Locating Principles & Devices
LOCATING PRINCIPLES

To position the work piece w.r.t. to tool, to ensure precision in machining

Locating: dimensional and positional relationship b/w work piece and tool

Locator: device to establish and maintain position of a part in a jig or fixture
BASIC PRINCIPLES

Positioning the locator
Accuracy & tolerances
Fool proofing
Duplicate location
Motion economy
1- Positioning the locators

Locators should **contact the work** (preferably machines surface) on a **solid and stable point**:

This permits accurate placement of the part in the tool & ensures the repeatability of the jig and fixture

- They should be **placed as far as possible**:
  - This permits the use of fewer locators
  - Ensures complete contact over the locating surface
2- Accuracy and Tolerance

The workpiece itself determines the overall size of a locating element.

Locators must be made to suit the MMC (Maximum-Material Condition) of the area to be located. (The MMC of a feature is the size of the feature where it has the maximum amount of material).

With external features, like shafts, the MMC is the largest size within the limits.

With internal features, like holes, it is the smallest size within the limits.
• The main considerations are the size of the area to be located and the required clearance between the locator and the workpiece.

• Make the locating pin slightly smaller than the hole.

• Here, the hole is specified as .500-.510" in diameter. Following the rule of MMC, the locator must fit the hole at its MMC of .500". Allowing for a .0005 clearance between the pin and the hole, desired pin diameter is calculated at .4995".

• Tool tolerance should be between 20 and 50 percent of the part tolerance.
FOOL PROOFING

Ensures that the part fits into the tool in its correct position only

The simplest and most cost effective method is positioning a fool proof pin.
FOOLPROOFING PIN

THREE LOCATING PINS USED TO ESTABLISH LOCATION OF PART ON THE LARGE DIAMETER

DIAMOND LOCATING PIN

BLOCK USED TO FOOLPROOF THE LOCATION OF THE PART
4- Duplicate locators

Redundant, or duplicate, locators should be avoided.

a) Flat surface can be redundantly located. The part should be located on only one, not both, side of surfaces.

b) Both the hub and the flange locating the same parallel surface

c) Difficulty with combining hole and surface location: Either locational method (locating from the holes or locating from the edges) works well if used alone.
5. Motion Economy

It involves use of easy, quick and economic loading of work pieces.
Degrees of Freedom

- Here we consider 12 degrees of freedom (not 6).

- 4 along each axis; 2 translational and two rotational.
Restriction of Movement:

Six-pin method (3-2-1 method):

- Motion is restricted using clamps and locators.
- A three pin base can restrict five motions.
  - Rotation about X, Y axes. (4 motions)
  - Translation along -ve z-axis (1 motion)
- Directions nine, ten and eleven are restricted by a clamping device. (3 motions)
To restrict the movement of the part around the ZZ-axis and in direction eight, two more pin-type locators are positioned in a vertical plane. (3 motions)

A single pin locator in vertical plane restricts motion along direction 7. (1 motion)

So motion in all 12 directions are restricted.
- Six-pins restrict nine motions.
- Other three are restricted by using a clamp.
This is the most common locating method employed for square or rectangular parts.

Flat bases may also be used, but these should be installed rather than machining into the base.

But pin/button type locators offers more accuracy as the area of contact is less. Moreover, they raise the work above the base so that chips wont interrupt the operation.
Workpieces with holes:

- Holes provide an excellent method for locating.
- A round pin inside the hole (primary) and a diamond pin (secondary) can restrict 11 motions!
Locating Methods:

Locating from a Flat Surface:

There are three primary methods of locating work from a flat surface:

- solid supports
- adjustable supports,
- equalizing supports
Solid supports:

- Easiest and cheapest.
- Less accurate.
- Used where machined surface acts as a locating point.
Adjustable supports:

- Used where surfaces are uneven (casting, forging..)
- Threaded style is the easiest and more economical.
- Adjustable locators are normally used with one or more solid locators to allow any adjustment needed to level the work.
Equalizing supports:

- They provide equal support through two connected contact points.
- As one point is depressed, the other raises and maintains contact with the part.
- This feature is especially necessary on uneven cast surfaces.
Locating from an Internal Diameter

• Locating a part from a hole or pattern is the most effective way to accurately position work.

• Nine of the twelve directions of movement are restricted by using a single pin, and eleven directions of movement are restricted with two pins.

• When possible, it is logical to use holes as primary part locators.
Locating Cylindrical Surfaces (Externally)  
“V”-locators

- Vee locators are used mainly for round work.
- They can locate flat work with rounded or angular ends and flat disc.
- Two types: Fixed and Adjustable:
Locating from Irregular Surfaces (External)

Locating work from an external profile, or outside edge, is the most common method of locating work in the early stages of machining.

- For simple components, a sighting plate may be used. Location is done by adjusting the workpiece in such a way that it has equal margins on all sides.

- In large parts cylindrical pins can be used.
cont.. (irregular surfaces)

- If there are large variations from batch to batch, eccentric locators can be used, whose eccentricity can be varied according to the profile.
- Eccentricity is varied just by rotating the locator until it holds the workpiece in position.
Locating from an External Profile

- **Nesting locators** position a part by enclosing it in a depression, or recess, of the same shape as the part.

- Nesting is the most accurate locating device for profile location.

- Obviously, the height of the nest should be lesser than the height of the workpiece.

