Other Mechanical Fastening Methods

- In addition to the mechanical assembly techniques discussed in the preceding, there are several additional methods that involve the use of fasteners. These include **stitching, stapling, sewing, and cotter pins.**

Stitching, Stapling, and Sewing

- Industrial stitching and stapling are similar operations involving the use of U-shaped metal fasteners.
- **Stitching** is a fastening operation in which a stitching machine is used to form the U-shaped stitches one at a time from steel wire and immediately drive them through the two parts to be joined.
- Figure (5-71) illustrates several types of wire stitches.

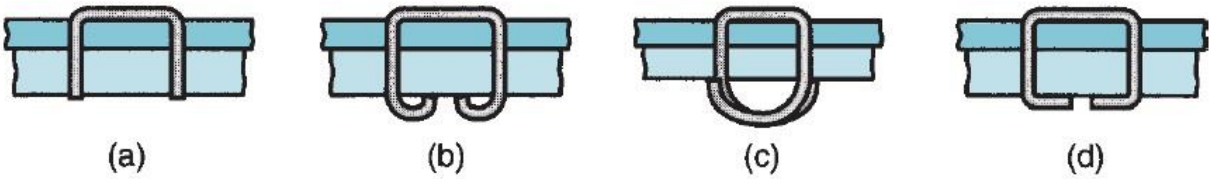

Figure (5-71) Common types of wire stitches: (a) un-clinched, (b) standard loop, (c) bypass loop, and (d) flat clinch.

- The parts to be joined must be relatively thin, consistent with the stitch size, and the assembly can involve various combinations of metal and nonmetal materials.
- **Applications of industrial stitching include light sheet metal assembly, metal hinges, electrical connections, magazine binding, corrugated boxes, and final product packaging.**
- Conditions that favor stitching in these applications are:
  (1) high-speed operation,
  (2) elimination of the need for prefabricated holes in the parts, and
  (3) desirability of using fasteners that encircle the parts.

- In **Stapling**, preformed U-shaped staples are punched through the two parts to be attached.
- The staples are supplied in convenient strips.
- The individual staples are lightly stuck together to form the strip, but they can be separated by the stapling tool for driving.
- The staples come with various point styles to facilitate their entry into the work.

- Staples are usually applied by means of portable pneumatic guns, into which strips containing several hundred staples can be loaded.
- **Applications of industrial stapling include: furniture and upholstery, assembly of car seats, and various light-gage sheet metal and plastic assembly jobs.**

- **Sewing** is a common joining method for soft, flexible parts such as cloth and leather.
- The method involves the use of a long thread or cord interwoven with the parts so as to produce a continuous seam between them.
- The process is widely used in the needle trades industry for assembling garments.

- **Cotter Pins** are fasteners formed from half-round wire into a single two-stem pin, as in Figure (5-72).

