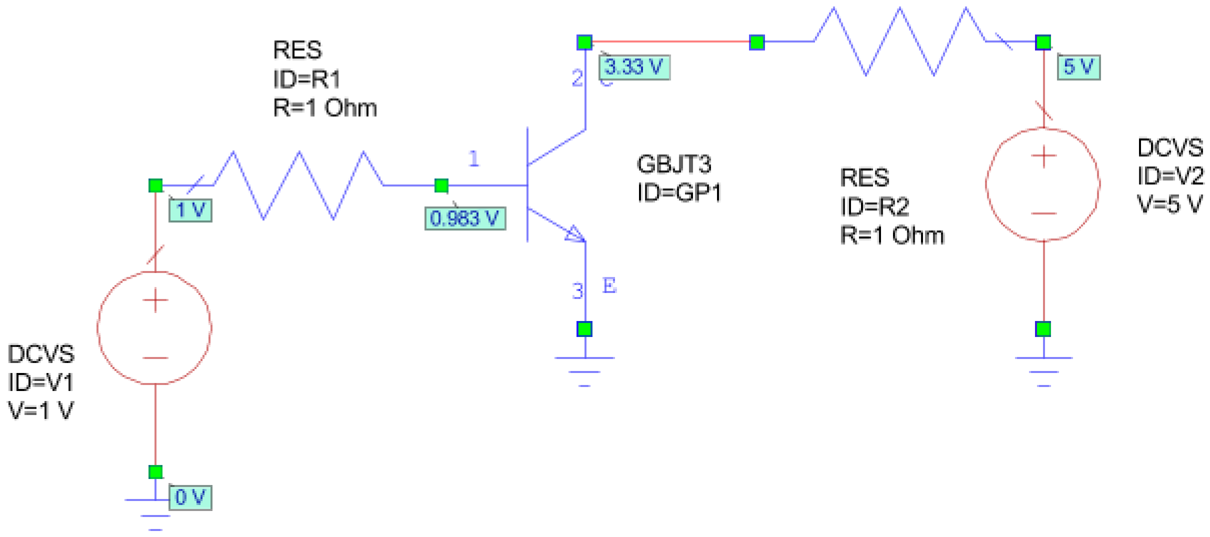
Schematic diagrams:

In an **Annotations** node beneath the **Circuit Schematics** or **System Diagrams** node, each annotated schematic is listed with its annotation below it. You can double-click an annotation to modify its settings. You can add multiple annotation types to a single schematic or system diagram.



After adding annotations, you can right-click on the schematic or system diagram node and choose from options for enabling/disabling/toggling all annotations.

The following figure shows a schematic with back annotation.



LO 3.3 – Apply Freehand drawing

Content/Topic 1: Materials for freehand drawing

A. Pencils: students and professional men should be equipped with a selection of good, well-sharpened pencil with leads of various degrees of hardness such as: 9H, 8H, 7H, and 6H (hard); 5H&4H (medium hard); 3H and 2H (medium); and H& F (medium soft). The grade of pencil to be used for various purposes depends on the type of line desired, the kind of paper employed, and the humidity, which affects the surface of the paper. Standards for line quality usually will govern the selection. For instance,

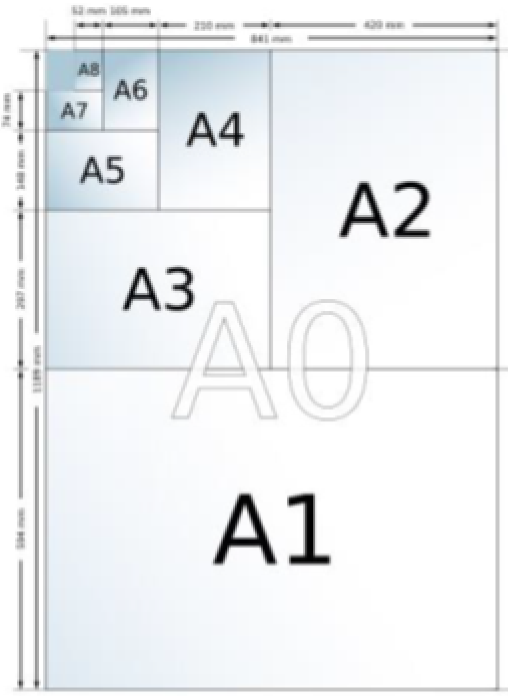
- **6H** is used for light construction line.
- **4H** is used for re-penciling light finished lines (dimension lines, center lines, and invisible object lines)
- **2H** is used for visible object lines

TASK	LEAD
CONSTRUCTION LINES	3H, 2H
GUIDE LINES	3H, 2H
LETTERING	H, F, HB
DIMENSION LINES	2H, H
LEADERLINES	2H, H
HIDDEN LINES	2H, H
CROSSHATCHING LINES	2H, H
CENTERLINES	2H, H
PHANTOM LINES	2H, H
STITCH LINES	2H, H
LONG BREAK LINES	2H, H
VISIBLE LINES	H, F, HB
CUTTING PLANE LINES	H, F, HB
EXTENSION LINES	2H, H
FREEHAND BREAK LINES	H, F, HB

Grades of lead (left) and lead-lines chart (right)

B. Papers: They are mainly classified as per their sizes from A0 to A6. There is also larger size like 2A0and 4A0 however at school we will be using A4 size. A0 is a rectangle with an area of 1m2. All A size sheets have their edge lengths in the same proportion. This proportion is in the ratio of short side to the long side and is equal to. Each lower size in the A series is obtained by exactly dividing the A sheet along its middle as shown in the following figure 1: $\sqrt{2}$

Format	Measurements in mm
A0	841 x 1189
A1	594 x 841
A2	420 x 594
A3	297 x 420
A4	210 x 297
A5	148 x 210
A6	105 x 148

