Router Bits For CNC Mills

In the market place today, there are companies utilizing CNC mills or machining centers. Some operations may be machining metal; but in many instances, fabricating, forming or molding products from plastic is occurring in the same shop.

Traditionally, these shops utilized endmills, which ran at relatively slow spindle speeds and feedrates compared to CNC routers. Endmills are typically toleranced for slower speeds and are manufactured as a robust cutting tool for heavy loads. However, a limited flute area interferes with the process of clearing stringy chips associated with plastic machining. Endmills are frequently designed with low clearance angles, which can aggravate melting and rewelding problems common in plastic cutting applications. Since the endmill tends to push the chip off the material, multiple passes are usually the norm to achieve a satisfactory finished part. Clearly, these tools are designed for ferrous applications, but endmills have been used because of availability, cost, and of course, tradition.

Figure 1

CNC mills and machining centers manufactured by companies such as Fadal, Haas, Mazak, Makino, Cincinnati, Mori Seki and Republic-Lagun, have drastically changed over the years with spindle speeds reaching 15,000 rpm and above accompanied by feedrates in excess of 600 ipm. Since routing speed by definition is around 8,000 rpm and above, this places these machines in the realm of router-type tooling. This exposes CNC milling operations to a whole new concept in high speed machining, which utilizes tools designed for specific plastic materials. These tools have an open flute area for adequate chip removal capabilities with rake and clearance angles varying by the type of plastic being machined. The problems of melting of chips and multiple passes to achieve maximum finish requirements are eliminated and production time is minimized in the process (See Figures 1 & 2).

In order to make this transition from endmills to router bits, the user must have confidence in a successful outcome. A comfort level can be achieved by understanding that the tooling and the machinery can withstand the feeds and speeds, which may be foreign to the user. The tooling has been tested extensively in real life situations with all types of materials and verified results have been documented. There is no question that choosing the correct tool for the job and maintaining proper chiploads on the tooling accentuates tool life, improves throughput, product quality, and ultimately profitability.

Tool Selection


Figure 2

Selecting the correct tool for the job is relatively easy in the initial stages. Plastic tends to be placed into two general categories: flexible or rigid. The router bits of choice for flexible materials usually involve the use of single or double edge “O” flute tools in straight or spiral flute configurations. Rigid plastics lean more toward double-edge “V” flutes, spiral “O” flutes with hard plastic geometry and two- and three-flute finishers. All of these tool styles are readily available in solid micro-grain carbide. In order to pinpoint the correct tool, the CNC machining center industry has a new resource on the internet at www.plasticrouting.com. This website recommends high spindle speed tooling by specific material and provides valuable information not only about tool selection, but also recommends appropriate speeds and feedrates to maintain acceptable finish requirements.

Key issues after tool selection are chipload and part finishes. The optimum chipload to achieve the best finish seems to be in the range of .004 to .012. This narrow range provides the best finish through the continuous generation of properly curled or sized chips. Soft plastic chips curl during machining and inadequate chiploads can lead to knife marks. The use of an “O” flute with high rake and low clearance, along with proper chiploads, can eliminate the knife marks by slightly rubbing the part during machining. In the case of hard plastic, the removal of equally sized chips of material avoids the cratering effect, which occurs when the process exceeds the shear strength of the material.

There does not appear to be any minimum combinations of feeds and speed as long as the proper chipload is maintained. However, the ability of router tooling to run at high feeds and speeds, and the obvious increase in productivity would encourage the user to maintain the proper chipload at an optimum level (See Figure 3).


Figure 3

The Machining Process

CNC milling/machining centers have a tremendous advantage in the area of rigidity and accuracy. The sheer size and weight of the centers, along with hard clamping devices with mechanical or pneumatic vice style clamps, inhibits vibration and provides rock solid part holddown. These conditions enhance the geometry of the high-speed routing tool and produce better chiploads and finishes in less cycle time. However, the user could further improve the overall machining process by taking a serious look at conventional milling versus climb cutting. This would be particularly advantageous in situations involving straight trim passes of scrap. The end result would be a one-pass finish cut as opposed to the rough and finish pass involved in climb cutting. The chiploads provided by the router tools with the correct geometry would also eliminate the need for coolant because the heat would be dissipated by the creation of a larger chip. Once again, productivity and tool life would be achieved simultaneously.

The whole area of tooling for the CNC milling/machining center market continues to be a dynamic process. Other products besides high-speed cutters continue to arrive on the scene. One such product is a drill designed expressly for plastic. The plastic machining industry has been at the mercy of inadequately designed drills for years. The jobber drill and similar tools were inappropriate in terms of providing clean holes in plastic material.

A new style drill (See Figure 4) is now available which allows fast plunge speed with reduction of chip wrap in soft plastic and crazing in hard plastic. The 60° point and flat face rake reduces the stresses introduced into the hole walls and provides a clean hole surface without clouding or crazing typical in standard drills. These drills are equally operational in the CNC machining center or the air driven hand drill.

CNC milling/machining concerns throughout the country involved in fabricating, forming and molding are busy producing nylon gears, parts for the food service industry, machine components, medical industry parts, electronic mounting points, electronic washing machines, brackets, clips and an infinite variety of other products from plastic. Tooling is readily available and specifically tailored to the vast array of materials being machined in this industry. As fabricators assess their productivity and the quality of their finished parts, router tooling with high spindle speed and feedrate capacities should be considered.

Figure 4