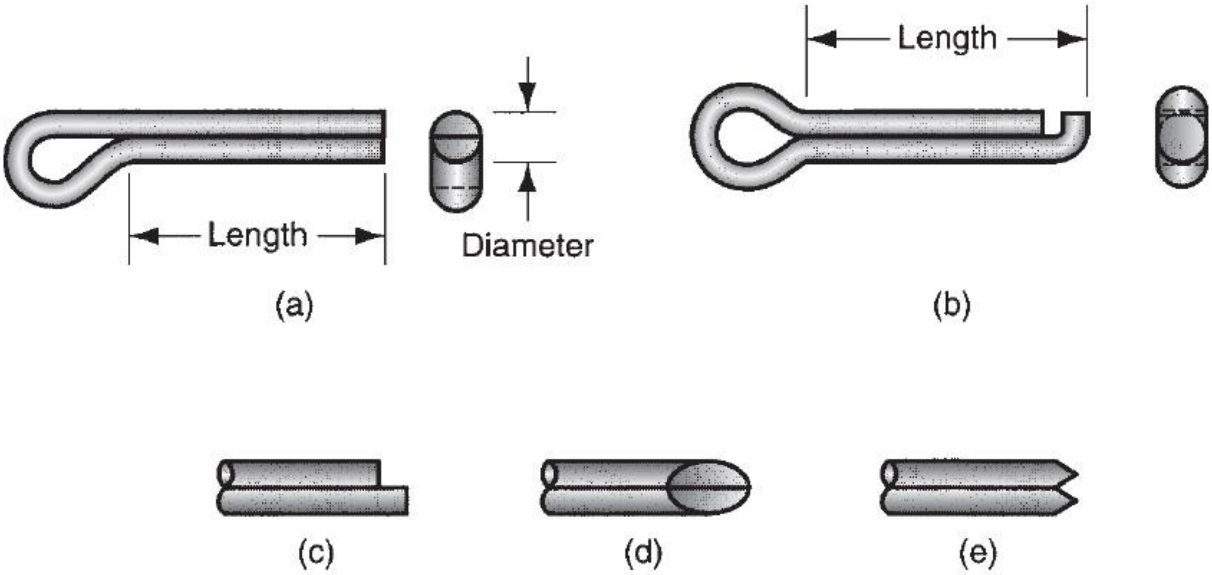

Figure (5-72) Cotter pins: (a) offset head, standard point; (b) symmetric head, hammerlock point; (c) square point; (d) mitered point; and (e) chisel point.

- They vary in diameter, ranging between 0.8mm and 19mm, and in point style, several of which are shown in the figure above.
- Cotter pins are inserted into holes in the mating parts and their legs are split to lock the assembly.
- **They are used to secure parts onto shafts and similar applications.**

Molding Inserts and Integral Fasteners

- These assembly methods form a permanent joint between parts by shaping or reshaping one of the components through a manufacturing process such as casting, molding, or sheet-metal forming.

Inserts in Moldings and Castings

- This method involves the placement of a component into a mold before plastic molding or metal casting, so that it becomes a permanent and integral part of the molding or casting.
- Inserting a separate component is preferable to molding or casting its shape if the superior properties (e.g., strength) of the insert material are required, or the geometry achieved through the use of the insert is too complex or intricate to incorporate into the mold.
- Examples of inserts in molded or cast parts include **internally threaded bushings and nuts, externally threaded studs, bearings, and electrical contacts**.
- Some of these are illustrated in Figure (5-73).
- Internally threaded inserts must be placed into the mold with threaded pins to prevent the molding material from flowing into the threaded hole.

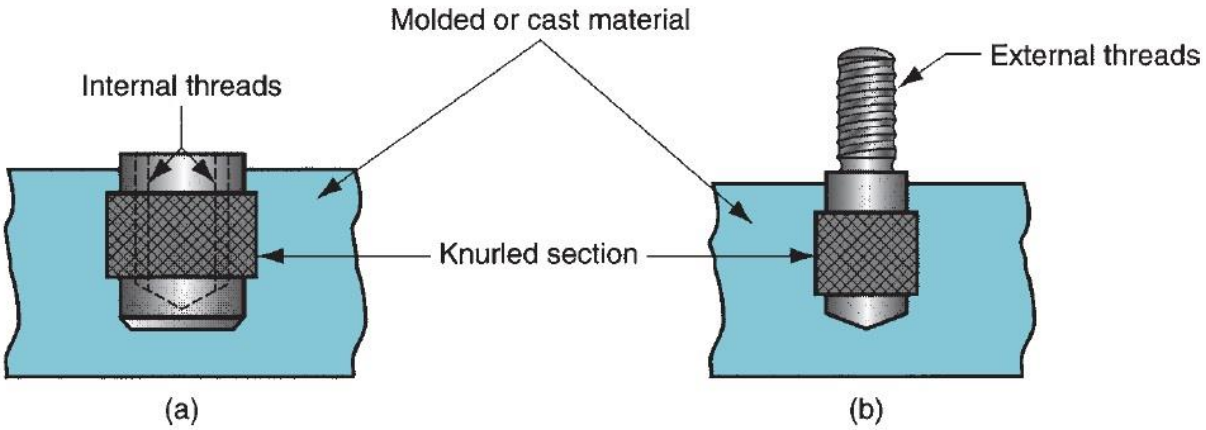

Figure (5-73) Examples of molded-in inserts: (a) threaded bushing and (b) threaded stud.

- Placing inserts into a mold has certain disadvantages in production:

(1) design of the mold becomes more complicated;
(2) handling and placing the insert into the cavity takes time that reduces production rate;
(3) inserts introduce a foreign material into the casting or molding, and in the event of a defect, the cast metal or plastic cannot be easily reclaimed and recycled.

- Despite these disadvantages, use of inserts is often the most functional design and least-cost production method.