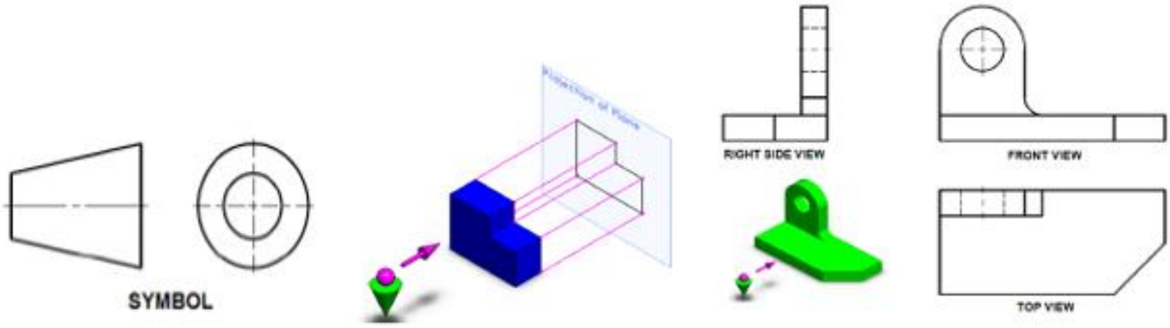


C. Rubber: The rubber is used for erasing (cleaning) extra pencil lines.

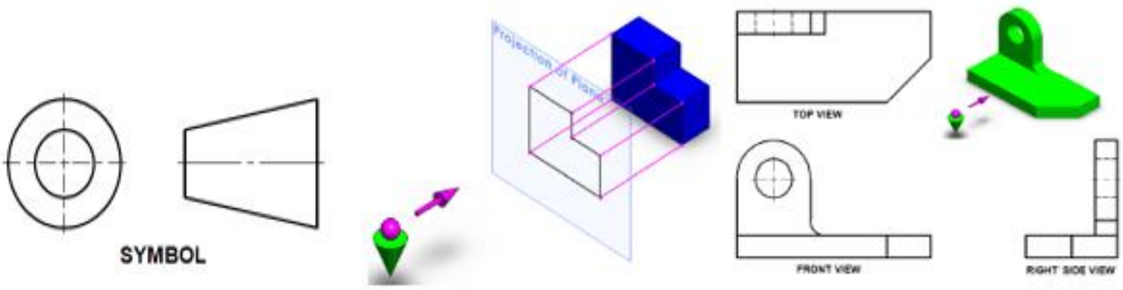
Content/Topic 2: Observation techniques

The difference between 1st angle and 3rd angle projection is that when 1st angle projection is used and planes are revolved, the top view will be below the front view, and that the left side view will be to the right of the front view.

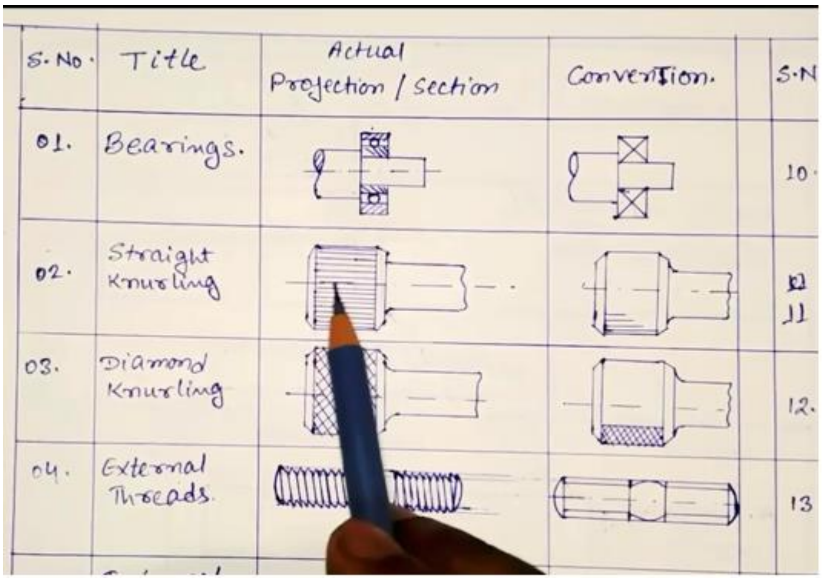
A. **First angle projection:** The object is imagined to be in first quadrant, the object is lies between the observer and plane of projection, the plane of projection is assumed to be non-transparent, when views are drawn in their relative position top view comes below front view, Right side view drawn to the left side of elevation.



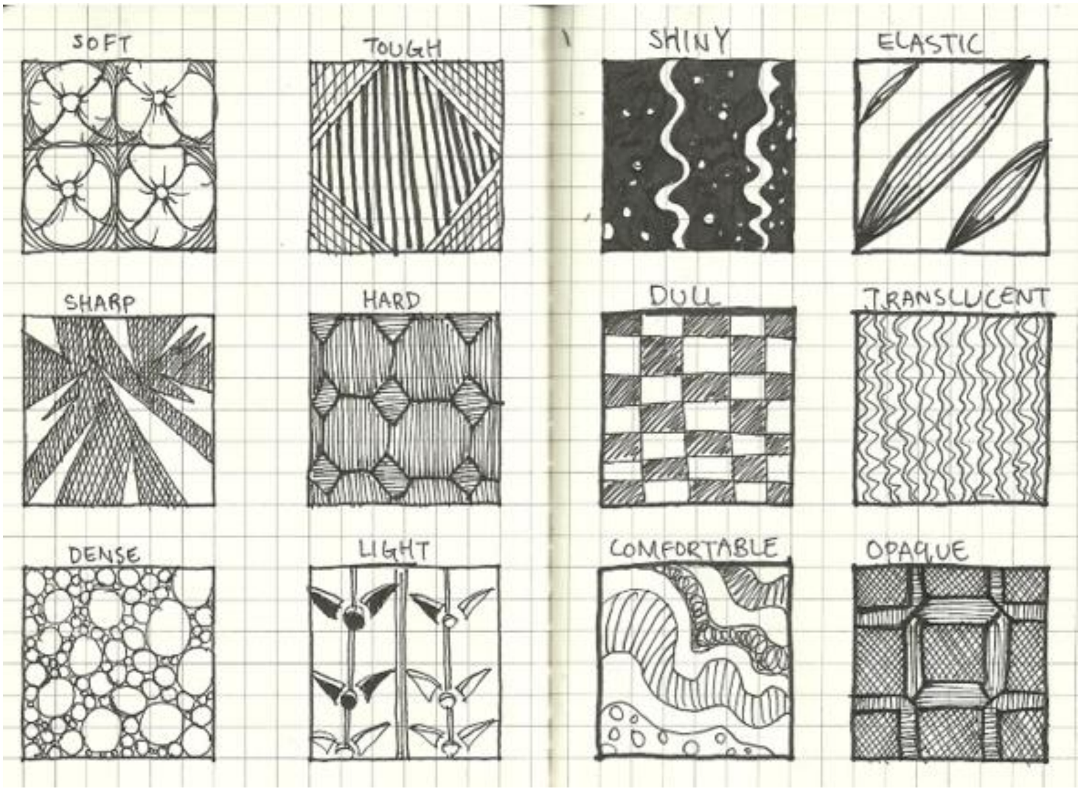
B. **Third angle projection:** The object is imagined to be in third quadrant, the plane of projection lies between the observer and object, the plane of projection is assumed to be transparent, when views are drawn in their relative position top view comes above front view, Right side view drawn to the right side of elevation.



Content /Topic3: Drawing representation

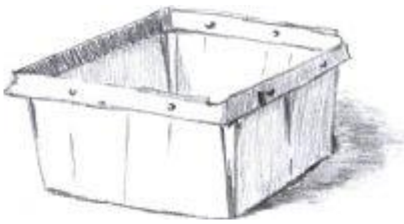


C. Texture: Texture is one of the seven elements of art and design. So why did my drawing teacher never discuss it? The answer is this – texture is subordinate to all the other elements of art. Simply put, texture is both the least important and the most challenging.



D. Light and shade: Adding light and shade to a drawing helps you obtain the true expression of any object. It is better than an outline because the shadow on any object varies with the form of the object and therefore describes it more expressively.

Create A Pencil Drawing Using Light and Shade



If you wish, you can still simplify a subject and leave out the detail seen in light and shadow. Natural drawings are very attractive in raw form.

