# IE 111 Computer Aided Engineering Drawing 

Projection Theory

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## Projection Theory

$\square$ The solid objects in the space are 3D. Although we perceive them in 3D (due to shading, color, etc.), we see them in 2D (You can not see the back of a wall/screen)!
$\square$ We can only see surfaces (2D shapes) that reflect light.
$\square$ Thus we project 3D solids to 2D shapes.


## Pictorial Illustration

Computer-generated pictorial illustration with shades and shadows. These rendering techniques help enhance the 3-D quality of the image.

## Projection Theory

$\square$ Engineering and technical graphics are also dependent on projection methods.
$\square$ The two projection methods primarily used

- Perspective projection
- Parallel projection
$\square$ Both methods are based on projection theory.


## Projection Theory

$\square$ Two variables involved in all projection methods;

- line of sight (the direction we look)
- plane of projection (the plane where the 2D shapes are seen).



## (2) Line of Sight

$\square$ An imaginary ray of light between an observer's eye and an object.
Drawing more than one face of an object by rotating the object relative to your line of sight hepls in understanding the 3-D form.


## Line of Sight

$\square$ In perspective projection, all lines of light atart at a point.
$\square$ In parallel projection, all lines of sight are parallel.


## Plane of Projection

- An imaginary flat plane upon which the image created by the lines of sight is projected.
$\square$ The image is produced by connecting the points where the line of sight pierce the projection plane.
- In effect, the 3-D object is transformed into a 2-D representation (also called projection).

$\square$ The paper and computer screen on which a sketch or drawing is created is a plane of projection.


## Classification of Projections



## Perspective Projection

## - Perspective projection mimics the human eye



Object at a distance (e.g. The Sun)

Object seen smaller than the original

## (D) Perspective Projection

## $\square$ Perspective projection mimics the human eye



## Perspective Projection

- Figure shows a perspective drawing of a road, as well as the "orthographic" side view of the same road.
$\square$ In the perspective view, the sky meets the ground at a line called the horizon or eye level.
- The plane upon which the object is projected is called the picture plane, where lines of sight from the object form an outline of the object.


Perspective View

## Perspective Projection

## Distorted Dimensions

Perspective drawings distort true dimensions.


## Pictorial Drawings

## Distorted Angles

Angular dimensions are distorted on pictorial drawings.


## Oblique Projection

$\square$ A parallel projection technique in which the plane of projection is not perpendicular to the parallel lines of sight.


## Orthographic Projection



## Perspective vs. Orthographic Projection


A. PERSPEGTIVE PICTORIAL PROJECTION


## Perspective vs. Orthographic Projection



## Orthographic Projection

$\square$ A parallel projection technique in which the plane of projection is perpendicular to the parallel lines of sight.
$\square$ It is the key point of engineering drawing.
$\square$ Some views created by orthographic projection:


Isometric


Multiview

## Ortographic Planes



## Orthographic Projection

Consider an object enclosed in an imaginary glass box, positioned such that the panes of glass are parallel to the major surfaces of the object and at 90 degrees to each other.

Imaginary Glass Box
http://www.theatre.ubc.ca/design/crslib/drft 1/orthint.htm

## Orthographic Projection - 6 Views



If one "projects" lines from the corners of the object (with each line at 90 degrees to a surface of the glass), until these lines intersect the glass, one can lay out 6 "views," each of which represents the object as it is
"seen" by the various panes of glass.

## Orthographic Projection - 6 Views

$\square$ Having projected the respective "views" of each face of the object onto the glass surfaces, we can "unfold" the glass box....


## Orthographic Projection - 6 Views

....until all the "views" are laid out in the same plane as the "Front" view, giving the figure shown below. Notice that each view can "see" (and show) only one aspect of the object, and that all the views are aligned to one another, because of the "unfolding" of the imaginary box.


