



Chapter 3

FABRICATION TECHNIQUES FOR STOCK SHAPES

Machinability

Plastic stock shapes may be easily machined. However, the tool geometry and speed must be adjusted for optimum performance with a specific material. The tolerances for machining plastics usually should be larger than those applied to metals. The tolerances must be larger because of thermal expansion and the shape changing from the relaxation of internal stresses within the material. In critical applications, it may be necessary to premachine the part slightly over-size and stress relieve or anneal the part before taking the final cuts.

Annealing is the baking of a material, without melting or distorting the part, for a time to relax the internal stresses. The internal stresses are usually caused by uneven cooling, that is the outside of the part cools much faster than the inside when the blank is made. This uneven cooling can also cause variations in the properties from the outside to the inside.

The poor thermal conductivity of plastics requires that care is taken to prevent the area being machined from getting too hot. The type of tool, depth of cut, rate of feed and coolant flow may have to be adjusted. If a coolant is used, make sure it does not chemically attack the plastic.

Check the supplier literature for specific recommendations on the types of tools and speeds to be used with a particular material.

Tolerances

Many designers will arbitrarily put a $\pm .005$ in tolerance on a part if it is to be machined. Quiz the designer to determine if the tolerances can be increased. Remember that a piece of paper is about .003 inch thick, $\pm .03$ is equal to 1/16 of an inch, and $\pm .06$ equals 1/8 of an inch. Look at a ruler to visualize the size of the tolerance and think about the tools available to make the cut. Work with the designer to specify the tolerances really needed to make his part work and that can actually be produced with the equipment available.

Thermoforming

Thermoforming is the process of creating a form from a flat sheet by combinations of heat and pressure, which first soften the sheet and then form the sheet into some three dimensional shape. This is one of the simplest, most economical plastic forming processes. There are numerous variations of this process. There are three types of thermoforming: roll-fed, sheet-fed and in-line.

Thermoforming offers many distinct advantages over other shaping methods: lower tool mold cost that is one-tenth that of injection molding, the use of water cooled aluminum tools providing surface temperature control, simplified formation of laminates containing layers of different materials and higher production/throughput capabilities.

In addition, thermoforming provides significant time and labor savings when producing large parts in smaller quantities. Design through final product (art-to-part time) is substantially reduced when using thermoforming. Other important benefits are low machine cost and short delivery time.

Compared to injection molding, thermoforming uses significantly less energy in order to form parts, often using sheets of different color and thickness for each part, resulting in lower mold costs and shorter lead times. The process also produces more stress-free products that resist cracking and is often the most cost-effective method to form large parts.

Thermoforming's disadvantages include the need to use more expensive plastic sheet rather than resins in pellet form, the required trimming operation, and the related problems of scrap storage.

Welding

Plastics welding techniques have been around for over 50 years; both hot gas welding and spin welding were first reported in the 1930s. The total number of welding techniques for plastics has risen to 20, six of which are still in various stages of development and have yet to find industrial applications. These are laser welding, microwave welding, infrared welding, forced mixed extrusion welding, orbital welding and friction stir welding. More common welding methods are extrusion welding, hot gas welding, butt welding, spin welding and solvent welding.

Bonding

Using adhesives to bond plastics offers many advantages over traditional assembly methods, including reduced weight, assembly costs, cycle times and safety concerns. To gain the full potential of adhesives, designers need an understanding of the performance characteristics of each adhesive, and knowledge of the factors affecting the bondability of plastics.

The wide variety of plastics substrates, an invaluable asset when selecting design materials, becomes a serious limitation when selecting the optimum adhesive. The number of adhesives, coupled with the many grades of plastics, make it difficult to locate bond

strength data for specific adhesive/plastic combinations. The designer must first select a plastic and then evaluate different adhesives to identify one which meets the performance requirements of the application. Such screenings typically occur without information on the adhesive's performance characteristics.

Other factors such as cure speed, environmental resistance, thermal resistance and suitability for automation play a role in selecting the best adhesive for an application. Lower performance adhesives include rubber base solvent cements, hot melts, two-part epoxies and urethanes, but they are not suitable for high speed automated processes.