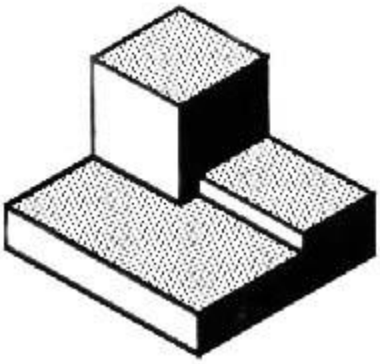
In this drawing, I shaded the inside of the box, under the darker edge, but it hasn't scanned well enough to show that. I draw lightly so I have to pay attention to making darks in any image dark enough to form a good contrast.

It's only a matter of careful study and practice that will lead you along the path to successful drawing with light and shade.

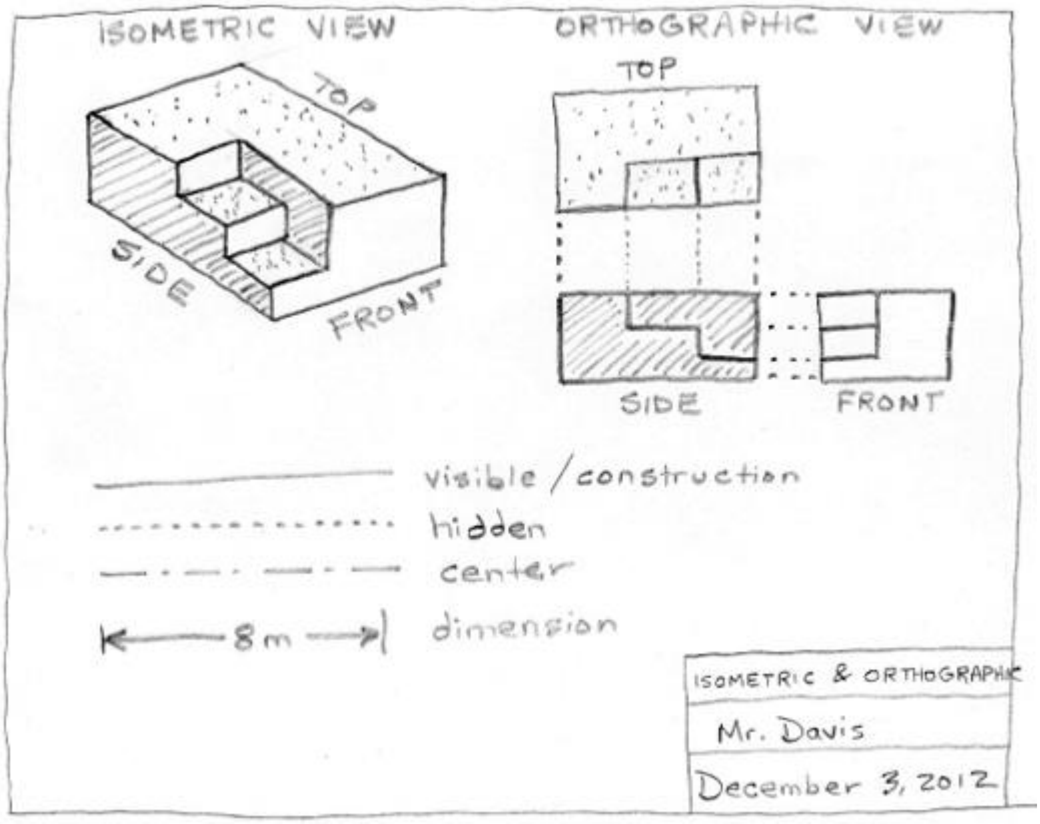
We will treat "sketching" and "drawing" as one. "Sketching" generally means freehand drawing. "Drawing" usually means using drawing instruments, from compasses to computers to bring precision to the drawings.

This is just an introduction. Don't worry about understanding every detail right now - just get a general feel for the language of graphics.

We hope you like the object in Figure 1, because you'll be seeing a lot of it. Before we get started on any technical drawings, let's get a good look at this strange block from several angles.



E. Freehand detailing



LO 3.4 – Use information and Communication Technologies

Content/Topic 1: CAD Application.

This process is used to create solid components of desired shape by joining and cutting different solid volumes. The final solid model is a virtual replica of an actual product but it can be seen and rotated like a real product.

A. **File management:** SOLIDWORKS® Data Management solutions offer a range of applications with capabilities for quickly and efficiently managing data files and documentation to maximize productivity and improve product quality.

B. **Graphics and CAD terminology**

   a. **Application**: A computer program. A CAD application, also called and add-on or plug-in, can carry out complex tasks specific to a particular drawing problem. CAD applications run in tandem with the CAD software to perform specialized or automated tasks.

   b. A**rrowhead:** The part of a dimension or leader, which points to an object or extension line. Arrowheads usually can be drawn automatically in several styles or shapes.

   c. **Attribute: AutoCAD**: Information or data about a drawing object which can be hidden or appear in the drawing as text. Often this information can be extracted from the drawing and used in a spreadsheet or other program.

   d. **Bezier curve:**A curve defined by endpoints, tangent lines, and control points at the ends of the tangent lines. Altering the length and angle of tangent lines alters the shape of the curve.

   e. **Bitmap:**A pixel based graphic or image inserted in a drawing. Bitmaps can be sized but not edited with most CAD programs.

   f. **Block**: (AutoCAD terminology), see symbol.

   g. **CAD:** Computer-aided design. Common CAD programs include: AutoCAD, Vectorworks, MicroStation. Programs differ greatly in features, complexity, cost, and hardware requirements.

   h. **CADD:** Computer-aided design and drafting.

   i. **Cartesian coordinates:** See coordinates.

   j. **Center point:** The defining point at the exact center of a circle, arc, regular polygon or ellipse.

   k. **Chamfer:** A diagonal line, which connects points on two intersecting objects such as an angled corner. The chamfer tool is an editing tool.

   l. **Control points:** Points determining the path and shape of a Bezier curve.

   m. **Cursor:** The screen symbol or icon, which represents the current mouse location relative to the drawing window or viewport. The cursor may appear as crosshairs or another symbol based on which command is active.

n. **Curve:** A complex entity created by the definition of endpoints of spline curve sections. Note, the type of curve you use determines the types of editing tools or functions that may be performed on it. See also Bezier curve

o. Datum: A temporary coordinate point set by the user which can be used as a snap point or reference point when drawing.

p. **Dimension line:** A line, usually with an arrow indicating the direction and distance of a drawing dimension. See also extension line.

q. **Editing tools:** A class of drawing commands used to modify drawing entities or objects. Common edit include trim, rotate, move and stretch.

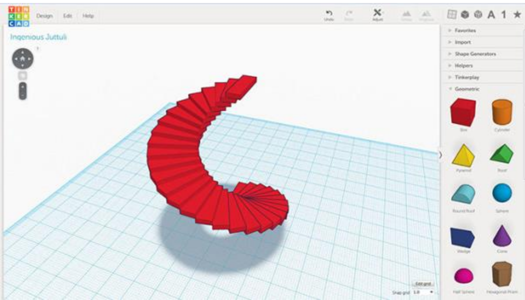
r. **Ellipse:** A CAD drawing object defined by a major axis, minor axis and CenterPoint. An ellipse may also be constructed out of arcs and line segments. An ellipse created in this way is not mathematically a true ellipse but is an easier object to edit.

s. Fillet: (Rhymes with skillet). An arc connecting endpoints of two intersecting lines or objects, often a rounded corner.

