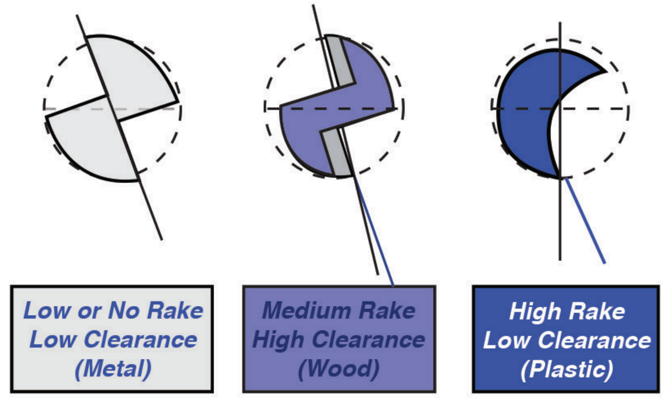
The Most Common Problems in Plastic Routing

The diversity of plastic material in the industry today makes it almost impossible to avoid some kind of machining problem. Plastic varies greatly through the manufacturing process, and these differences, combined with a multitude of applications, can serve as a precursor for problems. The focus of this discussion will be the most common of these plastic routing problems. However, before tackling the problems, a few basic premises should be reviewed.

TOOL GEOMETRY'S FOR PLASTICS



All plastic is not created equal. Many times, a user will know the trade or generic name of a plastic being routed, but will fail to recognize there are physical properties of the material germane to the machining process. It is important to understand that even a change in color can drastically alter the way a plastic material reacts to a cutting tool. Luckily, there are resources, which will be addressed later, to sort through these differences. However, as a beginning point for the machining and the tool selection purpose, plastic can be categorized as either soft or hard plastic. This can be determined easily by the flexibility or rigidity of the material or the type of chip it produces in the routing process. When proper routing tools with plastic relevant geometry are utilized, the soft plastic will "curl" a chip, while hard plastic produces a "splintered wedge" chip. However, sometimes there can be soft and hard plastic characteristics within a generic plastic group. For instance, cast acrylic is classified as a hard plastic, while extruded plastic falls on the softer side. They require different tooling considerations because of the way they machine in the routing process. The point is, all plastics are not the same and ignoring this fact can create problems from the beginning.

Cutting tool geometry is paramount. With the diversity of plastic in mind, it is equally important to acknowledge router tool geometry is the key to success. From the beginning, it was self-evident that plastic machined much differently that of other materials and special considerations were required. Through years of testing, tools specifically toleranced for plastic routing have been developed for hand fed as well as CNC applications. The common denominator in the success of these router tools is the presence of high rake and low clearance in the geometry of the tool.

Today, there are literally thousands of tools at the disposal of the plastic fabricator. By utilizing the soft and hard plastic categorization, a general tool selection process can be developed. Soft plastic utilizes "O" flute router tools in straight or spiral configurations **(Figure 1 and Figure 2)**. Hard plastic tools may use "V" flute straight flute tooling or "O" flute spiral tooling with hard geometry considerations **(Figure 3 and Figure 4)**. The decision, regarding using straight or spiral tooling, hinges upon the direction the user wants to influence the chip or part. Straight tooling has a neutral effect, while spiral tooling can move chips in an upward or downward direction. As the most common problems are discussed, the premise is that the correct tool has been chosen, but other considerations are needed to correct the problems. Although choosing the right-tool-for-the-job is key, properly applying it is the paramount.

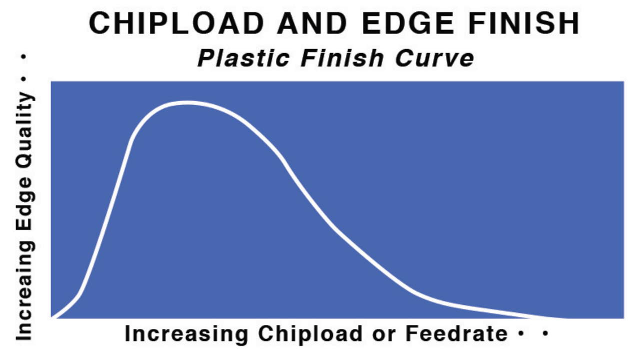
FIGURE 1 61-000 "O" Flute Straight — *FIGURE 2 63-750 "O" Flute Spiral* — *FIGURE 3 56-000P "V" Flute Straight* — *FIGURE 4 52-600 Double Edge Spiral "O" Flute*

Common Routing Problem #1

Welding of Plastic Material

Welding of chip during the routing of plastic parts is probably the most irritating problem encountered in the industry. It is costly in terms of time and scrap rate, but is also avoidable. Besides inappropriate tool selection, chip welding can occur because of improper chipload, small tool diameter size, influencing the chip improperly, or the direction of the cut. Plastic is extremely sensitive to heat, and the act of routing at high feed and spindle speed rates creates a rather warm environment. Chipload, which is the thickness of the chip, is formed through the function of feed rate, spindle speed, and the number of cutting edges in the router tool. The chip is the mechanism by which heat is transferred away from the tool and the part, thus maximizing it is critical.

The secret in plastic routing is producing an adequate sized chip to remove heat, while accommodating finish requirements. The chipload formula is as follows: chipload = feed rate/(RPM x # of cutting edges). As the formula indicates, there are several ways to adjust chipload. Merely raising feed rate to achieve maximum chip thickness is not always the best approach. In the case of small parts for instance, where feed rate is limited, the other part of the equation, namely spindle speed should be utilized to maximize chipload. Welding can also occur because of small tool diameter size, direction of cut and the way the chip is influenced. Small diameter tools because of limited chip clearance capability can cause welding. Selecting the right geometry for the router tool will fail miserably, if the chip is influenced incorrectly. For example, using a downcut spiral in a blind slot will serve to recut chips and thus weld. Lastly, direction of cut may be the culprit. In most cases, conventional cutting direction is recommended.



Only a very narrow range of chiploads (feedrates) will achieve an excellent edge finish. Typical ranges are from .004" to .012".

Common Routing Problem #1

Poor Finish

Probably the most important consideration in the plastics industry is the surface finish of the final product. This is especially evident in plastic products such as exhibits, signs, or P-O-P displays, where the public constantly views the finished edge of the product. As with all plastic routing applications, the selection of the proper tool is essential to good edge finish. However, finish is heavily influenced by the chipload. In plastic routing, the continuous generation of a properly sized chip will eliminate excessive knife marks in soft plastic and a cratered finish on hard plastic. The range of chipload for outstanding finish seems to occur between 0.004 and 0.012.

Resources

This information serves as a starting point to identify and correct the most common problems associated with routing plastic. However, there are many resources to further study these areas of concern and receive more detailed data. These would include the plastics material manufacturer or supplier, the CNC machinery manufacturer, www.plasticrouting.com, and The IAPD Magazine article archives at www.theiapdmagazine.com, where specific articles regarding tool selection, collet maintenance, and spoilboard techniques can be found and researched. The most common problems of welding and poor finish are not insurmountable. The key is to understand the material being machined, to select router tools with geometry specific to plastic, and to apply them with proper chipload recommendations. Rigidly holding parts and maintaining the integrity of the router machine through proper maintenance procedures will further enhance the process.

Van Niser
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