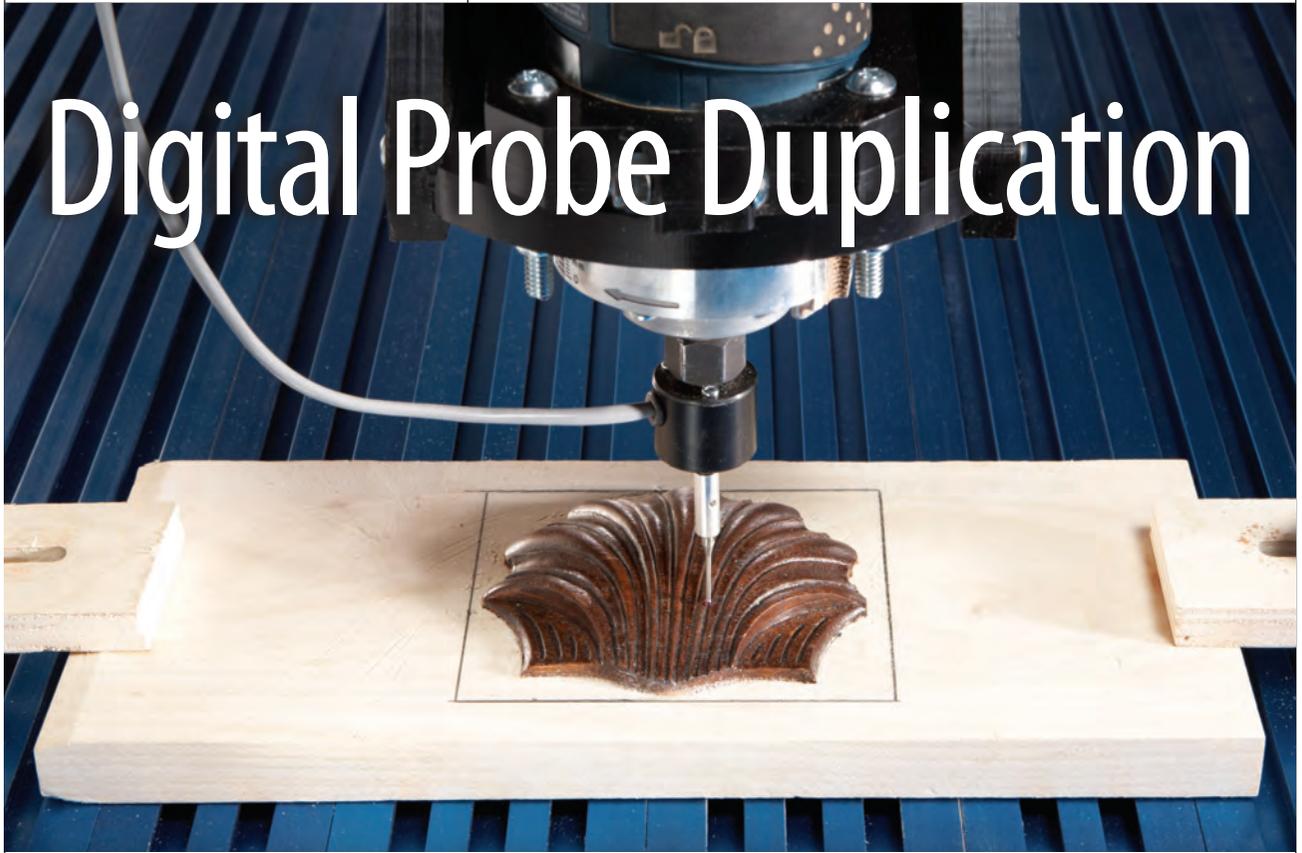


# Digital Probe Duplication



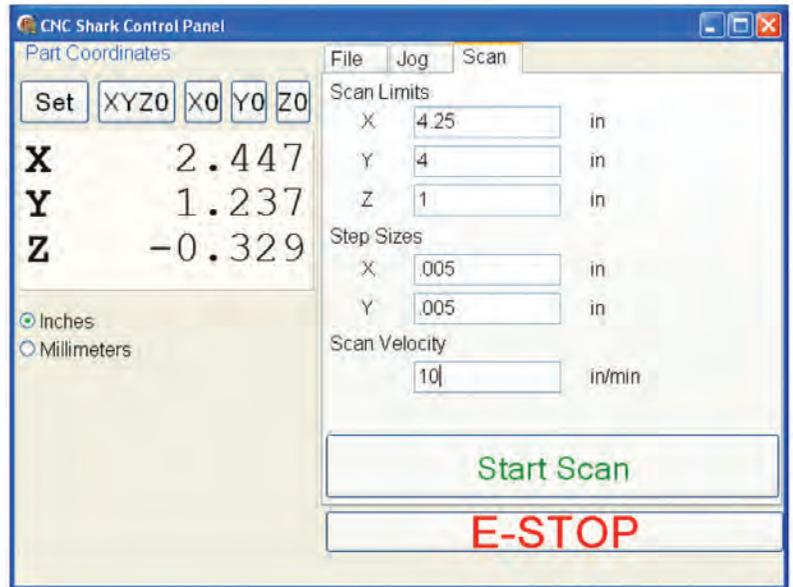
**ROUTER DUPLICATION HAS BEEN AROUND A LONG TIME.** Early machines used stiluses to follow the shape of a pattern or master, while on the other end of the machines, routers did the carving. In a similar but computerized fashion, CNC routers are also capable of duplicating existing carvings and furniture parts. A digital “touch” probe is first used in the CNC to sense the surface of the object, while the probe’s accompanying software creates a digital image of the part. The digital image is then converted to a 3D model and used to program CNC routing paths for a replica. To

