L3
Locating Methods

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Important Points to remember

- **Locators:** Device that establishes correct relative position of workpiece w.r.t. the cutting tool.

- **Fixture:** A device that is used to hold the w/p firmly and accurately to perform a machining operation.

- **Jig:** A device that is used to hold the w/p firmly and accurately and guides/supports the tool to perform a machining operation.

Drilling Jig

Milling Fixture

Fixture
Fool proofing

- *Foolproofing* is a means by which the tool designer ensures that the part will fit into the tool only in its correct position.

- The part in Figure A must be machined on the tapered end, so the tool designer includes a pin to prevent the part from being loaded incorrectly. This pin foolproofs the tool.

- The part in Figure B shows a hole that must be drilled with reference to the holes in the flange. A simple pin placed in one of these holes makes it impossible to load the tool incorrectly.

- Other foolproofing devices are just as simple. If foolproofing devices are not simple, they tend to complicate an otherwise easy task.
Important Points to remember

1. Configuration is a major factor that determines the way of location of a w/p.

2. Configuration of a w/p is determined by a combination of flat, circular and irregular surfaces.

3. Additionally, these surfaces may be rough or finished.
Location Types

Plane location normally is considered the act, or process, of locating a flat surface. Many times, however, irregular surfaces may be located this way as well. Plane location is simply locating a workpiece with reference to a particular surface or plane.

Concentric location is the process of locating a workpiece from an internal or external diameter.
Radial location normally is a supplement to concentric location. With radial location, the workpiece is first located concentrically, then a specific point on the workpiece is located to provide a specific fixed relationship to the concentric locator.
Degrees of freedom of a rectangular block: **Six DOF (12 directions)**

![Diagram of a rectangular block showing degrees of freedom](image)
Locating from plane surfaces: 3-2-1 Principle

1. For locating it is necessary to arrest all 12 directions to ensure the mechanical stability.
2. Pin C would arrest the translation motion along the z-axis (down) i.e 5
3. Still it can rotate about all three axes.
4. Pin A would arrest the rotary motion about the y-axis (3 & 4). Still it can rotate about x and z axes.
5. Pin B would arrest the rotary motion about the x-axis (1 & 2).
6. Adding another locator would not serve any purpose and act as redundant locator

Three locating pins A, B, C arrest 5 Directions
- 5 Arrested: z translation (down)
- 1,2 Arrested: rotation about x axis
- 3,4 Arrested: rotation about y axis
Locating from plane surfaces: 3-2-1 Principle

1. Pin D would arrest the translation motion along the y-axis (Left) i.e 8
2. Still it can rotate about z axis.
3. Pin E would arrest the rotary motion about the y-axis (6 & 7). Still it can rotate about x and z axis.
4. Adding another locator in this plane would not serve any purpose and act as redundant locator

Two locating pins D,E arrest 3 Directions

- 8 Arrested: y translation (left)
- 6,7 Arrested: rotation about z axis
- Total Directions arrested till now=5+3=8
Locating from plane surfaces: 3-2-1 Principle

1. Pin F arrests direction 9
2. Adding another locator in this plane would not serve any purpose and act as redundant locator
3. Total Directions arrested till now = 5 + 3 + 1 = 9
4. Remaining 3 Directions are only translation i.e. 10, 11 and 12
5. These three Directions can easily be restricted by clamps.
Locating Points should be placed as far as possible to minimize the inaccuracies and for better stability.
Locating from plane surfaces

Locating surfaces must be perpendicular. Otherwise,
1. The workpiece tends to rise due to wedge action.
2. The chips or dirt may clog between the pin and locating surface, that can further magnify the error.
Locating from Circular surfaces

1. Conical Location
2. V-location
Locating from Circular surfaces: Conical Location

- Used when locating is achieved from hole.
Locating from Circular surfaces: V- Location

