Unit 11

Section One: Reading Comprehension

Joining Processes

When we inspect the vast numbers of products around us, we soon realize that almost all of them are assemblages of components that were manufactured as individual parts. A typical automobile has 15,000 components, all of which must be assembled, using several joining methods.

The many diverse fastening requirements are met by a multitude of permanent and nonpermanent joining of fastening techniques and devices. The product engineer or designer must be familiar with the characteristics, advantages, and limitations of all the fastening techniques and devices in order to select and specify the one most appropriate for a given application.

In general, joining and fastening methods can be classified into broad categories of either mechanical fastening or bonding techniques. Mechanical fastening techniques may be either permanent or nonpermanent types while bonding techniques are considered to be of the permanent type. Permanent joining or fastening methods do not allow for adjusting, removing, or separating the parts once they are fastened together, such as the frame of an automobile.

Bonding processes consist of two categories, cohesion and adhesion. A common example of cohesion is welding. The cohesion processes feature the fusing of two or more pieces into a continuous, or monolithic, single piece. Cohesion is widely used in joining industrial products, particularly metals, although plastics are also extensively welded. Advantages of welding include speed, efficiency, and the adaptability to automated assembly processes.

Adhesion differs from cohesion because a substance that is entirely different from the joined pieces is used to bond, or glue, the pieces together. Adhesion includes the use of glues and adhesives and soldering and brazing. Brazing and soldering (which are actually the same thing but at different temperatures) depend upon the adhesion of a material such as brass or copper to other metals such as steel by capillary action, just as with glue and other adhesives.

Joining is an all-inclusive term covering processes such as welding, brazing, soldering, adhesive bonding, and mechanical fastening. These proc-

assembly are an important and necessary aspect of manufacturing operations. Although there can be different ways of categorizing the wide variety of joining processes, according to the American Welding Society (AWS), joining processes fall into three major categories: welding, adhesive bonding, and mechanical fastening (Figure 11-1).

Welding processes are, in turn, divided into three basic categories: fusion welding, solid-state welding, brazing and soldering. Some types of welding processes can be classified in both fusion and solid-state categories, major examples of which are upset and resistance welding. Fusion welding is defined as melting together and coalescing materials by means of heat. The thermal energy required for these welding operations is usually supplied by chemical or electrical means. Filler metals, which are metals added to the weld area during welding of the joint, may or may not be used. Fusion welds made with-

