Real World Routing Solutions: Part 4

This article is the last in a four part series of articles designed to bring to light some common routing problems and the tooling and/or process changes that became the solutions to the problems.

As more and more routers are sold for the purpose of machining plastics, more and more companies are running into problems that never existed when they were hand finishing plastics or machining other materials. The scenarios here look at four real world problems that happened at fabricators in the United States and the solutions that were found.

SCENARIO 1

Material Cut: Aluminum skinned acrylic
Product: Large decorative letters for sign displays
Router Type: 3-axis CNC
Feeds & Speeds: 18,000 RPM at 60ipm
Initial Tooling: 1/4” Upcut spiral “O” flute for hard plastics

Problems:

Aluminum chips were welding to the acrylic.

What happened with this fabricator is a very common problem in the Sign and Point-of-Purchase (POP) industry. A favorite material for sign displays is a clear or colored acrylic covered on one side with a thin sheet of aluminum that is attached with glue. This material is cut out for displays and letters and a premium finish is required on both the top (aluminum) surface and the edges of the material (the acrylic).

In this particular application, the material was 3/8” thick acrylic with a .015” aluminum skin. The fabricator was machining the material with the aluminum side down for better hold down and best surface finish and had already selected the correct tool for the job. The problem was that as the aluminum and its attached adhesive were cut and the chips flowed through the tool’s flute, they would heat up and weld or stick to the acrylic. This required a hand finishing operation that the fabricator was looking to remove from the process.

This scenario is similar to a situation written about in the last issue in which a fabricator was cutting letters in the same type of material with a 3/16” diameter cutter. In that instance, switching to a tool with better geometry was able to solve the problem. In this case, the glue and aluminum weren’t as well behaved and the machinist was already using the optimal geometry. The solution for this problem was to use a modified two-pass system for machining the part.

The aluminum side remained face down and the first pass of the cutter was set at a depth of .030” above the aluminum/acrylic interface and was set to leave the part .015” oversized. This enabled the cutter to remove the bulk of the acrylic material without cutting into the soft aluminum or the glue line. The second pass was machined at full depth and on-size. This gave a clean cut to the aluminum and acted as a finish pass to the acrylic without generating an excessive amount of heat or leaving a line at the depth step. Because the finish of the first pass was inconsequential and the finish pass was removing so little material, the feed speeds were increased to 250ipm from 60ipm and the total cycle time was less than original process. This method eliminated the hand finishing operation, reduced the cycle time, and increased the cutter life.

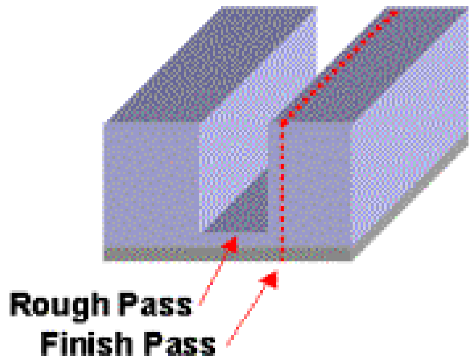

FIGURE 1

SCENARIO 2

Material Cut: Cast acrylic
Product: Display cases
Router Type: 3-axis CNC
Feeds & Speeds: 18,000 RPM at 160ipm
Initial Tooling: 1/4” Upcut spiral “O” flute for hard plastics

Problems:

Edge finish required multiple polishing operations after routing

This was a case of too much material for too little tool. The company was using a 1/4” diameter cutter with optimal geometry for cutting 1/2” thick cast acrylic. In many cases this is a perfectly acceptable method of achieving a premium edge finish if the equipment and fixturing is well maintained and very solid. Unfortunately for this company, time had taken its toll and the equipment did not have the rigidity required to remove that depth of material and still maintain a premium edge finish. Even with the machine reprogrammed for a rough and finish pass, the finish did not improve enough.

FIGURE 2

The second attempt to solve this problem was to use a multi-fluted acrylic finishing tool. In many instances, adding flutes can lead to an increase in surface finish, but it can be at the expense of heat buildup and tool life. The 3-flute finisher was used as a finish pass tool after the single flute spiral removed the bulk of the material. Unfortunately, this still did not produce the desired edge quality.