- Used to locate and/or clamp the round workpiece and workpiece having convex circular surfaces.
- Also called as **concentric location** because w/p is usually placed at common Centre.
- Optimum V angle is 90 degree.
- Smaller V angle holds more securely but susceptible to errors due to burrs, chips, dirt and w/p inaccuracies
**V- Location : Effect of W/p size**

- \( C = (R_2 - R_1) \cos(x) \)
- When \( x \) approaches \( 90^0 \), \( C \) is minimum but the workpiece is difficult to locate.
- The most desired \( x = 45^0 \),
- When \( x < 45^0 \), the workpiece may firmly located but create large deviation.
Locating from Circular surfaces: V-Location

• V should be directed in such a way to minimize the error and dependency on the size of workpiece.
Nesting

- The nesting method of location features a cavity in the work holding device into which the workpiece is placed and located. If the cavity is the same size and shape as the workpiece, this is an effective means of locating.

Disadvantages

- W/p difficult to lift out of the nest.
- the operation performed may produce burrs on the workpiece that tend to lock it into the nest.

The solution is partial nesting
Adjustable locators: For locating the Irregular surfaces
Adjustable locators

• These are movable and frequently used for rough-cast or similar parts with surface irregularities. Examples of adjustable locators are threaded, spring pressure, and equalizing.

• Adjustable locators are used in conjunction with fixed locators to permit variations in part sizes while maintaining a fixed relative position of the part against the fixed locators.

• Adjustable locators are widely used for applications where the workpiece surface is irregular or large variations between parts make solid locators impractical.

**Threaded type locator:** This type of locator can also be used as a clamping device rather than a locator
Lock nut and locking screw type locator

Threaded type adjustable supports.
Locating from irregular surfaces: Locating one plane

- **Adjustable pins**: The workpiece of any geometry can be located with adjustable pins.

- **Fixture jack**: The workpiece is positioned on three non adjustable locators and jacks are adjusted until they touch the workpiece surface.

- **Mechanical equalizing jack**: They give nearly equal contact pressure between the two locators.
Locating from irregular surfaces: Locating one plane

- **Mechanical equalizing jack**: They give nearly equal contact pressure between the two locators.

Equalizing rocker provides an extra point for better workpiece support
Locating from irregular surfaces: Locating more than one planes

Fig. 6.19 Adjustable locators that can be locked position

Brass inserts
Locating from irregular surfaces: Locating more than one planes

- The positional location is sometimes determined by sight location which is particularly applicable to first operation location of w/p with irregular surfaces.

- Punch marks, scribed lines or slight holes are provided in the jig or fixture and are used to locate the part roughly.
Locating Methods and Devices
Locator types

- **Fixed locators:** These are solid locators that establish a fixed position for the workpiece. Typical examples of fixed locators include integral, assembled, pins, V-type, and locating nests.

- **Integral Locators:** Integral locators are machined into the body of the work holder. In most instances, this type of locating or supporting device is the least preferred. The principal objections to using integral locators are the added time required to machine the locator and the problem of replacing the locator if it wears or becomes damaged. Another drawback to using integral locators is the additional material required to allow for the machining of the locator.
Locator types

- **Assembled locators:** Assembled locators are similar to integral locators in that they both must be machined. However, these locators have the advantage of being replaceable.
- Assembled locators may be used as locators for supports. Since they are not part of the major tool body, using assembled locators does not require additional material for the tool body.
- Assembled locators frequently are made of tool steel and hardened to prevent wear.
Locator types

**Pins.** A locating pin is the simplest and most basic form of locating element. These locators may be made in-house from steel drill rod or purchased commercially.

- Commercial locating pins are available in several styles and types.
- Standard hardened dowel pins are another form of commercial component frequently used for locating devices. Due to their simplicity, easy application, and replaceability, round pins are the most commonly used form of locating device.
Pin Locators
Locator types

• **V-Type:** A cylinder, like the prism, also has six degrees of freedom (12 directions). The cylinder in Figure A is free to move in two opposed directions along each axis and rotate both clockwise and counterclockwise around each axis. *To accurately locate a cylindrical workpiece, it must be confined to restrict motion in each of its directions.*

• **Figure B** shows a cylinder placed in the intersection of two perpendicular planes.

