Frequently Asked Questions in the Routing of Plastics #2

The following are a list of questions that are commonly asked during the setup or actual machining of plastics. The answers are general in nature, but should provide a starting point for further optimization of the cutting processes.

What is the difference between Climb and Conventional cutting and which is the better method?

Climb and Conventional cutting merely describe the way in which the cutter moves around the part in respect to its direction of rotation. In regards to a right-hand rotation spindle (the most common type), moving around a finished part counter-clockwise would be considered Conventional Cutting while a clockwise part path would be Climb Cutting. The terminology will be reversed if the spindle is of left-hand rotation or a pocket or hole is being cut out of the finished part.

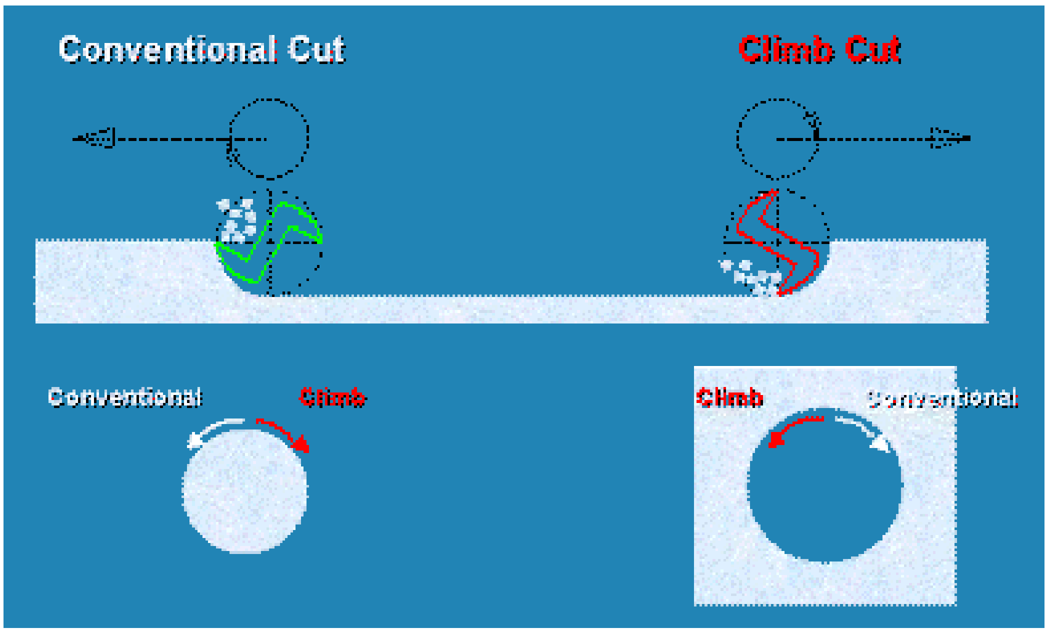

FIGURE 1

While Climb Cutting is the most

prevalent method in metalworking and Conventional Cutting is the dominant method in woodworking, plastics routing is somewhere in between the two. There are usually significant differences between the finish on a Climb Cut part and a Conventional Cut part and the degree of difference can vary by plastic and cutter geometry.

The only rule of thumb that can be offered is that most soft plastics (HDPE, UHMW, Polypropylene, etc.) respond best to Conventional Cutting, while some harder materials (Acrylic, Polycarbonate, Nylon) can occasionally respond better to Climb Cutting. Typically Climb Cutting will only show an improved performance in the smaller diameters (less than 3/8"), but of course there are always exceptions.

The other factors when considering Climb or Conventional Cutting is the aggressiveness of the cutter and part hold down. Climb Cutting is a much more aggressive means of cutting and can chatter or move small parts that are not fixtured well. In most cases soft chips that are difficult to extract from the cut are also more likely to weld to the climb cut side rather than the conventional cut side. The best method of approach for most new materials is to run sample parts with both methods of cutting at the same feeds and speeds and make the determination from there.

What is the best method for fixturing small parts, such as letters, that are difficult to hold with vacuum?

Far and away the best method seems to be using the paper masking as a source for additional holding power. By precisely setting the depth of the cutter in relation to the spoilboard, many fabricators are able to cut completely through the plastic sheet without actually perforating the bottom masking sheet. This allows both universal and conventional vacuum system to act upon a large surface area and allows the added benefit of "single sheet on"-"single sheet off" loading and unloading.

