The Cutting Edge of OT

By Jon Magill

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American Association of Woodturners

Ornamental turning—OT as it's known in some turning circles—is a broad and interesting, but specialized, niche of woodturning. Journal articles (see the Spring 2007 issue) and subsequent symposium demos have aroused considerable interest in OT.

Last year's goal of the Ornamental Turners International (an AAW chapter) was simply to expose more AAW members to this style of turning with a gallery of works, a project-centric article, and a hint of the range of what can be accomplished with OT. Armed with information on building a rose-engine lathe, many members have now started down the path of OT enjoyment.

Because learning ornamental turning is like learning to turn from the beginning, now seems like a good time to cover some OT basics.

The majority of what is accomplished in OT is attributable to the specialized cutting implements and ingenious chucks. The cutters (plain and profiled) produce endless patterns. The chucks move and position the work in ways that many find mystifying.

This ornamental turning sample shows just two variations of the thousands possible on the basket-weave pattern. The *left* is a simple alternating pattern; the *right* a pseudo-spiral effect. The face and the right end show two types of circular cuts possible with the eccentric cutting frame (ECF). The cut on the side of the cylinder has been "beaded" first with the ECF, then decorated on the resulting curved surface with additional circular patterns.

Over the centuries a dizzying and ingenious array of chucks have been invented that allow the positioning, orientation, and movement of the workpiece in ways that most find hard to visualize. Although the range of chucks is important for a full understanding of OT, we'll leave those for a future article.

For now, let's regress a step and take a closer look at the OT tool's role and the broad range of OT cutting implements. After all, this is where the whole story begins.

Because the majority of the work done on a rose engine uses only one cutter style, the previous rose-engine article oversimplified some of the details for tooling (cutters and cutting frames).

The typical tool used on a rose engine has a tip sharpened to a 60-degree angle and held in one orientation. As a result, the more involved discussion of various cutters and cutting frames was glossed over due to space limitations.

OT differs from regular woodturning in that most of the work is done with a rotary cutter introduced to the workpiece, which is either stationary, indexed to a specific spindle position, or slowly revolving.

OT is all about: 1) precisely positioning, orienting, and moving the cutter; 2) optionally introducing a profiled cutter; and 3) positioning or moving the workpiece itself. Applied in various combinations, these ingredients serve to create the infinite decorative possibilities seen in OT patterns.

Today, most of the cutting is performed with a rotary tool of some sort. It was the dramatic improvements and the invention of new types of rotary tools during the Victorian era in England that really enabled OT to take off in new and more creative directions.

Before the introduction and perfection of the modern rotary tools, fixed tools were the norm. These often carried the profile of a shape the turner wanted to produce on the work. In earlier work, these tools were often handheld, simply as horizontal scrapers.

By the Victorian era, many cutters were standardized in size and held rigidly in the sliderest. The sliderest allowed the controlled introduction of the tool to the workpiece, including controlled depths, for consistency, precision, and repeatability.

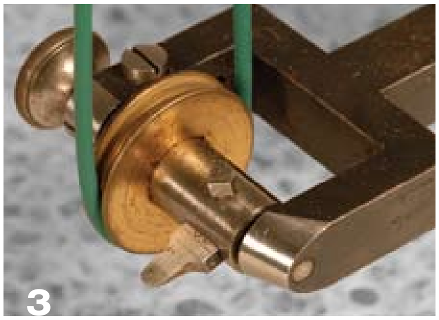
For more than a century prior to the Victorian era, drilling tools were widely employed. Although there was some use of simple pointed drills, many of the interesting early patterns were generated using elaborately profiled drills (**Photo 1**).

These profiled ornamental drills were mounted in a drilling spindle, the earliest of the rotary cutters (**Photo 2**).

A drilling spindle held in the toolbox of the sliderest could be maneuvered around a workpiece in a controlled fashion. Fluting is the easiest procedure to visualize. To cut flutes, the spindle of the lathe is locked in the desired orientation, and the drilling spindle is brought into the work to the depth for the intended pattern. Then using the sliderest, the drilling spindle is moved along the work using the hand crank of the sliderest, resulting in a fluted pattern. At the end of the cut, the drill is withdrawn, and the lathe's spindle is rotated to the next position and locked. The cutting process is repeated to create subsequent flutes around the piece.

Examples of antique ornamental drills. Note the variety of profiles among these antique ornamental drills. These are all slightly offset, or cranked out, so that as they revolve, they only cut from the centerline out. The inside corner of each tip is exactly aligned with the centerline of the drilling spindle.

This is the typical nose of a drilling spindle with a drill in place. The belting connects to the overhead drive.



A roundnose cutter is installed in this antique vertical cutting frame (VCF).