• The horizontal plane restricts rotation around the X axis and Y axis as well as translation in Y (downwards).

• The vertical plane restricts rotation around Y axis and the translation in X (leftward).
EFFECT OF W/P DIAMETER AND V-ANGLE

$C = (R2 - R1) \cos(\alpha)$

- Lower angle gives good reaction but causes greater misalignment when workpiece of larger diameter is located as the value of $C$ increases.
- Higher angle is ok but will reduce the wall reaction,
EFFECT OF IRREGULAR SURFACE OR CHIP

Perpendicular distance is always shortest
Button, Pin, Plug

• Button: Small size pin (used for vertical location)
• Pin/plug: Larger than button (used for horizontal location)
Location from Cylinder: Dowel Pins

- Dowel pin holes are drilled through so that the pin can be taken out.
- The recommended bearing length of a dowel pin in each part is 1 ½ to 2 times the diameter of the pin.
- Dowel pins are cylindrical or tapered.
- The straight type is available in unhardened and hardened form.
- The fit of the dowel pin can be a press fit in each part.
- Tapered pins are easily taken out by the application of light pressure or a blow on the small end.
- Dowel pins are extensively used in the construction of built-up fixture bodies.
Lock screw button and pins

Used in case of
• wear environment
• Frequently replaced
Diamond pins

• Diamond pins are used for radial location in conjunction with round locating pins.

• It is possible to accurately locate a workpiece with two round pins, but allowances must be made for the variations encountered in hole sizes and locations.
Principal locator

Diamond pin

\[ d = 2 \sqrt{\frac{D^2}{4} - V^2 - VW} \]

- \( C = \) Center distance
- \( V = \) Valuation in center distance
- \( D = \) Work piece bore min.
- \( d = \) Diamond pin dia. max.
Diamond Pin

AB = V
BC = W/2
AP = D (Workpiece hole dia.)
BP = dia & diamond pin = d

\[ AP^2 = AC^2 + CP^2 \]

\[ \left( \frac{D}{2} \right)^2 = \left( \frac{V}{2} + \frac{W}{2} \right)^2 + \left( \frac{d}{2} \right)^2 - \left( \frac{W}{2} \right)^2 \]

\[ \frac{D^2}{4} = V^2 + \frac{W^2}{4} + VW + \frac{d^2}{4} - \frac{W^2}{4} \]

\[ \frac{d^2}{4} = \frac{D^2}{4} - V^2 - VW \]

\[ d = 2 \sqrt{\frac{D^2}{4} - V^2 - VW} \]

C = Center distance
V = Valuation in center distance
D = Work piece bore min.
d = Diamond pin dia. max.
Design of non sticking plugs/pins
A plug of diameter \( d \) extending from a faceplate will not stick in the hole of diameter \( D \) if the plug length \( l = \sqrt{2WC} \). Where \( W = \) outside diameter of workpiece concentric with the hole, \( C = D - d \).
A projection of diameter \( d \) on a workpiece will not stick in a locating hole of diameter \( D \) if the hole is relieved or countersunk so that the length of engagement between the hole and workpiece is \( E = l - m \leq \sqrt{WC} \).
The plug is relieved by cutting away three equal segments at a workable angle of 15°.

\[ m = 0.35d \]

The required length of plug to prevent sticking

\[ l = 2.4 (2a + 0.85d) (D-d) \]
An aligning groove may be machined on the end of a plug of diameter \( d \) of unlimited length \( l \). Here

\[ l_1 = \sqrt{2AC_2}, \quad l = \mu d \]

\[ B = 0.985d \]

\[ A = \frac{2d^2}{D} - d \]
Spherical locating plug

• Prevents sticking due to minimum contact area
Rest pads and plates

- Their objective is just to locate the w/p like buttons/pins but of larger size.

Rest pads: for large size w/p

Rest plates: for even larger size w/p
Methods of controlling chips/burrs