test the capabilities of this technique, I hand carved a traditional scallop shell measuring about 4" x 4" to use as my original. My test revealed that a CNC digital probe is quite capable of accurately recording the shape of an object, with one exception; due to its ball-shaped tip, the probe rounds off the inside corners of fine details such as the veins on this shell. A little bit of hand carving easily adds the missing details. The three carvings in the photo below are duplicates of my original (photo above). Watch the digital probe in action at [AmericanWoodworker.com/CNC](http://AmericanWoodworker.com/CNC).



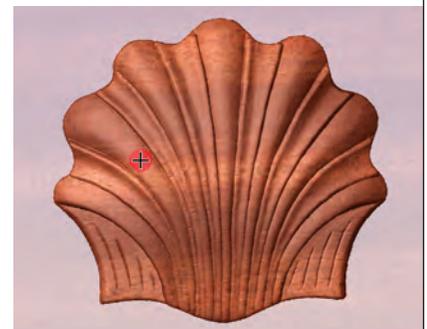
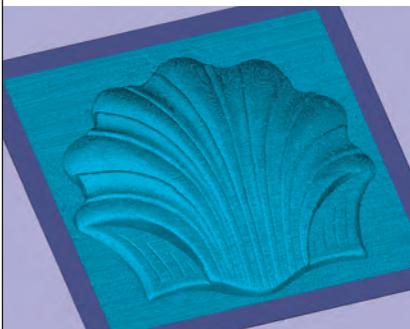
### Step 1

**Set the scanning parameters.** The software control panel is used to set the size of the scanning area, the precision or resolution of the scanning action, and the speed of the scan. The Scan Limits of X and Y represent the width and length of the scan area, while the Z Scan Limit represents the range the probe travels vertically. The Step Sizes are the X and Y distances the probe moves between measurements. The Scan Velocity controls the speed of the probe as it moves across the part's surface. The Part Coordinates show the location of the probe during operation. I used the Shark CNC Pro Plus to scan the shell for this article, but most CNCs, including the CarveWright and Shopbot, are capable of probe scanning.



### Step 2

**Scan the part.** I set parameters for this shell carving as shown in Step 1. The X and Y scanning limits are penciled on the backer board. The Z limit was set at 1" to provide sufficient vertical travel for the carving's 5/8" thickness. The step sizes of .005" for this shell equals 800 passes across the shell for a total of 680,000 steps, or measurement points, and took about 12 hours. (I ran this overnight). The Shark CNC probe has a .075" dia. wear-resistant industrial ruby tip, so certain details such as the fine veins on this shell were not fully captured; but the remainder of the surface was captured with surprising accuracy. A larger step setting can be used on objects with less detail, such as a chair seat. Doubling the step size reduces scanning time by a factor of four.



### Step 3

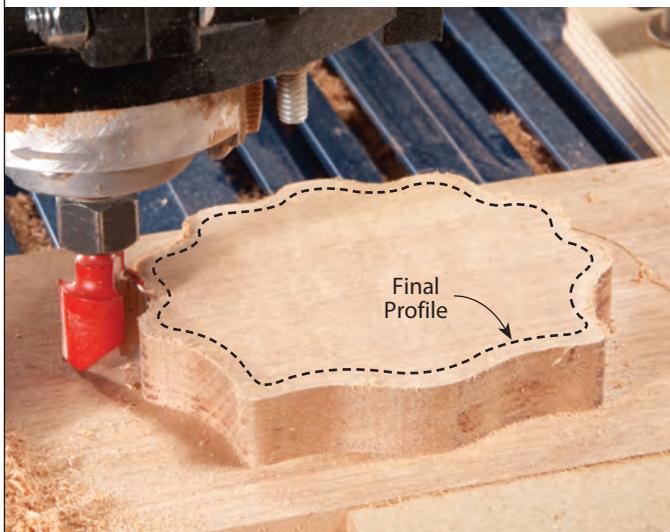
**Adjust the digital image.** The scanning creates an .stl file, which is a common file type used in 3D modeling. The scanned area surrounding the shell is not needed and is removed at this time.