Integral Fasteners

- Integral fasteners involve deformation of component parts so they interlock and create a mechanically fastened joint (most common for sheet metal parts).
- The possibilities, Figure (5-74), include:

(a) **lanced tabs** to attach wires or shafts to sheet-metal parts;

(b) **embossed protrusions**, in which bosses are formed in one part and flattened over the mating assembled part;

(c) **seaming**, where the edges of two separate sheet-metal parts or the opposite edges of the same part are bent over to form the fastening seam—the metal must be ductile in order for the bending to be feasible;

(d) **beading**, in which a tube-shaped part is attached to a smaller shaft (or other round part) by deforming the outer diameter inward to cause an interference around the entire circumference;

(e) **dimpling**—forming of simple round indentations in an outer part to retain an inner part.

- **Crimping**, in which the edges of one part are deformed over a mating component, (e.x.: squeezing the barrel of an electrical terminal onto a wire).

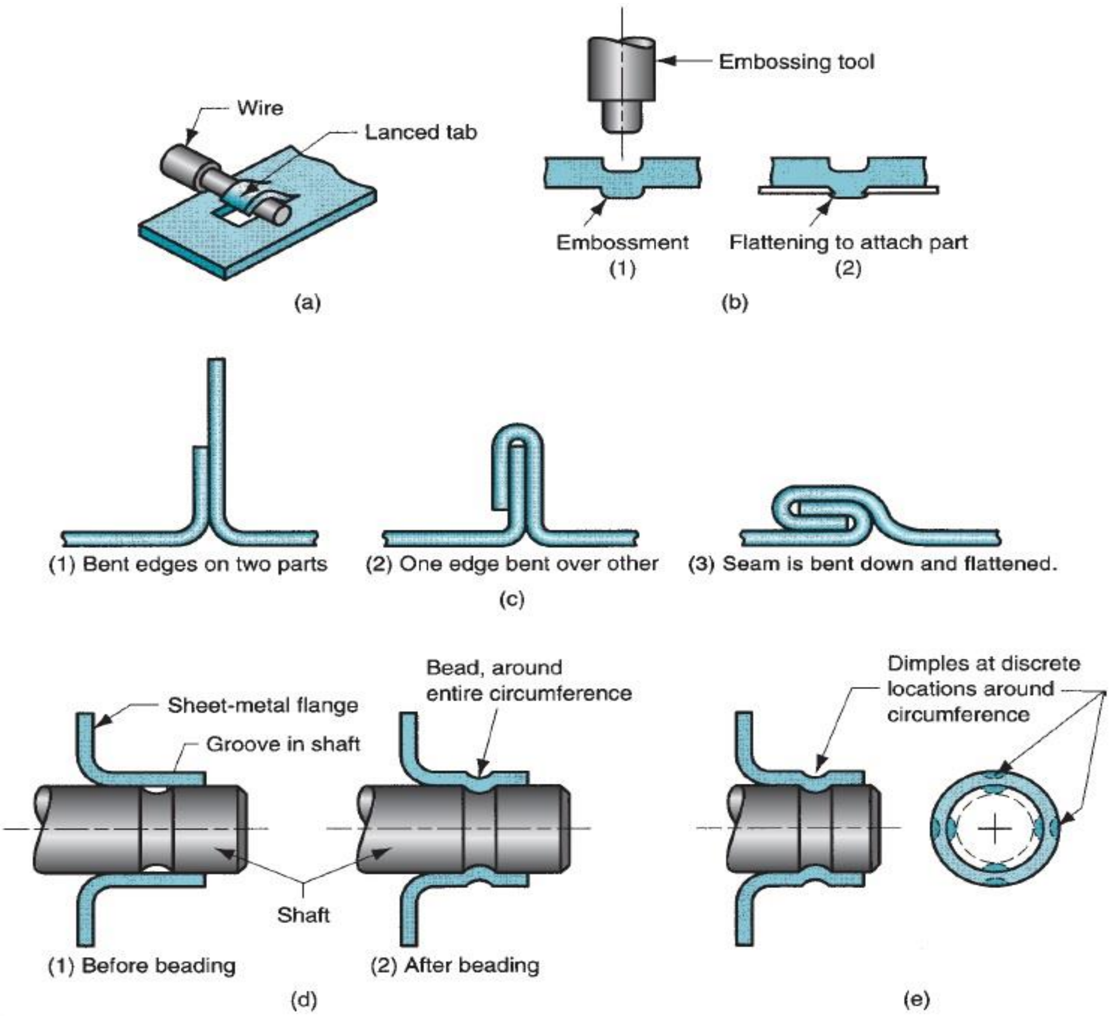

Figure (5-74) Integral fasteners: (a) lanced tabs to attach wires or shafts to sheet metal, (b) embossed protrusions, similar to riveting, (c) single-lock seaming, (d) beading, and (e) dimpling. Numbers in parentheses indicate sequence in (b), (c), and (d).