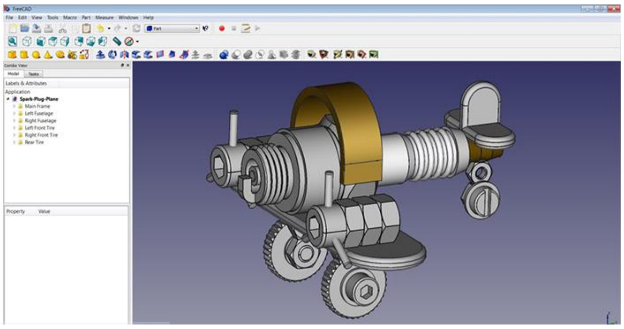
t. **Leader line:** The line portion of a leader connecting the shoulder to an arrowhead.

C. **Graphics and CAD software:** The software you should use when designing something to be 3D printed is entirely dependent on what you are trying to make. In general, 3D design software falls into two categories. CAD software is usually used when creating industrial objects such as mechanical objects. On the other hand, some CAD software enables more artistic freedom as designs do not need to work mechanically, be functional or fit to a real-world device. Historically, 3D modeling software has been used in film animations and video games to make organic designs. However, it can also be used to create 3D printable models.

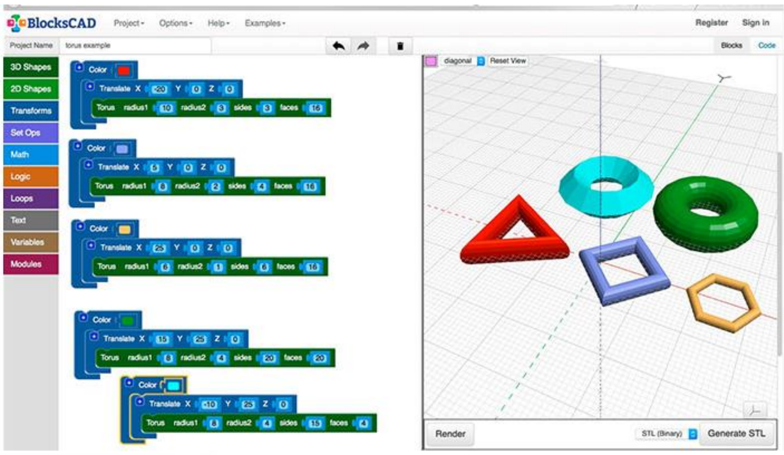
1. **Tinker CAD**: an online 3D design app geared towards complete beginners coming from Autodesk.



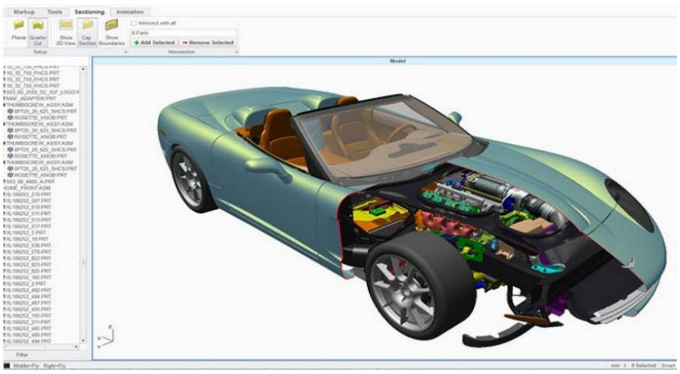
2. **Free CAD** is a completely free parametric 3D modeling tool that is open-source and enables you to design real-life objects of any size.



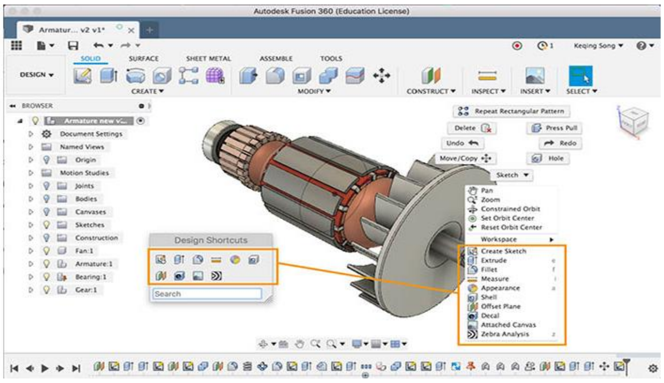
3. **Blocks CAD:** This 3D software is specifically created for educational purposes, its development is done so that anyone can later use Opens CAD, a more professional CAD software.



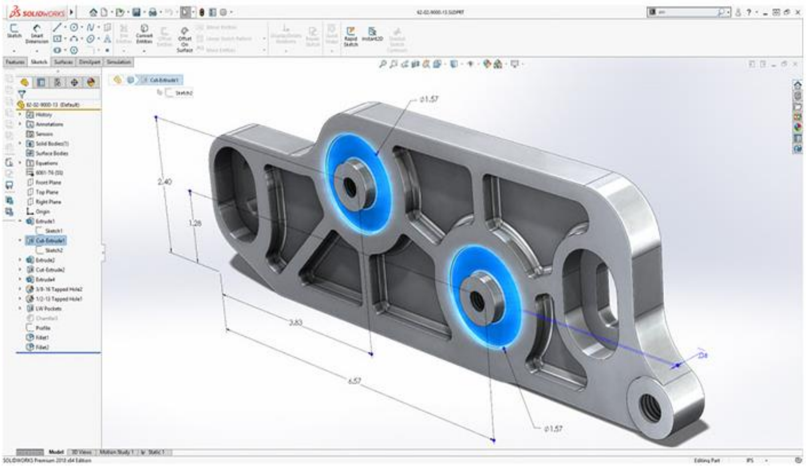
4. **Creo CAD** software is one of the market leaders in product design, developed by Parametric Technology Corporation more than 30 years ago.



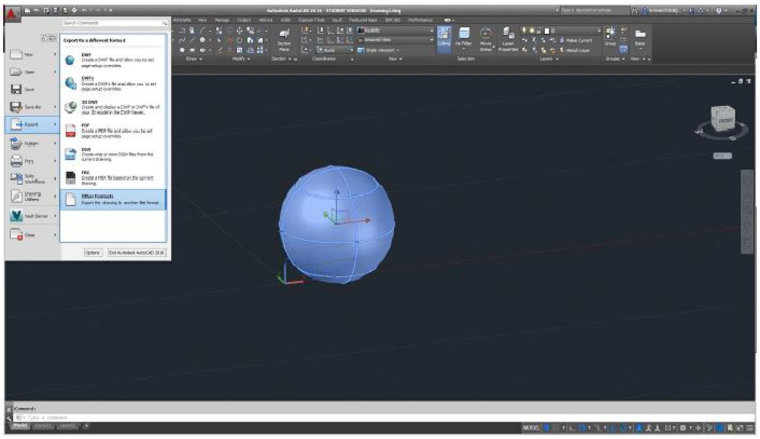
5. **Fusion 360** is a cloud-based 3D CAD program. It's unique in the sense that it uses the power of the could to bring together design teams to collaborate on complex projects.