## (1) Orthographic Projection



7


## (1) Orthographic Projection



15


16


## Orthographic Drawing-Necessary Views

- The purpose of an orthographic drawing of a solid object is to completely describe the object in a minimum number of views.
- The number of essential views depends upon the intricacy of the object; complicated designs may require several views in order to show complete detail. - When drawing an object, use only those views necessary for showing the shape of each detail of the object. The Top, Front, Right Side, Left Side, Bottom, and Back are called
 the Principal Views.


## Animations



## Multiview Drawings

To create multiview drawings, plane of projection should be oriented such that only two dimensions (e.g. height and width) of the object can be seen.


## Multiview Drawings

$\square$
Multiview drawing vs perspective drawing:

- Note that perspective drawing distorts objects (Objects that are far from the plane of projection are viewed smaller than they actually are.)
- However we need to present dimensions in engineering drawings, thus we need
 undistorted views.


## Perspective View Illusions



## Perspective View Illusions



## Perspective View Illusions



## First-Angle / Third-Angle Projection



## First-Angle / Third-Angle Projection



## First-Angle / Third-Angle Projection

## 3rd Angle Orthographic Projection

$\square$ The three planes form a glass boxwith the object placed inside the glass box. The viewer is outside the glass box looking at images of the object on the planes.


## 3rd Angle Orthographic Projection



## 3rd Angle Orthographic Projection

$\square$ The three planes form a glass boxwith the object placed inside the glass box. The viewer is outside the glass box looking at images of the object on the planes.


## 3rd Angle Orthographic Projection

$\square$ The three planes are hinged to open along the horizontal/frontal edge and and along the frontal/profile edge to show the relationship of the views to each other


## 3rd Angle Orthographic Projection

$\square$ The three planes can be removed leaving the three orthographic views. Projection lines can be shown lightly but omitted on the final plan.


## First Angle Projection



Each view of the object is projected "through" the object, onto the interior walls of the box.


## Third Angle Projection



Each view of the object is projected "through" the object, onto the exterior walls of the box.


## First vs Third Angle Projection



## Multiview Drawings



## (D) Multiview Drawings

Top wiaw


Frort view


Pight side vien


## Multiview Drawings

## Three Space Dimensions



TOP


FRONT

## Alternative View Arrangement

## Projections of Point A



First-angle projection (ISO)

## Multiview Drawings

Creation of multiview drawing of a simple engineering object:


Front View


Top View


Right Side View
$\square$ Combining these three multiviews fully explains the details of the 3D objects (?)

## Multiview Drawings

$\square$ Actually there may still be some details that are not visible on those three multiviews.
$\square$ The objects that cannot be visible on a plane of projection, must be projected on the plane by using "hidden lines".


## Multiview Drawings

The six principal views of an object


## Multiview Drawings




TOP VIEW


BOTTOM VIEW

## Six view drawing

## Multiview Drawings



# Conventional three view drawing 

## Multiview Drawing



## Multiview Drawings - Example 1

Create the three view drawing of the given object.


## Multiview Drawings - Example 1



|  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| \| |  |
| :---: | :---: |
| - 20 | - 30 |

## Multiview Drawings - Example 2

## Create the three view drawing of the given object.



## Projection of the Surfaces

$\square$ Surfaces parallel to the Viewing Plane:

- Such surfaces will show as a surface on one view and a line on the other view.



## Projection of the Surfaces

## - Projection of rounded

## surfaces:

- The rounded end of the object in the figure is represented as an arc in the front view.

- In the other views, it is a rectangle, because the curve is tangent to the sides of the object.
- If the curve were not tangent to the sides, then a line representing a change of planes would be needed in the profile and top views.



## Projection of the Surfaces

- A rule of thumb:
- Intersecting surfaces



## Projection of the Surfaces

## $\square$ Projection of hidden surfaces:

- In orthographic drawing, a hidden line is developed when a solid object is blocking other lines or surfaces in the flat orthographic viewing plane.
- Hidden lines are used to represent features that are invisible.
- Dashed lines are used to represent hidden lines.


The hole is actually invisible from the top.

## Projection of the Surfaces - Center Lines

- In engineering drawing, the centerline and center marks are used
> To locate center points
> To show symmetry and balance
> To show axes of cylindrical parts
- Centerlines need to be drawn when round shapes are seen in a view, as shown in the figure.
- Centerlines are also drawn along the surface where the circular form is not seen.