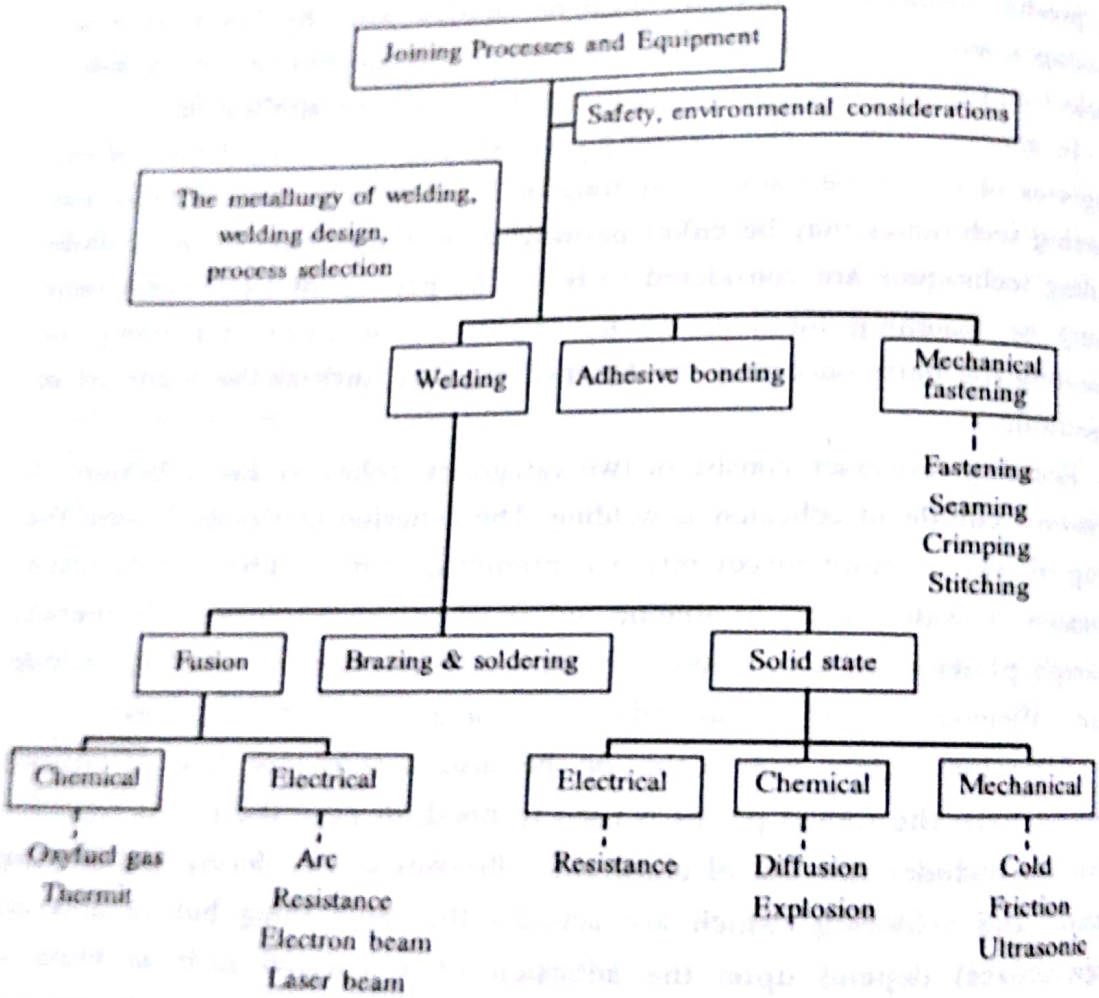

Figure 11-1.

out the addition of filler metals are known as autogenous welds.

Unlike the fusion welding, no liquid (molten) phase is present in solid-state welding. The principle of solid-state welding is best demonstrated with the following example. If two clean surfaces are brought into atomic contact with each other under sufficient pressure, and in the absence of oxide films and other contaminates, they form bonds and produce a strong joint. Heat and some movement of the mating surfaces by plastic deformation may be employed to improve the strength of the joint.

In almost all types of welding, the metals to be joined are heated to elevated temperatures by various means to cause fusion or bonding at the joint. But what if you want to join materials that cannot withstand high temperatures, such as electronic components? In this manner, they make use of brazing and soldering, which permit lower temperatures than those required for welding. In both brazing and soldering, filler metals are placed in or supplied to the joint. They are then melted using an external source of heat and, upon solidification, a strong joint results. Soldering temperatures are lower than those of brazing, and the strength of a soldered joint is not high. Thus brazing and soldering are arbitrarily distinguished by temperature.

Numerous components and products can be joined and assembled using an adhesive, rather than by any joining methods described thus far. Adhesive bonding has been a common method of joining and assembly for applications such as labeling, packaging, bookbinding, home furnishings, and footware. Plywood developed in 1905, is a typical example of adhesive bonding of several layers of wood with glue. Many types of adhesives are available, and continue to be developed, which provide adequate joint strength, including fatigue strength. The three basic types of adhesives are:

- Natural adhesives, such as starch, dextrin (a gummy substance obtained from starch), soya flour, and animal products.
- Inorganic adhesives, such as sodium silicate and magnesium oxy-chloride.
- Synthetic organic adhesives, which may be thermoplastics (used for nonstructural and some structural bonding) or thermosetting polymers (used primarily for structural bonding).

Two or more components may have to be joined in such a way that they can be taken apart sometime during the product's service life. The mechanical fasteners group includes all types of screws, pins, nails, staples, rivets, spring clips, and other such mechanical devices which join two or more parts by the addition of a separate piece which serves as the binding element. Numerous

objects, including mechanical pencils, caps, and lids on containers, mechanical watches, engines, and bicycles, have components that are fastened mechanically. Mechanical fastening generally requires that the components have holes through which fasteners are inserted. These joints may be subjected to both shear and tensile stresses and should be designed to resist these forces. As a broad group, the advantages of mechanical fastening are the adaptability and versatility of mechanical fasteners in terms of size, shape, strength, cost, and the ease of assembly using both common and specialized tools. An additional factor can include the ease of service or repair by utilizing certain types of fasteners.

Exercises