6. **Solidworks:** Published by Dassault Systems, it is often used by professional 3D designers. It is a parametric featured-based model. The software includes a wide range of features such as design validation tools, or reverse engineering.

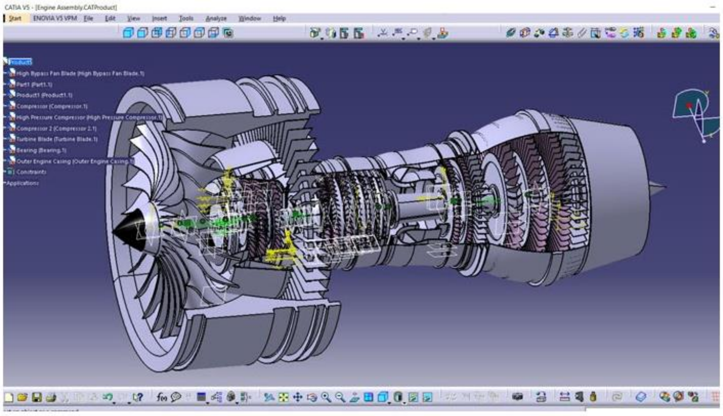


7. **AutoCAD** software from Autodesk was one of the first CAD software to be released on the market in 1982, making it a very established CAD software across industries. Even though AutoCAD is popular and widely used, in the 3D printing.

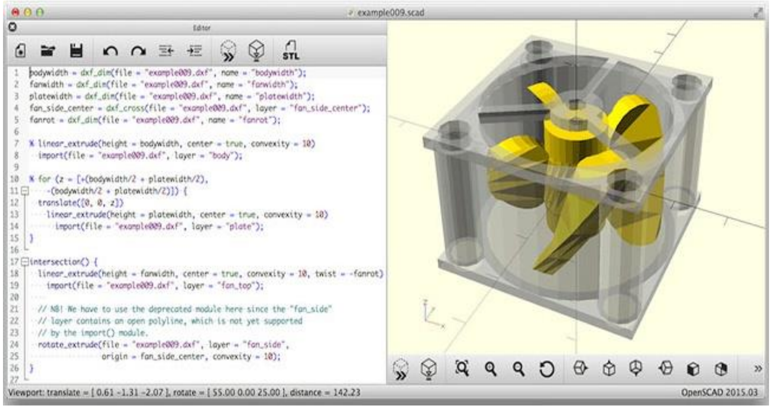


8. **CATIA CAD** solution has historically been developed for Dassault Aviation's own needs. It is more than a simple CAD Software, as it is also a multi-platform

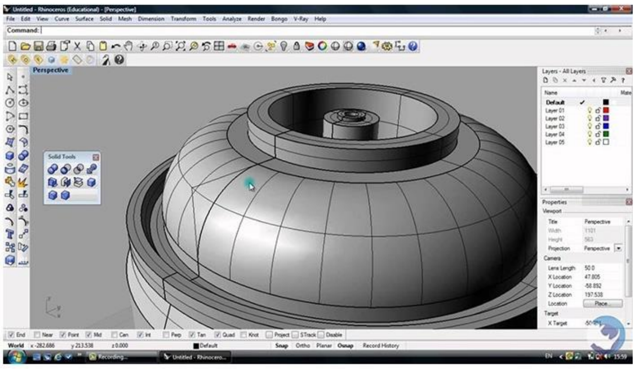
software suite for CAD, CAM (Computer Aided Manufacturing), CAE (Computer Aided Engineering) and more.



9. **Opens CAD** is a free, open-source CAD software aimed at making solid 3D models. It is suitable for experienced users seeking a platform for an elaborated project. Also, given its Constructive Solid Geometry (CSG) and the Extrusion of 2D outlines, this software is intuitive for coders/programmers.

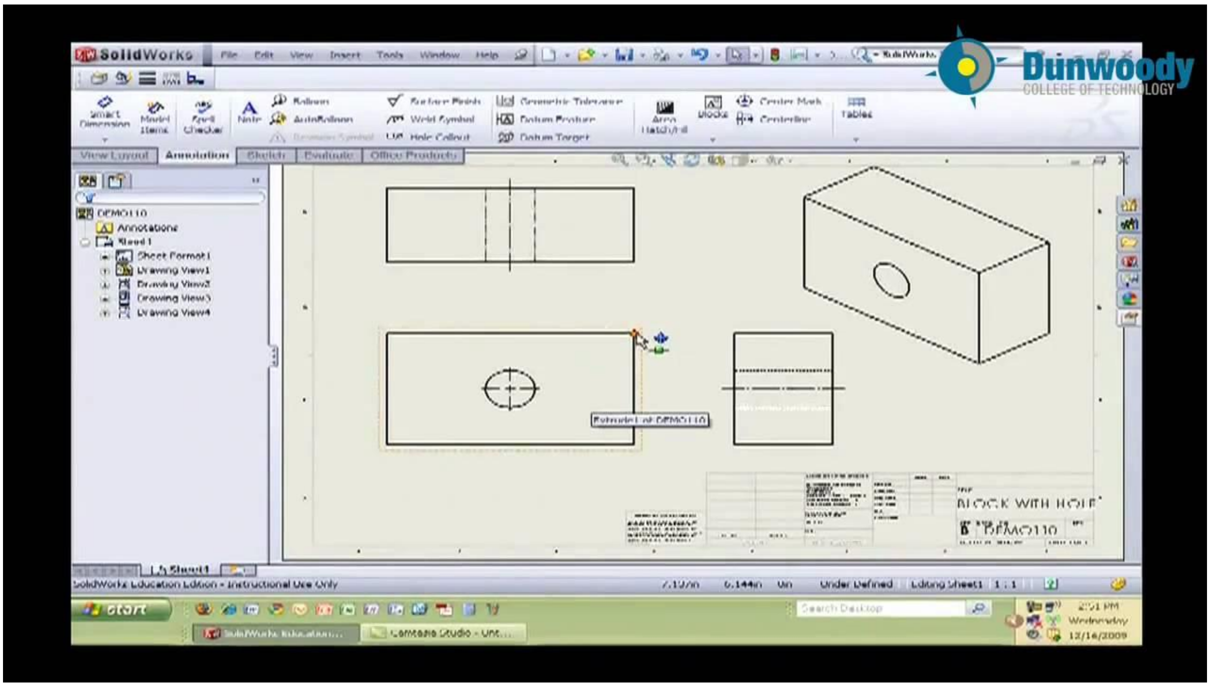


10. **Rhino**: The company behind this software markets it as the world's most versatile 3D-modeler. It is a commercial 3D computer graphics and CAD software. The program uses a precise and mathematical model known as NURB which allows to manipulate points, curves, meshes, surfaces, solids and more in all sorts of ways.



