

# Major Consideration in the Routing of Plastics

Before the process of routing or machining plastic, the user must evaluate the capabilities inherent to the operation.

## Capability

The first consideration is in the area of machinery, which can vary widely in the world of plastic fabrication. Machines of choice include: air and electric routers, pin routers, and CNC machinery. These types of machines are prevalent in sheet fabrication, thermoforming, rotational molding and blow molding operations throughout the plastic industry.

Air, electric and pin routers, fall into the categories of hand fed applications, and present an entirely different set of circumstances than a CNC application. Since these machines are heavily influenced by the skill of the individual operators, the tooling material of choice should be high speed steel or carbide tipped with a steel shank. These tool materials are more forgiving in a hand fed application, and less likely to fail than solid carbide, which thrive best in the controlled environment of CNC.

### Assembly Diagram

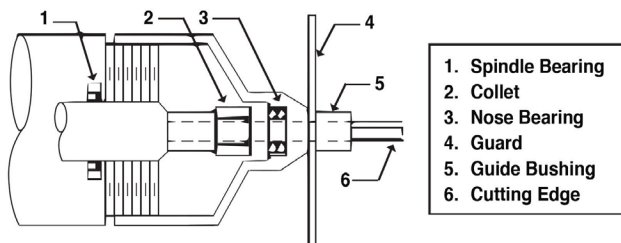


Figure 1

Within hand fed operations, one of the more prevalent machines is the air router. The air router has some characteristics, which has a direct effect on the tooling choices. The diagram below, (**Figure 1-Air Router Assembly Diagram**) illustrates that the air router has a nose or support bearing, a guard and a guide bushing. All these features have important functions, but they necessitate the use of router tooling specific to the air router. These tools must be manufactured with long enough overall length

to bottom out in the collet and extend beyond the guide bushing while making contact with the work piece. Also, the tools must be slightly undersized along the entire length of the tool to pass smoothly through the support or nose bearing. The forcing of on size tooling through the support bearing alters the bearing and negates the function of this critical mechanism, which adversely affects the concentricity of the cutting tool. Consequently, it is important to incorporate tooling properly toleranced for air routers.

CNC routers are extremely popular among plastic fabricators with 3 axis and 5 axis machines fulfilling a variety of needs. Generally speaking, flat sheet fabricators utilize 3 axis, while thermoformers with a need to attack multi-shaped parts at an angle, account for most of the 5 axis machines. Solid carbide is the tooling material widely utilized because of its toughness, and the longevity of the cutting edge when chipload is properly maximized. Solid carbide router tools are available in a broad range of geometries and styles. Sheet fabricators usually prefer upcut spirals to aid in the extraction of potentially soft plastic chips. On the other hand, thermoformers with formed fixtures tend to use straight edge tooling, which has a neutral effect on the part. Downcut spirals can be utilized in some 5-axis applications, but

the fixturing must be such that the chips fall away from the part. If the chips cannot fall freely from the part, recutting of plastic chips can cause welding to occur which is detrimental to the part and the router tool.

Regardless of the type of machinery utilized, the ability to properly hold the part is critical. The three methods associated with part holddown include: mechanical i.e.; clamps, dedicated, and flow-through spoilboard systems. Dedicated and flow-through are the two most prevalent systems in the area of CNC routing. Flow-through has become the most popular because of the ease of setup, but there is no question that the best approach to solidly holding parts is a properly built dedicated spoilboard. The savings in reworked parts, scrapped parts and overall cycle time is well worth the effort.

Lastly in terms of capability and machinery, the machinery is only as good as it's maintenance schedule. The critical maintenance on a router as it relates cutting tools is the collet. Concentricity of the router tool can only be accomplished with a clean and well-maintained collet system.

## Tool Selection

Once capability has been determined in terms of properly maintained machinery and rigidity of part to be machined, tool selection becomes paramount. Router tools for plastic cutting are application and material specific. In almost all cases, one cutting tool cannot be utilized across a variety of plastic material.

Generally speaking, plastic can be categorized as either hard or soft plastic. Soft plastic will curl a chip and hard plastic tends to produce a splintered wedge, which is actually broken off in the machining process. The use of "O" flute tools in straight and spiral configuration with high rake angles and low clearance will aid in eliminating the knife marks associated with soft plastic. Hard plastic is best routed with double edge "V" flutes, spiral "O" flutes with hard plastic geometry, or two and three edge finishers. These tools along with the proper chipload produce a crater free finish. Cratering in hard plastic occurs when the shear strength of the material is exceeded in the routing process.



Single Edge  
Spiral "O"  
Flute



Double  
Edge  
"V" Flute



Three  
Edge  
Finisher

The aforementioned tooling suggestions are accurate starting points, but extremely general in nature.

Once tool selection has been finalized, chipload becomes a critical consideration. Chipload or the actual thickness of the chip is a function of the spindle speed (RPM), the travel speed of the cutting tool (IPM), and the number of cutting edges of the tool. In plastic, there is a very narrow range of chipload to maximize finish and cycle time. Since finish seems to be one of the most important factors in machining plastic, the range falls between .004 and .012. However, finish is always a personal decision and some applications may warrant a larger chipload at

the expense of finish to increase productivity. In other words, do not be limited by the recommended range, but use it as a guide.

## Conclusion

Plastic is material showing up in routing and machine shops everywhere. It is a new material for many and it cannot be machined with the same tools or same methods used for metal or wood. The systematic process of considering machine capability, tool selection, and a functional chipload, which is the outcome of feed and speed is critical. Once this has been accomplished, the user is prepared to enter the world of machining plastic with confidence.

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