## Distortion of Some Features

Some features are distorted in orthographic projection.

- Distortion of circular features (foreshortening):


Front


Isometric
View

Right Side

## Distortion of Some Features

- Distortion of inclined (angular) surfaces (foreshortening):

(a) CLINOGRAPHIC

(b) ORTHOGRAPHIC
right side view


## Linetypes in AutoCAD

-New line types can be loaded by selecting linetype command from format menu. Linetype Manager will appear when linetype command is selected. New line types can be added by clicking load button.
-The new line types will appear on the line type list.
-The new line types can be selected either from Line type Manager or from the shortcut menu.


## Orthographic Drawing - Alignment of the Views

- An example of orthographic drawing


Note that the views are aligned. This is required in order to represent the relation between the views.

## Alignment of the Views

Three-view drawings are aligned horizontally and vertically. In this arrangement, the front view is the central view. Also notice that


TOP surfaces are the same distance apart in the related views: top and right side.


## Alignment of the Views

$\square$ In order to align your three view orthgraphic drawings on A3 size template, you should

- Leave 50 mm distance between all views and calculate the width and length of your drawing dimensions.
- Center your drawing considering the paper size. You must leave equal distances from the sides of your drawing to the edges of the drawing area.



## One View Drawing

## $\square$ Simple cylindrical shapes

$\square$ Spheres

- Thin parts
- Map drawings





## Two View Drawing

- Cylindrical shapes

Conical shapes $\square$ Pvramidal shapes




## N <br> General Procedure to Draw Quickly and Effectively

$\square$ Set the drawing limits
$\square$ Set up your Layers
$\square$ Set up the Titleblock

- Create the Front View
- Create the Top View
- Create the Side View

Dimension the three views

- Add the center lines
$\square$ Create the hidden lines


## General Procedure to Draw Quickly and Effectively

$\square$ Set the drawing limits
Set the limits so that the entire drawing will match the A3 paper it is meant to print on. Now set the grid to 10 and the snap to 1 , and zoom the drawing to the limits.

- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View
- Create the Side View
- Dimension the three views
- Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers

Create the outline, titleblock, text, dimension, centerline, hiddenline, phantom line layers. Make sure to load the Linetypes you need and set each layer to the appropriate colors and linetypes. Finally, Set the current layer to titleblock.

- Set up the Titleblock
- Create the Front View
- Create the Top View
- Create the Side View
- Dimension the three views
- Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
$\square$ Set up your Layers


## - Set up the Titleblock

Draw a rectangular perimeter line at the drawing limits to simulate the paper's edge. Now create your personal titleblock in the lower right corner of this frame according to the guidelines provided. Finally create a revision table in the upper right corner. When you are satisfied with your titleblock and revision table, set the current layer to outline.
$\square$ Create the Front View

- Create the Top View
$\square$ Create the Side View
- Dimension the three views
$\square$ Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View

Choose the longest view of the object to be the front view and create it in the lower left quadrant of your drawing. Do not forget to use the Snap and Osnap tools while drawing.

- Create the Top View
- Create the Side View
- Dimension the three views
$\square$ Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View

Using the Front view as a reference, draw outline lines as appropriate and form the Top view.

- Create the Side View
- Dimension the three views
- Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View

Create the Side View
As you did in the last step, draw outline lines from the Front view to form the Side View.

- Dimension the three views
- Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View
- Create the Side View

D Dimension the three views
Change the layer to dimension and create the dimensions on this layer. Apply dimensions to the object.

- Add the center lines
- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View
- Create the Side View
$\square$ Dimension the three views
- Add the center lines

Switch the current layer to centerline and apply necessary center lines for circles and axes of symmetry.

- Create the hidden lines


## General Procedure to Draw Quickly and Effectively

- Set the drawing limits
- Set up your Layers
- Set up the Titleblock
- Create the Front View
- Create the Top View
- Create the Side View
$\square$ Dimension the three views
$\square$ Add the center lines
$\square$ Create the hidden lines
Set the current layer to hidden line and draw any hidden lines.