D. Generate working drawings from part

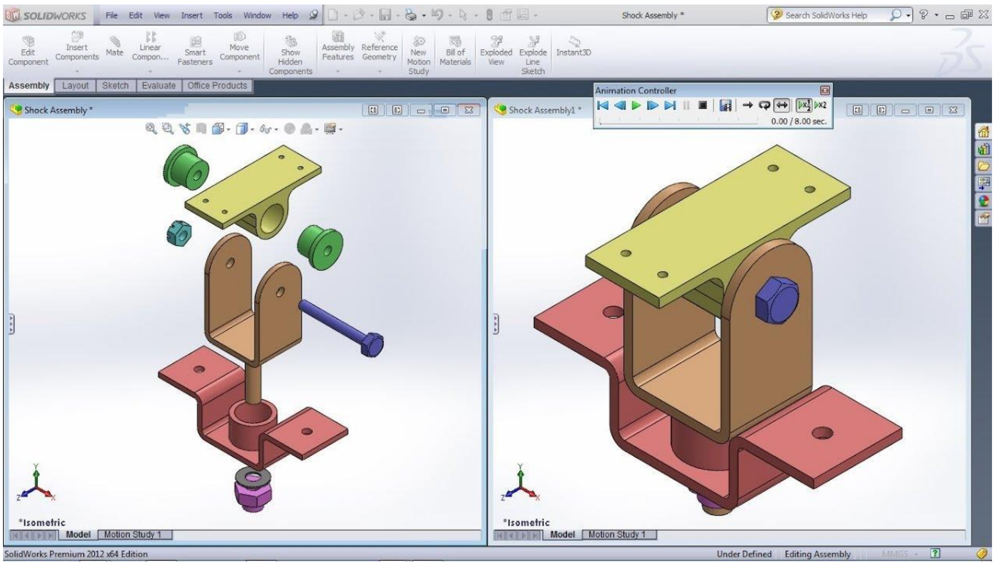
E. Views and animated and assembly models: You can impose a motion on the assembly through the animation by changing the view orientation of the camera over time. The



camera view orientation defines how a model is viewed during animation.

1. Right-click Orientation and Camera Views in the Motion Manager design tree and select Disable View Key Creation.
2. Drag the time bar to a new position, past the start time.
3. Drag the key point from the Orientation and Camera Views line to the time bar, and select Place Key.
4. Do one of the following:
    - Rotate, pan, or zoom the model to present the view of interest.
    - Select a standard view tool from the View toolbar.
    - Right-click the key point in the line that extents from Orientation and Camera Views, select View Orientation, and select a standard or named view.

5. Repeat steps 2 through 4 to define the camera view orientation key points for this animation.
6. When the animation is complete, right-click Orientation and Camera Views and select Disable View Key Creation to prevent any further changes in views from being included in the animation.
7. Click Play from Start (Motion Manager toolbar) to test your results.



Content/Topic 2: CAD sketching principles

A. Creating 3D assemblies: When you add a set of subassemblies sequentially to a baseline (for example, lane, curb, side slope, then ditch), they are all added to the same subassembly group. The next time you select the assembly baseline, a new group is created and subsequent subassemblies added belong to the new subassembly group.

1. Click Home tab ➤ Create Design panel ➤ Assembly drop-down ➤ Create Assembly Find.
2. In the Create Assembly dialog box, in the Name field, enter a name for the assembly. **Note**: To name the assembly, select its default name and enter a new name, or you can use the Name Template.
3. For Description, enter an optional description of the assembly.
4. For Assembly Type, select the type of corridor in which the assembly will be used.
5. For Assembly Style and Code Set Style, either accept the default style, select another style, or create a new style.
6. Click to select a layer.
7. Click OK.
8. To insert the assembly into the drawing, click a baseline location in the drawing. The assembly name is displayed under the Assemblies collection in the Prospector tree. A vertical line with a circular marker in the middle is inserted

into the drawing. This is the assembly baseline location point, where you will attach one or more subassemblies.

9. Select a subassembly from a tool palette, or from a tool catalog through the Content Browser.

   Note: Not all subassemblies in Autodesk Civil 3D are located on a tool palette by default. All subassemblies are stored in the Content Browser, and you can add subassemblies that you use frequently to a tool palette for easy access.

10. To attach the subassembly to the assembly baseline location, select the baseline point or the baseline marker. Typically, the baseline marker displays as a vertical line. The subassembly name is displayed in the Subassemblies collection in the Prospector tree. A subassembly group is added to the assembly.

11. To add subassemblies to the subassembly just added, do any of the following:

- Select a subassembly in a tool palette, or in a tool catalog, and then select an appropriate marker point on the previously added subassembly.
- When you are prompted to select a marker point, you can choose to either insert a subassembly between two existing subassemblies, replace an existing subassembly, or create a detached subassembly.
- Select a subassembly that is already attached to an assembly and click Copy to Assembly, Move to Assembly, or Mirror Subassemblies on the Modify Subassembly panel of the Subassembly tab. You can also select multiple subassemblies using these features.

B. Generation of presentation drawings from parametric models: Parametric is a term used to describe a dimension's ability to change the shape of model geometry as soon as the dimension value is modified.

Feature-based is a term used to describe the various components of a model. For example, a part can consists of various types of features such as holes, grooves, fillets, and chamfers. A 'feature' is the basic unit of a parametric solid model.

Parametric modelling uses the computer to design objects or systems that model component attributes with real world behavior. Parametric models use feature-based, solid and surface modelling design tools to manipulate the system attributes. One of the most important features of parametric modelling is that attributes that are interlinked automatically change their features. In other words, parametric modelling allows the designer to define entire classes of shapes, not just specific instances. Before the advent of parametric, editing the shape was not an easy task for designers. For example, to modify a 3D solid, the designer had to change the length, the breadth and the height. However, with parametric modelling, the designer need only alter one parameter; the other two parameters get adjusted automatically. So, parametric models focus on the steps in creating a shape and parameterize them. This benefits product design engineering services providers a lot.

The Parametric Modelling Process

Parametric models are built from a set of mathematical equations. For parametric models to have any legitimacy, they must be based on real project information. It is the modernity of the information examination techniques and the breadth of the hidden undertaking information, which decides the viability of a modelling solution.

There are two popular parametric representation models:

i. **Constructive Solid Geometry (CSG):** CSG defines a model in terms of combining basic (primitive) and generated (using extrusion and sweeping operation) solid shapes. It uses Boolean operations to construct a model. CSG is a combination of 3D solid primitives (for example a cylinder, cone, prism, rectangle or sphere) that are then manipulated using simple Boolean operations.

ii. **Boundary Representation (BR):** In BR, a solid model is formed by defining the surfaces that form its spatial boundaries (points, edges, etc.) The object is then made by joining these spatial points. Many Finite Element Method (FEM) programs use this method, as it allows the interior meshing of the volume to be more easily controlled.