The final solution was to use a 1/2” diameter acrylic finishing tool and to take a single pass. The added stability of the 1/2” diameter combined with the increased surface speed of the cutter edges produced the premium edge the company was looking for. By changing their fixturing and programming, the company eliminated 2 of the polishing operations.

SCENARIO 3

Material Cut: Thermoformed acrylic
Product: Display rack
Router Type: 3¼ HP hand router
Feeds & Speeds: 18,000 RPM and hand fed
Initial Tooling: 3/16” single edge “O” flute for plastics

Problems:

Edge finishes were inconsistent.

The 3/16” diameter tool being used by hand was producing varying finishes depending on the operator running the material. Depending on the force and feed rate applied by the operator, the bits were either breaking, clouding the edge, or cratering the material. The solution was to replace the 18,000 RPM router with a smaller laminate trim router running at 28,000 RPM. The increased surface footage allowed the cutter to feed more easily and the edge finishes were produced with a much more consistent result.

FIGURE 3

SCENARIO 4

Material Cut: ABS and acrylic
Product: Awards
Router Type: 3-axis CNC
Feeds & Speeds: variable
Initial Tooling: 1/8” diameter spiral “O” flute

Problems:

Tools were breaking when materials were switched.

In many cases, router operators fell comfortable with a particular tool and do not want to bother with the time and expense of testing and operating multiple tools. This case was no exception. The operator was very happy with the finish that was generated by the 1/8” spiral “O” flute in both 3/8” thick acrylic and 1/16” thick ABS. Unfortunately the tools kept breaking when they were used to machine the thin ABS. The problem originated in the fact that the cutting edge length required for the acrylic (½”) was too long for the ABS. By using the same tool with a ¼” cutting edge length, the breakage problems were eliminated and the operator was able to use the same type of tool without going through the exercise of trying multiple cutting geometries.

This article is the last in a series describing actual routing problems and the tooling, fixturing, and programming methods used to solve them. The points that should be taken from these articles are these:

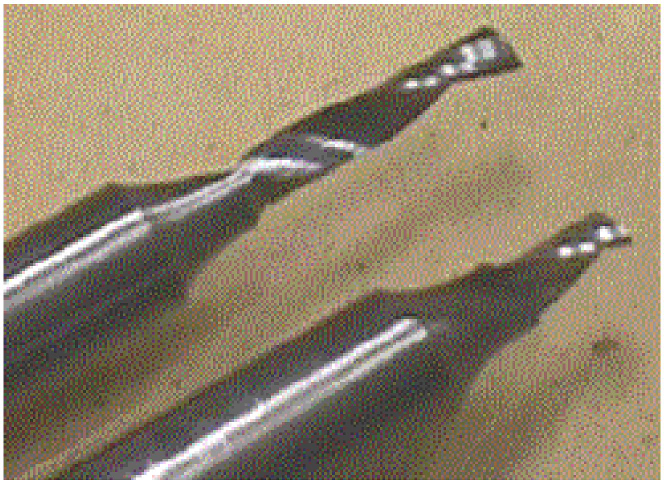

FIGURE 4

Pick the Right Tool for the Job: The single most avoidable mistake that users of CNC routers make is picking the wrong tool. There are hundreds of tools available for cutting hundreds of different types of plastics. Diameter, geometry, chip evacuation, and flute count are all variables that need to be considered for each machining job.

Employ Solid Fixturing: It is difficult to achieve premium edge finishes (measured in millionths of an inch) if the fixturing allows the parts to move a few thousandths of an inch. This is a critical issue and should be evaluated for each job setup.

Be Willing to Change Programs: If the finished part parameters are not acceptable or optimal after selecting the correct tool and fixture, the answer can frequently be achieved through programming. Whether it is a rough/finish pass combination, multiple depths of cut, conventional or climb cutting, or changes in feeds and speeds, there are many options available to increase part quality and throughput.

If these three issues are evaluated and solved, productivity, quality, and efficiency should be greatly improved.