Two examples of horizontal cutting frame (HCF) cutter heads are shown *above*. Both have 60-degree tips appropriate for rose-engine work. The motorized version, *left*, uses $\frac{1}{8}$" round carbide cutters. The belt-driven version, *right*, uses triangular carbide inserts borrowed from the metalworking industry.

4 basic cutting frames

Moving beyond the patterns possible with rotating drills required the invention of new cutting tools, known as **cutting frames**.

Cutting frames, and drilling spindles for that matter, are usually belt-driven, typically with $\frac{1}{8}$" round belting, coming down from an overhead drive. The overhead drive, typical of all OT lathes, is the hallmark by which an ornamental lathe can be immediately recognized. (See a related article about overhead drives on *page 30*.)

Because they could hold a cutter and rotate in a particular orientation, cutting frames revolutionized OT when they were introduced. The simplest is the **vertical cutting frame** (VCF). The name can be confusing in that the cutter is spinning about a horizontal axis but making a vertical cut. The typical VCF has a single pulley for the drive belt, which goes up to the overhead drive. When the VCF is employed with a square-tipped cutter, it creates the familiar basket-weave pattern so often associated with OT (**Photo 3**).

Next in the cutting-frame family is the **horizontal cutting frame** or HCF. The belt-driven HCF is simply a VCF with the addition of two jockey pulleys that allow the cutter to spin about a vertical axis and make a horizontal cut. These added pulleys allow the belting to bend 90 degrees and go up to the overhead drive. For 90 percent of rose-engine lathe work, an HCF is used with a cutter sharpened to 60 degrees (**Photo 4**).

5

This universal cutting frame (UCF) is styled after the original design by Birch. The bevel gears on this model allow the belt to remain directed upward to the overhead drive while the cutting head can be tipped through various angles between horizontal and vertical.

6

A surprising range of patterns can be created with the UCF simply by tipping it at angles. This pattern was produced using a rose-engine lathe and the UCF tilted to about 30 degrees.

7

With chips flying, a modern eccentric cutting frame (ECF) uses an ⅛" round carbide cutter. An example of the ECF's versatility is that it can cut a variety of hemispherical shapes merely by introducing it to the work at an angle, shown here at about 45 degrees.

Why not allow the cutter to work at any angle between vertical and horizontal? That's the job of the **universal cutting frame** or UCF (**Photo 5**). You can create many interesting patterns just by tipping the cutter at an angle (**Photo 6**). However, the UCF's greatest value is in making cuts where the angle must be aligned precisely, as when matching the lead angle of a spiral cut as it wraps around a cylinder.

Suffice it to say that the UCF adds significant complexity over the VCF and HCF. There have been many ingenious schemes to allow tipping the cutter over at any angle while maintaining the belt orientation upward toward the overhead drive.

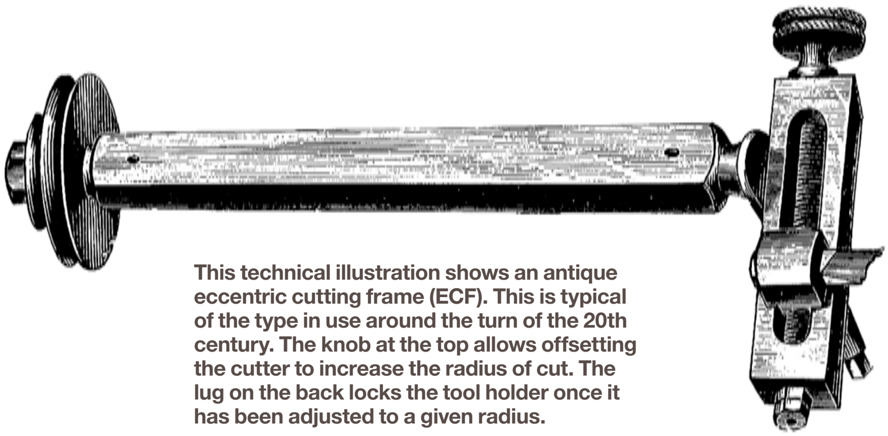
Last but not least of the conventional cutting frames is the **eccentric cutting frame** or ECF. The ECF has a cutter holder that can be moved off-center relative to the axis of its spindle, thereby cutting circular patterns. Antique ECFs had a threaded screw running through the head and a knob with a micrometer scale to accurately set the eccentricity of the cutter. Contemporary ECFs tend to be simpler in design and often can be set by direct measurement off of a known centerline position. These modern ECFs are also often designed as simply a cutting head to be held in a drilling spindle.