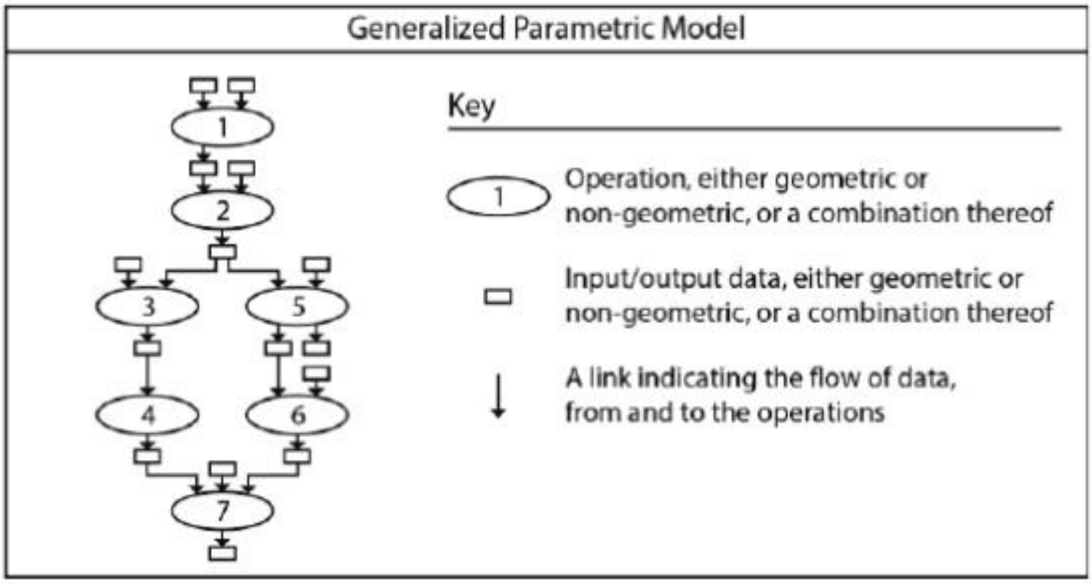
C. Generation of exploded sequences from parametric models: Generalized Parametric Model (GPM), represented by a Directed Acyclic Graph (DAG), as a means to analyze and compare different parametric modelling methods. The GPM is used as an analytical device and there is no suggestion that the systems being discussed were actually implemented using such a DAG.

Modelling methods that cannot be mapped into the proposed GPM are categorized as not being parametric modelling methods.

This broader category will be addressed in the final discussion. A GPM graph consists of a set of nodes connected with directed edges. Nodes are distinguished as operation nodes and data nodes. The former represents general computational operations, both geometric and non-geometric.

The latter represent the input and output data for the operations, either geo-metric, non-geometric or a combination thereof. Edges connect operation nodes with data nodes and represent the flow of data from and to the operations.

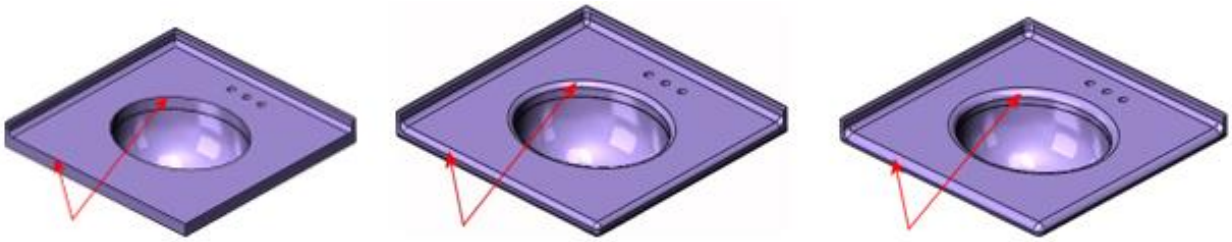
An example of a GPM graph.



D. Modeling and editing: Use the SOLIDWORKS Feature Manager design tree and the Property Manager to edit sketches, drawings, parts, or assemblies. You can also edit features and sketches by selecting them directly from the graphics area. This visual approach eliminates the need to know the name of the feature. Editing capabilities include:

- **Edit sketch**: You can select a sketch in the Feature Manager design tree and edit it. For example, you can edit sketch entities, change dimensions, view or delete existing relations, add new relations between sketch entities, or change the size of dimension displays. You can also select the feature to edit directly from the graphics area.
  Once you create a feature, you can change most of its values.

- **Edit feature:** Featu**re** to display the appropriate Property Manager. For example, if you apply a **Constant radius** fillet to an edge, you display the Fillet Property Manager where you can change the radius. You can also edit dimensions by double-clicking the feature or sketch in the graphics area to show the dimensions and then change them in place.

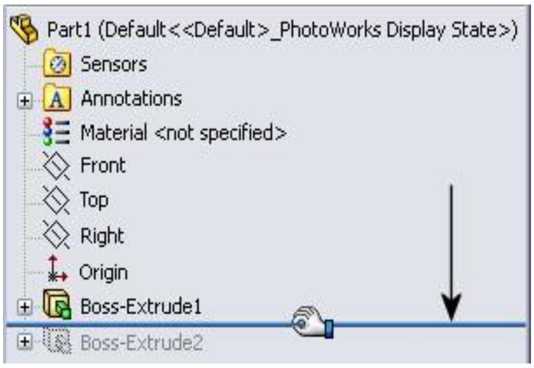


No fillet features Edit model dimensions from a drawing Fillet feature: 18mm applied

- **Hide:** with certain geometry such as multiple surface bodies in a single model, show you can hide or show one or more surface bodies. You can hide and show sketches, planes, and axes in all documents, and views, lines, and components in drawings.

- **Suppress:** You can select any feature from the Feature Manager design tree and suppress the feature to view the model without that feature. When a feature **unsuppressed** is suppressed, it is temporarily removed from the model (but not deleted). The feature disappears from the model view. You can then unsuppressed the feature to display the model in its original state. You can suppress and unsuppressed components in assemblies as well.

- **Rollback:** When you are working on a model with multiple features, you can roll the Feature Manager design tree back to a prior state. Moving the rollback bar displays all features in the model up to the rollback state, until you revert the feature Manager design tree back to its original state. Rollback is useful for inserting features before other features, speeding up time to rebuild a model while editing it, or learning how a model was built



E. Use of templates and libraries: Template is a file you use to start a drawing (or any other documents). By default, almost every software provides it. But the default that comes with the box usually only provide very basic configuration. And mostly don't meet your criteria. When you started AutoCAD, by default it will use cad.dwt. It holds minimum information you need to create a proper drawing. It uses inch as units. For me who use metric units, I have to change it to mm. Then I have to do these following things:

1. Create layers and set their properties.
2. Create styles for text, dimensions, and other annotation.
3. Setup my layout for plotting
4. I don't usually do this, but I saw some users create block symbols. I prefer to keep them in a block library.
5. Then I start drawing, Imagine that I have to do that steps each time I start a new drawing. How many hours that I waste in a month? In a year? Wouldn't it be nice when we start our drawing, we start directly That's what a template is for? We set our common settings and styles.