Design For Assembly

- Design for assembly (DFA) has received much attention in recent years because assembly operations constitute a high labor cost for many manufacturing companies.
- The key to successful design for assembly can be simply stated:
  (1) design the product with as few parts as possible, and
  (2) design the remaining parts so they are easy to assemble.

- The cost of assembly is determined largely during product design, because that is:
  (1) when the number of separate components in the product is determined, and
  (2) decisions are made about how these components will be assembled.

- Much of the research in design for assembly has been motivated by the increasing use of automated assembly systems in industry.
- Accordingly, our discussion is divided into two sections, the first dealing with general principles of DFA, and the second concerned specifically with design for automated assembly.

General Principles of DFA

- Most of the general principles apply to both manual and automated assembly.
- Their goal is to achieve the required design function by the simplest and lowest cost means.
- The following recommendations have been compiled from:

- **Use the fewest number of parts possible to reduce the amount of assembly required:**
- This principle is implemented by combining functions within the same part that might otherwise be accomplished by separate components (e.g., using a plastic molded part instead of an assembly of sheet metal parts).
- **Reduce the number of threaded fasteners required:**
- Instead of using separate threaded fasteners, design the component to utilize snap fits, retaining rings, integral fasteners, and similar fastening mechanisms that can be accomplished more rapidly.
- Use threaded fasteners only where justified (e.g., where disassembly or adjustment is required).
- **Standardize fasteners:**
- This is intended to reduce the number of sizes and styles of fasteners required in the product.
- Ordering and inventory problems are reduced, the assembly worker does not have to distinguish between so many separate fasteners, the workstation is simplified, and the variety of separate fastening tools is reduced.
- **Reduce parts orientation difficulties:**
- Orientation problems are generally reduced by designing a part to be symmetrical and minimizing the number of asymmetric features.
- This allows easier handling and insertion during assembly.
- This principle is illustrated in Figure (5-75).
- **Avoid parts that tangle:**
- Certain part configurations are more likely to become entangled in parts bins, frustrating assembly workers or jamming automatic feeders.
- Parts with hooks, holes, slots, and curls exhibit more of this tendency than parts without these features.
- See Figure (5-76).

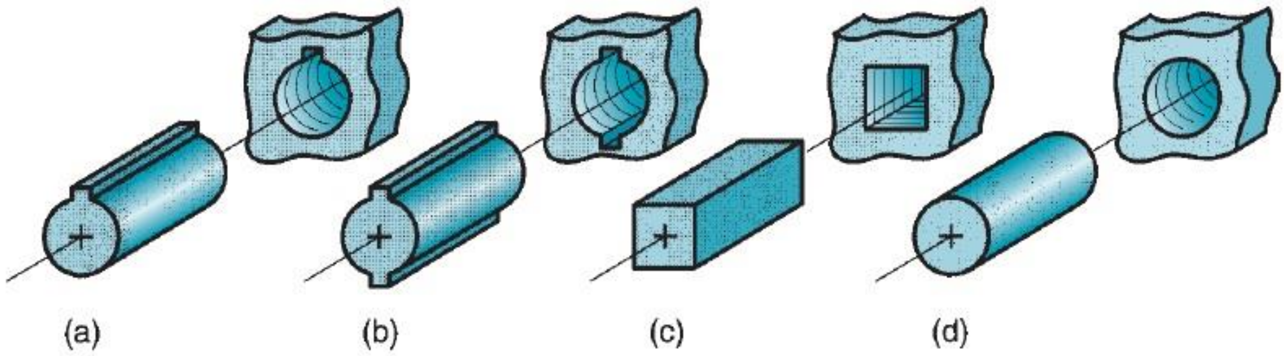

Figure (5-75) Symmetrical parts are generally easier to insert and assemble: (a) only one rotational orientation possible for insertion; (b) two possible orientations; (c) four possible orientations; and (d) infinite rotational orientations.