- In case of sheet-metals or thin workpieces, finger slots or ejector pins should be provided.
Pin and button locator

- Locator used to support or hold the workpiece in position.
- Pins locators are longer and for horizontal locations. Button locators shorter, vertical locations.
- Locating buttons-press fit and screwed (wear and tear more — replaceable)
Figure 8.80. Use of Pins and Buttons as Locators.
Rest pads and plates

- Used with heavier and larger workpiece.
- To support and locate the work vertically.
- Hold jig or fixture base plate by socket-head cap screws.
Diamond pin locator

- Work piece with the drilled holes use two round pins
- If dimension variation between centre to centre distance of the holes, one round and diamond pin locators are used
- Binding is eliminated
- Prevents movement around the pin and are relieved on two sides to allow variation
\[ B = \delta_1 + \delta_2 - 2c \]

where

\[ B = \text{width of the diamond pin} \]
\[ \delta_1 \rightarrow \text{Tolerance on workpiece} \]
\[ \delta_2 \rightarrow \text{Tolerance on Jig} \]
\[ 2c \rightarrow \text{Diametrical clearance in setting the workpiece on cylindrical pin} \]

If \( \delta_1 + \delta_2 > 2c \) then diamond pins should not be used.
FIGURE 6-22
Use of one round and one diamond locating pin.
Nesting locator or cavity locator

- used to position the work piece
- Accurate method for profile location
- No need of supplementary locating devices
- But it is difficult to lift out of cavity

Common types:-
Ring Nest

- Used for cylindrical workpiece.
- It encloses the workpieces fully.
1. Full Nest

- For work pieces other than cylinders.
- Encloses the work completely.
Partial Nest

- For larger work pieces a nest may not be possible to enclose it completely.
- In such cases partial nests are used which encloses certain contours of the work.
Figure 3-28 Partial nest.
Spherical locator

- Spherical location reduces contact area.
- Material not in direct contact with the work piece.
- Binding not possible in this case.
3-24 Spherical locators.
Split contact locator

- Relieved locator used in thick workpiece
- Locator is relieved in the middle
- Only top and bottom areas come in contact with workpiece

Figure 3-22 Split contact relieved locator.
Raised contact locator

- Raised contact design reducing the chance of binding
- Contact point is raised to the middle of the workpiece and contact area reduced
- Moving the contact area from the base plate reduces the effect of dirt, chip and burrs

![Diagram of raised contact locator](image)

*Figure 3-23* Raised contact relieved locator.
Split pin or groove pin

- Used in place of dowel pins to reduce cost and time
- Not so accurate as they don’t employ the reamed hole as in the case of dowel pins

Figure 3-35 Split and grooved dowels.
Dowel pin locator

- Most common type of fixed locator

Figure 3-34 Doweled locators.
Cylindrical pin

- Used when the workpiece contains holes drilled into it
- Pin will bind unless centreline of the hole is perfectly aligned with centreline of locator
Machined Fixed stop locator

- Used for parts that cannot be used in either a nest or V-locator
- Are usually machined into the tool body
- Since they are machined into the tool body the entire body has to be changed when locator is worn out
Installed fixed stop locator

- Most economical to use
- Since it is installed into the tool body and not machined it can be easily replaced when worn out
- No need to make the locator body entirely again
- Saves time

Figure 3-33 Installed fixed-stop locators.
Standard parts
jig button

- Commonly made from case hardening steel (16MnCr5 or 20MnCr5C15)
- Have a hardness value of about 60 HRC
- Have a case depth of 0.3 to 0.5 mm
Jig bush

- Jig bushes locate and guide cutting tools
- Several types like linear, renewable, slip and screw bushes exist
- Made from direct hardening type steel such as En31, T90, 20MnV8
- Hardness is usually 60 HRC with case hardened depth of 0.5 to 0.8mm

![Figure 3-17 Pin locators and bushing.](image)
Ejectors

➢ Used to remove the workpiece from close fitted locators and are present behind the workpiece
➢ Speed up the operation by reducing unloading time
➢ They are of 2 types:
  • Mechanical type
  • Spring plunger

![Ejectors Diagram](image-url)

*Figure 3-40 Ejectors.*
Jig feet bolt and nuts

➤ Usually purchased as standard parts and they are built into jig body except in casting construction

➤ Jig feet is bounded with lug and grounded in order to make geometrically true surface
Pressure pads

- Used above or below the workpiece depending on size and shape of workpiece
- Necessary when workpiece contains sharp corners or irregular surfaces
- Also used to absorb shocks
- Pressure for pads applied by springs, air or hydraulics
- Urethane pads require less space than springs since they withstand greater pressure with less deflection compared to springs

Figure 4-30  Pressure pads.
- Used for positive clamping force
- They should have hardness value less than the mating surface
- Used for compensating length in bolt size and to grip the clamping force
- C washer, swing C washer, spherical washer, lock washer, internal star washer

*Figure 4-11 Spherical nuts and washers.*
Hand grip screws

- Used for positive clamping
- Used to tighten the part
- Cylindrical end, groove end, floating end are the various types
Wing or fly screws

- used for light positive tightening
- Cylindrical end, groove end, floating end are the various types
Quarter turn screw

- Also called thumbscrew latch
- Designed in such a way that the operator can easily turn the screws even if the threads are covered with dry oil, dust and chips
- It is kept perpendicular to confirm tightening
Sight Locators:

- Used for rough machining.
- Less accurate.
- Work fits into specific slots on the locating plate known as sighting plates.

2 types

- Sight location by slots on the table.
- Sight location by lines etched on the tool.