Chapter 11

DESIGN FEATURES THAT INFLUENCE PERFORMANCE

BASIC DETRACTORS AND CONSTRAINTS

In Chapters 3 through 5, 7, and 8 in particular some of the design problems of plastics were discussed. This chapter provides more detail on this important subject. Even though some of the analyses here will pertain to a specific process, many will relate to other processes, so it is best to review them all. Also, most of the characteristics of plastics that detract from their effectiveness refer to injection molding and provide guidelines for all the processes. Although it is not actually the product designer’s job to do so, the designer should have some idea of where problems can develop, based on how a mold or die is designed and manufactured [1, 2, 5–14, 21–32, 40–42, 45–46, 50, 55–68, 166, 208, 225, 253, 409, 478, 498, 564–70, 593, 637, 674, 807–15].

The successful design and fabrication of good plastic products requires a combination of sound judgment and experience. Designing good products requires a knowledge of plastics that includes their advantages and disadvantages and some familiarity with processing methods. Until the designer becomes familiar with processing, a fabricator must be taken into the designer’s confidence early in development and consulted frequently during those early days. The fabricator and mold or die designer should advise the product designer on materials behavior and how to simplify processing. The designer should not become restricted by understanding only one process, particularly just a certain narrow aspect of it (see Chapter 7) [10–14, 32, 33, 40–42].

One of the earliest steps in product design is to establish the configuration of the parts that will form the basis on which strength calculations will be made and a suitable material selected to meet the anticipated requirements. During the sketching and drawing phase of working with shapes and cross-sections there are certain design features with plastics that have to be kept in mind to avoid degradation of the properties. Such features may be called property detractors or constraints. Most of them are responsible for the unwanted internal stresses that can reduce the available stress level for load-bearing purposes. Other features, which are covered in this chapter, may be classified as precautionary measures that may influence the favorable performance of a part if they are properly incorporated [4–6].

Although there is no limit theoretically to the shapes that can be created, practical considerations must be met. These relate not only to part design but also to mold or die design, since these must be considered one entity in the total creation of a usable,
economically feasible part. In the sections that follow, various phases considered important in the creation of such parts are examined for their contribution to and effect on design and function.

Prior to designing a part, the designer should understand such basic factors as those summarized in Table 11-1 and Figure 11-1. Success with plastics, or any other material, for that matter, is directly related to observing design details. For example, something as simple as a stiffening rib is different for an injection molded or structural foam part, even though both parts may be molded from the same plastic (see Fig. 11-1). However, a stiffening rib that is to be molded in a low-mold-shrink, amorphous TP will differ from a high-mold-shrinkage, crystalline TP rib, even though both plastics are just injection molded (see Chapter 2). Ribs molded in RP/composite plastics have their own distinct requirements (see Chapter 5). Hollow stiffening ribs of the type produced by thermo-forming, blow, or rotational molding have the same function, but they are designed to be totally different [807].

The important factors to consider in designing can be categorized as follows: part thickness, tolerances, ribs, bosses and studs, radii and fillets, draft or taper, holes, threads, color, surface finish and gloss level, decorating operations, the parting line, gate locations, molded or extruded part shrinkage, assembly techniques, mold or die design, production volume, the tooling and other equipment amortization period, as well as the plastic and process selected. The order that these factors follow can vary, depending on the product to be designed and the designer's familiarity with particular materials and processes.

Preparing a complete list of design constraints is a crucial first step in plastic part design; failure to take this step can lead to costly errors. For example, a designer might have an expensive injection mold prepared, designed for a specific material's shrink value, only to discover belatedly that the initial material chosen did not meet some overlooked design constraint. Flammability, glass-fiber fillers to provide a higher modulus, and other requirements are best considered before a tool is made. Otherwise, the designer may have the difficult if not impossible task of finding a plastic that does meet all the design constraints, including the important appropriate shrink value for the existing mold. Such desperation in the last stages of a design project can and should be avoided. As emphasized from one end of this book to the other, it is vital to set up complete checklist of product requirements, to preclude the possibility that a critical requirement may be overlooked initially. Recognize that the "impossible" as well as the "approaches"

Figure 11-1. An example of how different plastics and molding processes can affect the design details of a stiffening rib.