Real World Routing Solutions: Part 3

CNC routers continue to improve and enable users to do more in less time. Rigidity, fixturing, feed rates, spindle capabilities and ease of programming CNC routers increase every year. Tooling must keep pace. Cutting tools must not only be geometrically competent to meet the technology challenge, they must be application specific. The days of generic – one tool does all – router bits are over. The tool must be optimized for the job as a part of the set up.

SCENARIO 1

Material Cut: 1/8" acrylic
Product: Plaque faces
Router Type: 3- Axis CNC
Feeds & Speeds: 18,000 rpm at 100 ipm
Initial Tooling: 1 pass with CT straight, 1 pass CT radius

Problems:

Long cycle time required to complete product resulting in unacceptable cost.

In this particular application the customer wanted to accomplish a two-step process in one pass. Two passes were too time consuming and expensive. In addition when the radius tool made a final pass on the part either the paper-masking or the poly-masking would be torn such that it was unacceptable to ship the part without re-masking. The goal was to be able to cut the part cleanly with one pass and be able to ship the parts right off of the router. By choosing a solid carbide bit with a radius ground into the cutting edge, the customer had excellent results and was able to cut the parts and radius them at the same time at a much higher feed rate. No remasking was necessary either. The customer accomplished their ultimate goal in a timely manner.

FIGURE 1

SCENARIO 2

Material Cut: Acrylic with laminated aluminum face
Product: Back lite lettering for signs
Router Type: 3-Axis CNC
Feeds & Speeds: 18,000 rpm at 40 ipm
Initial Tooling: Solid carbide metalworking end mills

Problems:

The plastic and aluminum was welding together after being cut.

This sign manufacturer was trying to machine dissimilar materials at the same time. The tools that cut the aluminum well performed poorly while cutting the acrylic and the tools that cut the acrylic well left a burr on the aluminum.

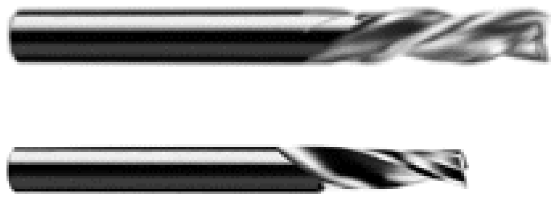

FIGURE 2

The problem arose from the fact that while both acrylic and aluminum require a sharp edge, the cutting geometry is quite different. Metalworking tools normally have a large cross-section that limits the size of the chip formed. Unless a large enough chip is formed, it cannot be thrown clear. Thus it is re-cut, usually resulting in re-welding of the chip back to the base material.

Selecting the right geometry was critical in this case with the aluminum laminate on the top of the material. It took a specialized tool design of a solid carbide “O” flute spiral upcut router bit. It was critical to use an upcut tool due to the chip extraction. A small (3/16”) bit was required due to inside radius in the corners of the letters. To overcome the upcut tool’s tendency to lift the part, the customer was required to cut all the way through the aluminum laminate, and acrylic, but not the paper masking on the bottom side of the acrylic. They were able to accomplish this by first planing the table true with a spoilboard-surfacing tool allowing a consistent plane to be maintained. Then by not cutting through the paper masking they were able to hold parts in-place.

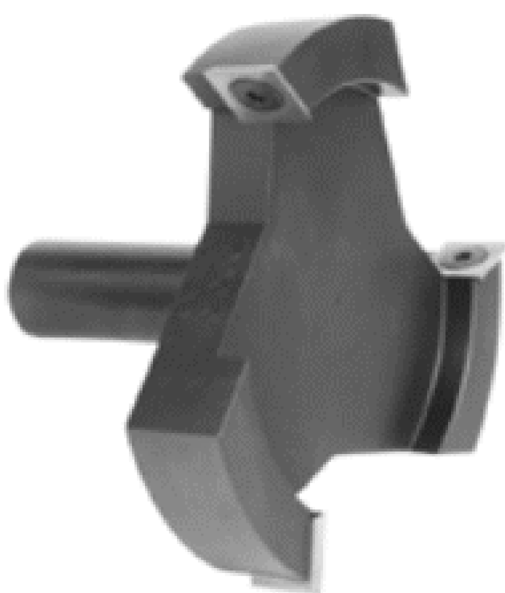

FIGURE 3

SCENARIO 3

Material: ¼” polyethylene
Product Fabricated: Office machine housing
Router Type: 5 -Axis CNC

Feeds & Speeds: 18,000 rpm at 50 ipm
Initial Tooling: Carbide tipped straight

Problems:

Poor and inconsistent edge quality, bird nesting when making holes

The customer was utilizing a ½" diameter carbide tipped tool, designed for cutting wood and getting mixed results in finish quality of the edge. The part was a large one with many planes to be cut and required both long extension from the spindle and as well as long cutting edge length. The tool performed a number of operations including interpolating holes as well as perimeter trimming. While the perimeter trimming was a relatively easy operation, it resulted in an inconsistent finish and could not be run as fast as the machine would cut without chattering. The holes to be interpolated were also a problem due to " birdnesting" of the chips when the tool plunged into the workpiece. This is a common problem in 5-axis CNC routing. It is a result of tool selection and programming technique. The tool rotating at 18,000 rpm comes into contact with the part 300 times a second if it is a single edge design. While plunging at a feed speed of 40 to 50 ipm, the tool is not allowed to cut a large enough chip to adequately expel the chip from the cut. This inability to expel the chip causes a string or thread to form and wrap itself around the tool. While initially not causing much of a problem the "bird nesting" continues to grow and as the "nest" gets larger scratching begins to occur. This requires the operator to stand there with an air tool and continuously remove the chip build-up. This not only wastes time, it can be dangerous and usually results in inconsistent quality of parts requiring some secondary processing. The best way to eliminate this type of problem is to reduce the rpm and increase feed rate. RPM's for hole making should be reduced to 8000-9000 allowing the tool to cut a large chip, throwing it free from the cut and eliminating build up on the tool. Feed rate should be increased to approximately 150 inches per minute. This combined with the selection of proper geometry plastic tools allows for excellent hole making and with change in rpm and feed rate, excellent perimeter routing. In this case, a ¼" diameter tool was able to not only eliminate the "bird nesting" problem but also to run much faster on the perimeter due to the reduced resistance offered by the ¼" tool in a single edge 0 flute design. The design selected was a straight tool even though a spiral might help chip ejection, it would cause other hold down

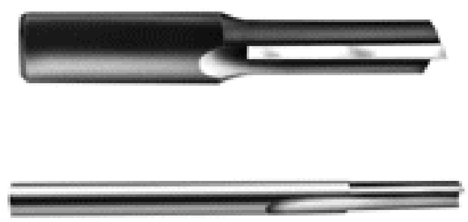

FIGURE 4

issue problems while cutting the perimeter of the part.

Each of these examples illustrates the fact that tools designed specifically to cut plastic provide a better solution when plastic materials are machined. Plastic tools have sharper edges because they have a higher angle of cut. This enables the chip to be quickly removed and the piece part to have a better finish.