Robert A. Malloy

Plastic Part Design for Injection Molding

An Introduction

With 427 Illustrations

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2.6 Part Ejection

2.6.1 Introduction

In the final phase of the injection molding process, the mold opens and the part is ejected from the tool. Ideally, this ejection phase of the process is accomplished without imparting any damage or distortion to the molded part as it is stripped from the cavity or core. While it is generally the responsibility of the tool designer to design a suitable ejection system for a given part geometry, it is the part designer that establishes ease or difficulty associated with this stage of the plastic part manufacturing process. The plastic part must be designed with ejection considerations in mind. This can be done if the product designers work closely with (or consult with) the tool designer right from the early stages of product development, when the part begins to take shape. The tool designer can comment on specific ejection related concerns and possible part design changes. Plastic part design considerations that influence the ease of ejection and ejection related tooling costs include:

- Draft angles or tapers
- Surface finishes
- Esthetic requirements
- The presence of undercuts or holes
- Stationary or moving half ejection
- Parting line location

Almost all of the features associated with a particular part geometry will have some impact on the ability to eject the part. Ejection systems for even a relatively simple plastic part can be expensive (in terms of tooling cost) if the part is not "designed for ejection".

2.6.2 Draft Angles

Cavity Draft: Draft angles or tapers are generally used to facilitate ejection of any molded part that has a significant depth of draw. When parts are produced using the standard cavity and core configuration, the cavity is stationary while the core is attached to the moving platen. In most cases, the part tends to stay with the core when the mold opens since (i) material shrinkage causes a contact pressure and normal frictional forces between the part and the core, and (ii) material shrinkage through the wall thickness tends to pull the part away from the cavity wall. It should also be noted that the area of contact between the part and the cavity can be greater than that of the part and the core, however, contact pressures with the cavity are likely to be lower due to shrinkage through the wall thickness of the part. Draft angles are typically added to the cavity side of the tool to assist in releasing the part from the cavity when the mold opens at the end of the molding cycle. The draft also reduces the potential for scuffing or abrasion to the outer (cavity) sidewall surfaces of the part when the tool opens.

Cavity draft angles reduce the effects of undercuts, eliminate sliding friction and part damage after the initial break away as the tool opens, and facilitate air movement to compensate for vacuum effects as the tool opens. Typical cavity draft angles range from a fraction of a degree to several degrees. The draft angle that is required varies with

parameters such as depth of dr
roughness and material shrinkag
special mold action, such as a spl
the part as the mold opens.

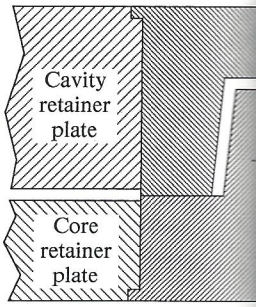

Figure 2.81. Cavity draft angles are u
core draft angles are added to facilitate re

The split cavity action reduces m
for the part sticking to the cavity,
scuffing due to sliding friction
essentially large side actions, and
slots and other undercut feature
costly than more conventional op
and potentially flash, will be visib

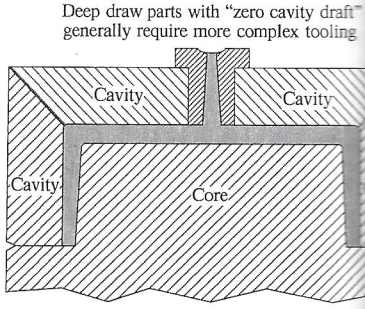

Figure 2.82. It is possible to produce
must be used to facilitate part release fro

attached to the moving or force platen of the molding machine). It is generally preferred to have the part stay with the moving half of the mold so that the molding machine's knockout system can be utilized to activate the molds ejector system. However, if the outer surface of the part is an appearance surface, sprue gating into the top exterior surface is esthetically unacceptable. As an alternative, the part could be gated on the underside , however, because parts tend to stay with the core (they shrink onto the core) and the ejector marks must be hidden, the tool must then be designed with ejection provisions on the stationary side of the tool. While this can be accomplished, it is not standard practice, and will result in additional tooling costs. The designer should recognize that there are other possible options or alternatives to stationary side ejection in this case. For example, the conventional cavity and core set up could be used with a cavity side sprue gate was used, if the sprue gate vestage was covered up using a label or logo.

2.6.5 Undercuts and Holes

Ideally, a plastic part should be designed so that it can be ejected from the mold without any special mold actions. Special mold movements such as side action, side coring, angle pins, collapsible cores, unscrewing mechanisms and the like should be avoided whenever possible. These special mold actions can be expensive to tool, add to mold maintenance, may interfere with the mold's cooling layout, and may ultimately add to the overall cycle time for part production. While it may not be possible to eliminate special mold movements, their use should be limited whenever possible. If side actions must be used, movement in a direction perpendicular to the mold opening direction is preferred. Actions at oblique angles should be avoided whenever possible. As an example, the hole in the sidewall of the part shown in Figure 2.95 would require side action to pull the small core pin (that produces the hole) from the hole before the part can be released from the cavity as the mold opens. The side action, and added tooling cost, could be eliminated if the part is designed with consideration towards ejection. For example, the hole could be replaced by a slot in the line of draw, and as a result, no special side actions or core pulls are required.

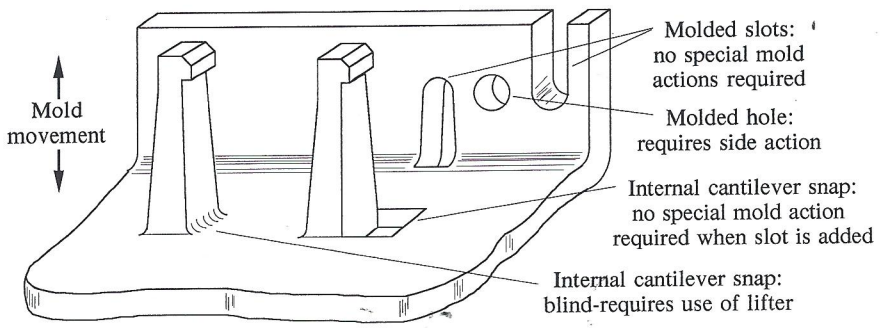

Figure 2.95. Whenever possible, part features such as holes or cantilever snap beams should be "designed for ejection". For example, changing a hole in a part sidewall to a slot will eliminate the tooling costs and maintenance problems associated with side action.