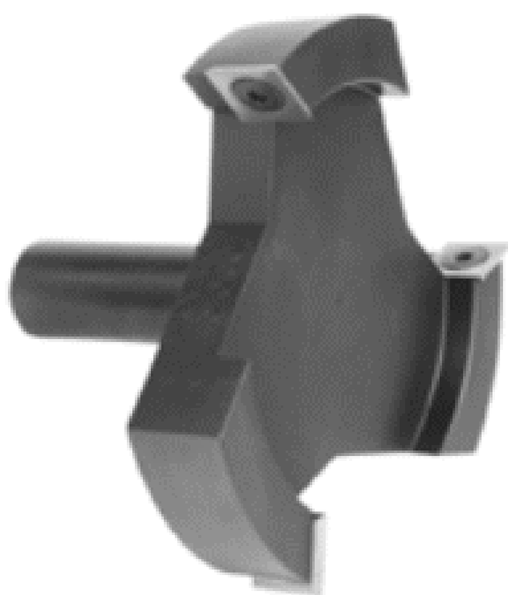

FIGURE 2

The only drawback to this method is the difficulty in routing at a precise depth over multiple sections of the spoilboard without plunging through the paper masking. While the routers have enough positioning accuracy to repeatedly locate at the same depth, the spoilboards typically will have some bow or flex that can overcome the .010" thick paper zone. The standard solution is to fly-cut the board before use with a large diameter cutter to make it flat and parallel to the router head. There are dedicated cutters for this purpose but just about any large carbide tipped cutter will work for infrequent surfacing.

Many fabricators will fly-cut before each shift or more often depending on humidity and warpage factors. Typically only .010" to .020" of an inch will need to be removed which will give significant life to a ¾" MDF universal spoilboard.

How can chip wrap, crazing, or "keyhole" slots be prevented when plunging in plastics?

While these problems are not unique to the machining of plastics, they can be much more difficult to solve than when confronted with them in metalworking or woodworking. Chip wrap is perhaps the most confounding problem, in that it does not always respond well to the standard peck or chipbreak drilling cycles that are available in the router controls. In the very soft and tough plastics such as polypropylene, it can take reducing the peck amounts to as little as .010" to prevent the long chip from curling around the plunging cutter. This can add significant cycle time and Z-axis wear over long runs. A better method is to program the router to ramp on entry for all transverse cuts and to helical ramp and interpolate for any holes that need to be made. This will prevent chip wrap and typically save cycle time. Crazing and "keyhole" slots typically require the same solution method.

Crazing, or cracking of the material, is a result of the flat bottom cutter inducing too much stress into the part during the plunge. Ramping will ease the cutter in and prevent the bottom of the part from stress fracturing. If ramping is not an option, a higher spindle speed or slower feed rate can also reduce stress, but it sometimes shows a poor edge finish.

Keyhole slots are the result of the router bit "walking" when it plunges. Drill bits have a sharp centering point and a cylindrical land around the outer diameter of the body that helps to keep them aligned in the cut. Router bits do not have any centering action and will aggressively try to move in a lateral direction. Because of this, the entry hole is often slightly larger than the bit diameter and it will be noticeable when the cut transitions from the plunging area to the routed slot. Once again, ramping will prevent any noticeable change in slot width throughout the entire cut.

What causes the inconsistency in hole sizes, particularly in stacked sheets or thick plastics?

The first cause is explained above. As the cutter plunges, it has a tendency to "walk" and create a larger diameter hole than intended. This is another reason that interpolating the hole as opposed to plunging a hole is a better idea when using router cutters. Interpolated holes will exhibit improved diameter consistency versus plunged holes.

The second factor is typically a heat and material issue. It is not uncommon for a plunged hole to actually be smaller than the router bit that created it. This is a result of heat buildup and thermal expansion of the hole wall. It is particularly apparent in soft plastics and there are a number of solution methods that can be tried. Since heat buildup is the cause of the problem, the best methods of solution center around heat reduction. Slower spindle speeds, faster plunges, air blasts, or coolant will all reduce the effects of wall expansion. Peck or chipbreak drilling cycles can be a mixed bag depending on the cutter and the plastic. Some times they will eliminate the problem and other times they will exacerbate it.