F. Data exchange between applications

1. **Copying Data:** In Windows NT/95/98, the **clipboard** is used to copy data from one application to another (i.e. a table from Excel to Word or from Word to Excel). No connection of any kind is maintained between the source file and the destination file.
2. **Linking Objects:** With a linked object, information is copied from one file to another, but a connection (link) is maintained between the source file and the destination file. The link that is created is called a **DDE Link** (dynamic data exchange link) or just a **dynamic link**. It is also sometimes referred to as a **live link**, because the linked object is updated whenever the source file changes. Use linking when:
    a. File size is important (for instance, lack of space on a file server)
    b. User have access to the source file and source application
    c. The information is updated frequently

3. **Embedded Objects**: With an embedded object, the entire source file (not just the object to be included) is copied into the destination file. Unlike linking, the embedded object is NOT automatically updated when changes are made to the source file. However, the object can be updated by running a command from within the destination file. Use embedding when:
    a. File size is NOT important (embedding takes up more space that linking)
    b. User have access to the application but NOT the source file
    c. The data changes infrequently

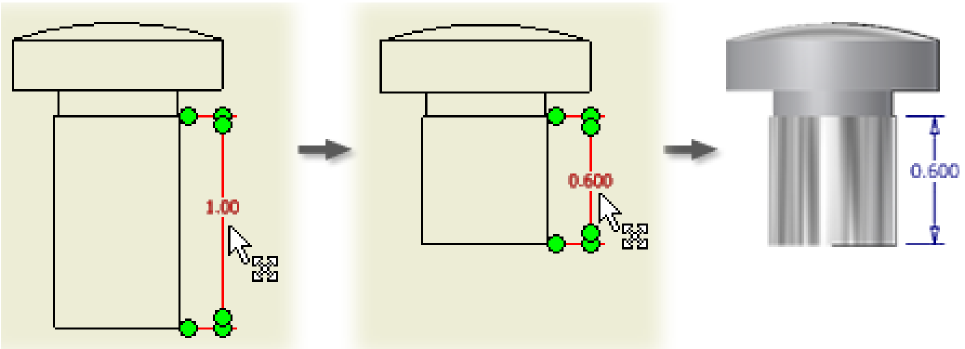
4. **Merging (Mail merging): Merging** is the process of inserting test from a source document into a second, main document.
    a. **Data Source Document** - Contains information that is to be inserted into the main document. Each category of information is labeled by a field name. A **record** is the variable information that comprises all the data for one person, group, etc.
    b. **Main Document** - A type of form, with the places were information will be inserted are marked by field names.
5. **Exporting and Importing.** Are the processes of moving documents according to their location.

G. Graphic output

- Select the dimension to change.
- Right-click, and then select Edit Model Dimension from the menu. Enter the new dimension in the edit box.

- To change the dimension tolerances, right-click in the edit box, and then select Tolerances.

Note: If you did not select the option to edit model dimensions in drawings when you installed Autodesk Inventor, this option is unavailable. It is also unavailable when the selected dimension is a drawing dimension.



Content /Topic3: File management and organization

A. File formats and extensions: There are many different types of file formats. Each format represents a particular way of storing the data that makes up a file. Some types of media can be found in many different formats. For example, an image can be stored as a PNG or as a JPG (as well as many other formats). These two image formats store the information that makes up a picture in very different ways.

File names have extensions which are supposed to identify the format. So, for example, a PNG file should have the extension .png. The extension tells you and other programs on your computer what the file format is supposed to be.

Unfortunately, it is possible to change the file extension from a file name, or remove it altogether. This doesn't actually change the format — you haven't edited the file at all, just changed the name. This can cause problems — without the right extension, the computer won't know what type of file it is supposed to be, and usually won't be able to open it. Or, if it can open it, it won't display or run properly.

Some people think they can just change the extension in order to change the file format. For example, perhaps an online profile requires a .jpeg image and all you have is a .gif (another image format). You cannot simply change the file name and expect for it to work. It won't. (There are, though, file format converters).

Some file formats are essentially **text-based**. Usually, it's because the content of the file is text-based, and so that's the easiest way to store the data as text. This is true of many file formats used for human-readable text (like the HTML file you are reading currently) as well as source code for computer programs.

You can view these files in a text editor, and you'll be able to read the text. There will often be additional characters which don't seem like part of the text, and which are hidden when viewing the file normally.

Other file formats are "**binary**". This means that the content of the file is only understandable by the computer. Apps, images, videos, and many other types of files are binary, if you viewed them in a text editor you wouldn't see anything meaningful, just a bunch of numbers.

B. **Web research:** Generally, skills get more complex as you move to the bottom of the document although the order I have used is subjective. Choose a topic to research that relates to your current curriculum. Using these skills in a real context creates a much more interesting richer experience.

I would expect Year 3 to go as far as using the synonym search. I would expect Year 6 children to have covered everything by the time they leave the school.
Some skills and Understanding are good to combine in a lesson. For example, I might combine bookmarking, multiple word searches and understanding the order of the results in Year 3.

If you are teaching this in Year 4, 5 & 6 at Abbots wood there is a Google Survey in templates that you can use as a pre-test to help you target gaps in pupils' knowledge.

C. **Presentation techniques using ICT and CAD software**

Traditional computer-based technologies

- **Standard office applications**
- **Word processing**: e.g. MS Word to write letters, reports etc.
- **Spreadsheets**: e.g. MS Excel to analyze financials, calculations, create forecasting models etc.
- **Database software**: e.g. Oracle/MS SQL Server/Access to manage date in many forms from basic lists (e.g. customer contacts to catalogues)
- **Presentation software**: e.g. MS PowerPoint to make presentations
- **Desktop publishing**: e.g. Adobe in Design/Quark Express/MS Publisher to produce newsletters, magazines and other complex documents
- **Graphics software**: e.g. Adobe Photoshop and Illustrator to create and edit images such as logos, drawing or pictures for use in DTP, websites or other publications.

Specialist applications

- **Accounting package**: e.g. Sage/Oracle to manage an organization account
- **Computer Aided Design (CAD):** to assist the design process. Specialist programs exist for many times of design such as architectural, engineering, electronics and roadways
- **Customer Relations Management (CRM):** to allow businesses to better understand their customers by collecting and analyzing data such as their product preferences

and buying habits etc. Often linked to software applications that run call centers and loyalty cards, for example

Digital communication technologies

Communication of data by electronic means, usually over some distance is often achieved via networks of sending and receiving equipment, wires and satellite links.

The technologies involved in communication tend to be complex. You certainly don't need to understand them for your ICT course. However, there are aspects of digital communications that you need to be aware of. These relate primarily to the two types of network and the ways of connecting to the internet. Let's look at these two briefly:

- **Internal networks:** Usually referred to as a local area network (LAN), this involves linking a number of hardware items (input and output devices plus computer processing) together within an office or building.

The aim of a LAN is to be able to share hardware facilities such as printers or scanners, software applications and data. This type of network is invaluable in the office environment where colleagues need to have access to common data or programs.

- **External networks:** Often you need to communicate with someone outside your internal network, in this case you will need to be part of a wide area network (WAN). The internet is the ultimate WAN - it is a vast network of networks.

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