## Creating a Three-View Sketch



Completed three-view sketch

## Multiviews from 3-D CAD Models

1. Create the 3-D Model.
2. Change the viewpoint of the 3-D model to front view, create the 2-D front view using FLATSHOT command and save as a block.
3. Change the viewpoint, create the 2-D top view using FLATSHOT command and save as a block.
4. Change the viewpoint, create the 2-D right view using FLATSHOT command aand save as a block.

## Multiviews from 3-D CAD Models

5. Arrange the 2-D views on a new drawing by retrieving blocks created earlier. Bring the views in at the proper scale and correct alignment.
6. Edit the views to change solid lines to hidden lines and to add center lines in accordance with accepted standards.


## View Selection

Good Orientation


Suspend the object in the glass box so that major surfaces are parallel or perpendicular to the sides of the box.

Poor Orientation


Suspending the object so that surfaces are not parallel to the sides of the box produces views with many hidden lines.

## View Selection

## Natural Position

Always try to draw objects in their natural position.


## View Selection

## Minimum Number of Views

Select the minimum number of views needed to completely describe an object. Eliminate views that are mirror images of other views.


## View Selection

## Most Descriptive Views

Select those views that are the most descriptive and have the fewest hidden lines. In this example, the right side view has fewer hidden lines than the left side view.


## Sample Drawing



## Work Book Problem 5.5-Multiview Sketching 2

Sketch the front, top, and right side views using the gridded space.


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Sketch the front, top, and right side views using the gridded space.


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## Work Book Problem 5.5-Multiview Sketching 2

Sketch the front, top, and right side D.




## Problem 5.5 - Figure 5.122

Sketch or draw with CAD multiviews of the objects shown in the pictorials.

(1)

(4)

(2)

(5)

(3)

(6)

## Problem 5.5 - Figure 5.122

Sketch or draw with CAD multiviews of the objects shown in the pictorials.

(13)

(16)

(14)

(17)

(15)

(18)

## Problem 5.5 - Figure 5.122

Sketch or draw with CAD multiviews of the objects shown in the pictorials.


## Problem 5.5 - Figure 5.122

Sketch or draw with CAD multiviews of the objects shown in the pictorials.

(91)

(94)

(92)

(95)

(93)

(96)

## Multiview Exercise 5_17.dwg



## Multiview Exercise 5_18.dwg



## Sample Drawing



## English - Turkish Dictionary

| projection | izdüşüm | Line of sight | Görüş hattı | Plane of <br> projection | Izdüşüm düzlemi |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Perspective <br> projection | Perspektif izdüşüm | Parallel projection | Paralel izdüşüm | Oblique <br> projection | Eğik izdüşüm |
| Orthographic <br> projection | Ortografik (dik <br> çizgisel) izdüşüm | horizon | ufuk | Eye level | Göz hizası |
| Picture plane | Resim düzlemi | Frontal plane | Önden görünüş <br> düzlemi | Horizontal plane | Yatay düzlem |
| Profile plane | Yanal düzlem, profil <br> düzlemi | unfold | açוlım | Top view | Üstten görünüş |
| Front view | Önden görünüş | Side view | Yandan görünüş | illusion | illüzyon, görüntü <br> yanılması |
| First angle | Birinci dördül bölge <br> açısı | Third angle | Üçüncü dördül <br> bölge açısı | Vanishing point | Ufuk noktası, sıfır <br> noktası |
| Multiview <br> drawing | Çoklu görünüşlü <br> çizim | Hidden line | Gizli çizgi | Dashed line | Kesik çizgi |
| 3-view drawing | Üç görünüşlü çizim | intersecting | Kesen, kesişen | centerline | Merkez hattı |
| distortion | bozulma | alignment | hizalama | inclined | eğimli |
| foreshortening | Görüntü kısalması | Viewing plane | Görüş düzlemi | Principal views | Ana (esas) <br> görünüşler |