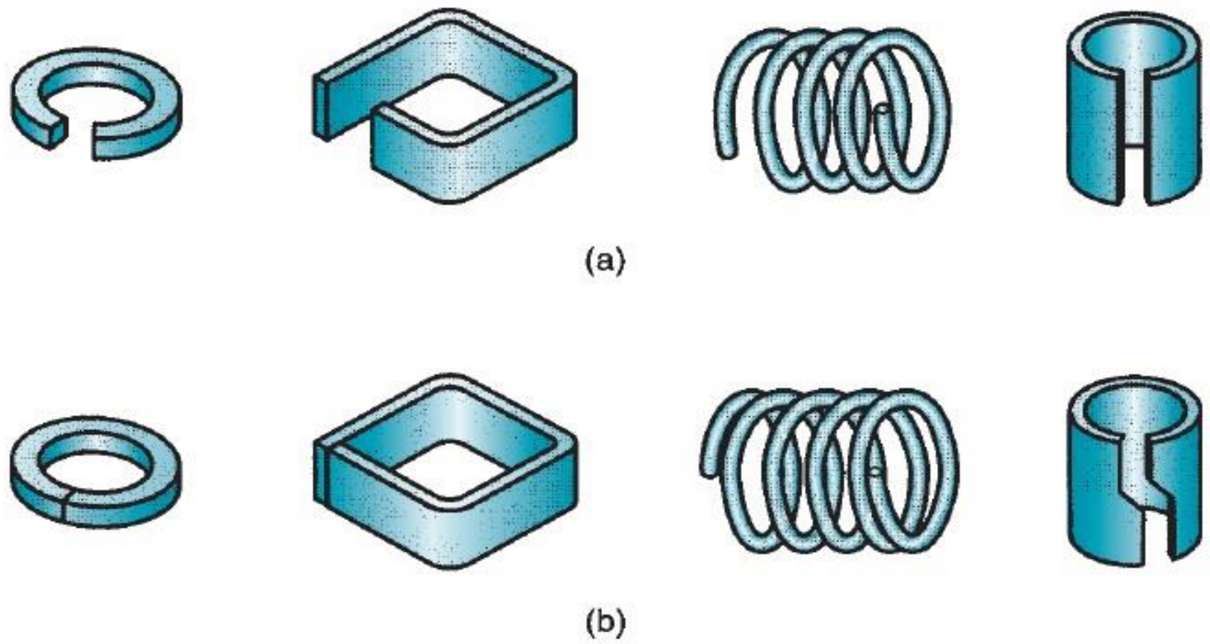

Figure (5-76) (a) Parts that tend to tangle and (b) parts designed to avoid tangling.

Design For Automated Assembly

- Methods suitable for manual assembly are not necessarily the best methods for automated assembly.
- Some assembly operations readily performed by a human worker are quite difficult to automate (e.g., assembly using bolts and nuts).
- To automate the assembly process, parts fastening methods must be specified during product design that lend themselves to machine insertion and joining techniques and do not require the senses, dexterity, and intelligence of human assembly workers.
- Following are some recommendations and principles that can be applied in product design to facilitate automated assembly:

➢ **Use modularity in product design:**

- Increasing the number of separate tasks that are accomplished by an automated assembly system will reduce the reliability of the system.
- To alleviate the reliability problem, researchers suggest that the design of the product be modular in which each module or subassembly has a maximum of 12 or 13 parts to be produced on a single assembly system.
- Also, the subassembly should be designed around a base part to which other components are added.

➢ **Reduce the need for multiple components to be handled at once:**

- The preferred practice for automated assembly is to separate the operations at different stations rather than to simultaneously handle and fasten multiple components at the same workstation.

➢ **Limit the required directions of access:**

- This means that the number of directions in which new components are added to the existing subassembly should be minimized.
- Ideally, all components should be added vertically from above, if possible.

➢ **High-quality components:**

- High performance of an automated assembly system requires that consistently good-quality components are added at each workstation.
- Poor quality components cause jams in feeding and assembly mechanisms that result in downtime.

➢ **Use of snap fit assembly:**

- This eliminates the need for threaded fasteners; assembly is by simple insertion, usually from above.
- It requires that the parts be designed with special positive and negative features to facilitate insertion and fastening.