### Step 4

**Create the 3D model.** The .stl file is converted to a 3D model with CNC design software such as Aspire by Vectric. I also used Aspire to increase the thickness of the shell's base to 1/4".

### Step 5

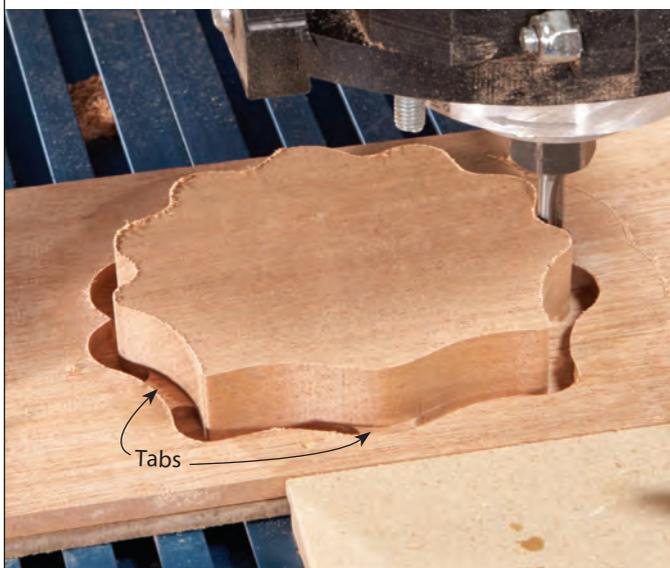
**Smooth the surface.** If needed, the design software can also be used to smooth the surface of the model. My scan was fine enough so I only needed to remove a couple scratches.



## Step 6

### Remove the background.

I removed the background to get the waste material out of the way in order to make it easier to add the final hand carved details in Step 10. I programmed the toolpath for the 3/4" straight bit at a .1" depth-of-cut per pass and a stepover (pass width) of .2". The tool path was also programmed to leave the shell profile .125" oversize. Removing the background for the three shells took about 30 minutes. The board started out .875 (7/8") thick and the routed background is .25" thick. The shell will have a final thickness of .75".



## Step 7

### Rout the final profile and tabs.

The final profile is made using a 1/4" straight bit that cuts all the way through the material. Tabs are left to hold the shell in place. These tabs can also be seen in bottom photo on page 15. A piece of plywood underneath protects the metal machine bed from damage. I programmed the toolpath for the 1/4" straight bit for .125" depth passes. The profile and tab routing of the three shells took about 8 minutes.



## Step 8

### Rough rout the shape.

To accomplish the rough routing I used a 1/4" ballnose bit programmed to a .1" depth of cut and .1" step over (pass width). This roughing phase removes the majority of the material. The amount of material left by the rough pass is adjustable, with .02" being common for a carving such as this shell. Leaving this small amount allows the final pass to be completed in one pass, saving time and wear on the finishing bit. The rough routing of the three shells took about 60 minutes.





### Step 9

#### Rout the final pass.

The final carving is done with a specialty .0625" (1/16") ballnose bit (available at BeckwithDecor.com). I programmed this bit to make .01" wide (1/100") passes. The tiny tip of this bit is capable of recreating a considerable amount of detail, and leaves a surface that only requires a light sanding with 220 grit sand paper to make it ready for finishing. The final routing of the three shells took about 70 minutes.



### Step 10

#### Detail by hand as needed.

Complete the carving with some touch-up hand carving of the veins and finish sanding. There are CNC operations where the goal is to create a part that requires no additional hand work—this application is not one of them. A CNC is a tool capable of many things, but a realistic expectation of what it can do is also important. In the case of these shells, I accepted the fact that I would need to do some hand detailing to achieve the results I wanted, similar to scraping or sanding a board after jointing and planing.

### Project Time Card

**CNC the lids:** 55 minutes each

**CNC the boxes:** 50 minutes each

**Set up and material prep:** 15 minutes each

**Detailing and sanding:** 45 minutes each

**Staining and finishing:** 20 minutes each

**Total time:** 3 hours 30 minutes each

I spent 5 hours 15 minutes (total for all three) doing something else while the CNC ran.



### Step 11

#### Make the boxes.

After making the shells, the box shape is simple to program using the profile of the shell as a pattern. It took about 150 minutes to rout the 3 boxes on the CNC using a 1/4" up-spiral bit. They were cut out of 1-1/2" material.



See how I designed and machined these shell boxes at [AmericanWoodworker.com/CNC](http://AmericanWoodworker.com/CNC)