The range of patterns possible with the ECF nearly defies description. For this reason many hold the ECF in the highest regard due to its versatility. It can obviously cut circular patterns on the face or side of a cylinder, as shown on *page 32*. By cutting on the side of a slowly rotating cylinder, the ECF will produce a shallow bead. When set at a 45-degree angle to the end of a cylinder, the ECF can produce hemispherical shapes. Nearly complete spheres can be cut as well by swinging the ECF around until it is almost perpendicular to the workpiece (**Photo 7**).

Beyond the scope of this article, members may be interested to learn more about other specialized cutting frames that existed. These were far less used, rare, and often very obscure in their application. Some of the special cutting frames include the elliptical, epicycloidal, and rose-cutting frames. Many books on OT describe these in overview terms.

The OT cutters

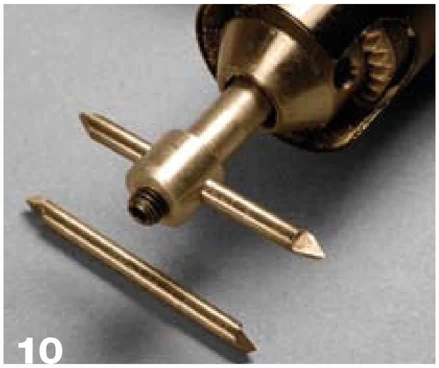
Antique cutting frames typically employed cutters that came in two different sizes. The larger of the two sizes was based on the same width and thickness as the standardized small sliderest tools of the day. These were typically 11⁄32"



This technical illustration shows an antique eccentric cutting frame (ECF). This is typical of the type in use around the turn of the 20th century. The knob at the top allows offsetting the cutter to increase the radius of cut. The lug on the back locks the tool holder once it has been adjusted to a given radius.

Period cutters from the heyday of OT include large-size cutting frame cutters, *top right*, stamped to indicate their 0.20" width. The small-size cutting frame cutters, *bottom right*, are often referred to as ECF cutters, as ECFs typically did not accommodate the larger sizes. The left three cutters are elaborately profiled examples of special cutters used as fixed tools in the sliderest.

Using materials available today, a flex-shaft handpiece can be adapted to be held in the sliderest, thereby allowing use of various router bits and slotting cutters. From experience, burrs, like those pictured *lower left*, do not produce desirable patterns and should be avoided.



This is a simple design for a cutter to hold round carbide split-end blanks, reshaped and sharpened as desired. This one is a ⅛"-diameter cutter with a 60-degree point. From readily available blanks, cutters can be made in a variety of sizes.

wide and 5⁄32" thick. The smaller of the two cutting frame sizes was 0.210" wide and 0.110" thick. These smaller cutters could be accommodated in most cutting frames via a packing trough or C-shaped adapter that reduced the size of the cutter opening in the cutting frame, while keeping the cutting surface of the smaller cutter on the same centerline as a larger cutter would have been.

The cutters were normally sold in sets, with multiples of each profile included, in a range of sizes. The profiles were known by their own numbers, and the width of a given cutter (in hundredths of an inch) was normally stamped on the cutter shank. A typical set of the day may have exceeded 300 cutters, with an assortment of sliderest tools, large and small cutting frame cutters, and a variety of drills (**Photo 8**).

Fortunately, tastes and styles have changed since the Victorian era. The modern OTer doesn't need to buy a set of 300-plus cutters to get going. Many of the cutters that are the easiest to make also yield the highest visual impact. Square, convex, concave, and the simple radiused tips produce striking results.

The old cutters were made of high-carbon steel of high purity. They were typically in the Rockwell C hardness range around 65. Today we have many off-the-shelf cutters that can be shaped and sharpened easily. Carbide split-end blanks offer a great starting point and are available in a variety of diameters and lengths from most machine-tool suppliers.

Some carbide-tipped router bits and slotting cutters lend themselves to reshaping as well. Of course, silicone carbide (green) or diamond wheels are required to shape and sharpen carbide cutters.

***Safety note**: Be sure to use a respirator whenever grinding carbide.*

Finally, if you are contemplating making your own cutters, why not make your own cutting frame too? The easiest adaptation to get started is to use a flex-shaft tool. Many of these can hold shank tools up to ¼", including router bits mentioned earlier.

Make your own cutters

Devise some means to hold the handpiece vertically, horizontally or anywhere in between. Then adapt some type of cutter to it (**Photo 9**).

You might try off-the-shelf slotting cutters, which can easily create a basket-weave pattern. Avoid using burrs (intended for rotary carving), because few, if any, create pleasing results.

Using carbide split-end blanks mentioned earlier, you can make a simple holder for round bits (**Photo 10**).

Antique drills, cutters, and VCF courtesy of Fred Armbruster, Ornamental Turning Works.

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We have only seen the tip of the iceberg; there is a lot more to cover in OT. Look for future articles on the array of specialized OT chucks and how to adapt your existing lathe to do a variety of OT work.