Manufacturing Tooling
4. Work Holding Principles

Nageswara Rao
Posinasetti

Work Holding

- Work holder includes all devices that hold, grip, or chuck a work piece to perform a manufacturing operation.

Figure 4-1. Principles of workholders.
Figure 4-2. Multiplication of holding force.

- Holding force
- Workpiece held, e.g., filing, grinding
- Serrations to increase resistance to slipping
- Force multiplication

\[
H = \frac{O \times F}{D}
\]

Figure 4-3. Elementary workholder (vise).

- Workpiece
- Holding force
- Screw
- Fixed jaw
- Movable jaw
- Torque and groove used for attachment to machine
- Lever
- Torque = F x a

Figure 4-4. Vise with hydraulic clamping.

- Movable jaw
- Fixed jaw
- V slots
- Removable base
- For attachment to machine when used without base
- For attachment to machine
Purpose & Function of Work Holder

- Location
- Clamping
- Support
- Cutting forces
- Safety

General Considerations

- Physical characteristics of the workpiece
  - Degree of precision
  - Strength and stiffness of workpiece
  - Production requirements
  - Safety requirements
- Standard work holders
Locating Principles

- Work piece surfaces
  - Flat surfaces
  - Cylindrical surfaces
  - Irregular surfaces
- Types of location

Plane Location

Figure 4-6. Plane location.

Concentric Location

Figure 4-7. Concentric location.
3-2-1 Method of Location

*Figure 4-11.* Three pins arrest three directional movements.

3-2-1 Method of Location

*Figure 4-12.* Five pins arrest eight directional movements.
Figure 4-13. Six pins arrest nine directional movements.

Figure 4-14. Base and center pin restrict three directional movements.

Figure 4-15. Base, center pin, and radial locator restrict 11 directional movements. Chomping will restrict Z11 if required.
Basic Locating Rules

- Position and Number of Locators
- Redundant Locators
- Locational tolerances
- Fool proofing

When more than one locator is placed on a surface, they should be distributed as far apart as possible on the surface

- When more than one locator is placed on a surface (plane), they should be distributed as far apart as possible on the surface.
- This would help in placing the workpiece on locators without much skill.
- Also the clamping forces would not be able to shift the workpiece from such locators.
- A blank with irregular surface (such as sand casting) would be better located on such distributed locators.

When more than one locator is placed on a surface, they should be distributed as far apart as possible on the surface

- Machining forces would not be able to disturb the equilibrium of the workpiece in the fixture with properly distributed locators.
- Wear of any locator contributes less to the inaccuracy of location if the locators are placed far apart.
While selecting the surface for the largest locators, consideration should be given to the largest area of the workpiece.

The two locators should be placed on the surface with the next largest area and the single locator on the surface with the least surface area.

**Figure 4-16. Magnification and projection of error.**

**Figure 4-17. Redundant locators.**
Redundant Locator

To prevent incorrect loading

Correct Loading

Figure 4-18. Foolproofing.

To prevent incorrect loading

Correct Loading

Figure 4-18. Foolproofing.
Basic types of Locators

- External locators
  - Fixed
  - Adjustable
    - Threaded locators
    - Spring pressure locators
    - Equalizing locators
- Integral locators
- Assembled locators

Integral locators

Figure 4-19. Integral locators.
Basic types of Locators

- Locating pins
- V-locators
- Locating nests
- Adjustable locators

Locating pins

Figure 4-21. Locating pins.
Locator 0.5 in (Jergens)

Figure 4-22. Simple workholder made of plane surface and pins.

Figure 4-23. Vertical locating with pins.
Figure 4-24. Six degrees of freedom and 12 directions of a cylindrical workpiece.

Figure 4-25. Seven directional movements arrested by V locator with stop pins.

Figure 4-26. Workholder with multiple V locators.
V-locator error?

Adjustable Locators

Figure 4-33. Threaded adjustable locator.
Support surfaces

- Select a surface where there is maximum likelihood for the part to deflect under the action of clamping and cutting forces.
- Support areas selected should not disturb the location of the workpiece in any manner nor displace the locators while providing the support.
- Support areas selected should not interfere with the loading and unloading of the component into the work holding fixture.

Adjustable Supports

- Adjustable locators positioned beneath the workpiece
  - Threaded
  - Spring
  - Equalizers
Internal Locators

- Use holes or bored diameters

Figure 4-39. Machined internal locator.
Pin locators

- Plain
- Shouldered
- Undersized (0.0005 to 0.002")
  - Prevent jamming
**Figure 4-42. Relieved locators.**

**Diamond Pin**

- Radial location

**Figure 4-43. Radial location with internal pins or plugs.**
Figure 4-44. Locating completely with diamond pins.

Figure 4-45. Floating locating pin. (Courtesy, Carr Lane Manufacturing Co.)

Figure 4-46. Floating locating pin used in combination with round locating pins. (Courtesy, Carr Lane Manufacturing Co.)
Chip and Burr Problems

- Make locators easy to clean
  - Small and hard
  - Open jigs
- Make them self cleaning
  - Edge relief around locators
  - Wipers
- Protect them
Figure 8-26. Examples of proper chip clearance around locating pins and blocks.
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### Diagram
