The Reverse Curve
How to Design, Visualize and Produce Complex Curves

In recent years, I have taken up playing pocket billiards, commonly known as pool. There are many reasons for this infatuation. For one, I am trying in some futile way to recapture my misspent youth, as I remember how much fun I had playing pool years ago. Pool is such a beautiful game which reveals many aspects of geometry and physics in a simple and elegant way. My enjoyment of the game is enhanced by playing with pool cues I made myself, and turning pool cues is possibly the only thing (or two) I can think of that is more fun than playing pool.

See What You Are Looking At
But a further reason is that I think my woodworking skills can be improved by playing pool, because pool teaches me to see what I am looking at. Years ago an old timer said to me, “To be a cabinetmaker, you got to have good eyes.” Back then I didn’t understand what he meant. But now, decades later, I think I do. You have to learn to see things because woodworking, like all sculptural arts, is intended to create a three dimensional visual impression.

A simple example of this occurs when we visit the lumber yard and sort through the boards in the rack. We are looking for warp, or other defects in the shape of a piece of lumber. We sight down the board for crook or twist. This is an acquired skill, but with some practice one can do it in seconds without thinking very much.

Seeing a bump in a straight line is one thing, but in this article I will teach you how to visualize complex curves. With this information you can design shapes which present the visual impression you want to project, locate errors in curves, and produce the curve at the lathe using only your eyes and a single caliper measurement as a guide.

The Vocabulary of Shapes

Spindle turnings are composed like music. The various elements are arranged in sequence along a line. Each one leads into the next, and must harmonize with its neighbors and to the whole form. None of the elements mean very much on their own, just as a single note played on a piano doesn’t make much of an impression. It is only the way they relate to each other that gives the turning elegance, grace, a sense of proportion, and finally the aforementioned sculptural visual impression we are seeking.

There are a small number of shapes which make up the vocabulary of the woodturner, but of course their variations and combinations are infinite. These are straight lines, simple curves and complex curves. Simple curves are either convex (beads and ball forms) or concave, (coves and hollows). But by far the most powerful shape used in woodturning is the reverse curve, or S-curve, because it is a combination of both convex and concave. This is sometimes referred to as the “vase form”, but it should be noted that it is equally effective upside down or on horizontal members such as stretchers.

Elements of the Reverse Curve

Figure 1 illustrates all five elements of the reverse curve:

1. Overall length
2. Location of the high point
3. Location of the low point
4. Location of the inflection point
5. End point angles

The overall length is labeled (L). It is measured parallel to the axis (axial length) and is not the length of the curved line itself which of course is slightly longer. When commencing to produce the curve at the lathe, the overall length is the first item to locate and mark out.

The high point is labeled in the figure. It is the distance from the end of the curve which is critical, that distance is
these turnings do not look at all alike even though the length and diameter measurements are the same. This shows how important it is to pay attention to the location of the inflection point in designing and producing reverse curves.

Finally, the remaining element which defines the curve is the end point angle. Every curve has two end points. A line tangent to the curve at the end point forms an angle with the radial line and these are shown as $P^\circ$ and $Q^\circ$ in Figure 1. End point angles are critical to simple curves such as beads and coves as well as complex curves such as the reverse curve shown here.

The most common design error is end point angles that are too large. This results in features that are shallow, poorly defined, and do not make sharp lines at their end points – Figure 3. These sharp lines are formed at the intersection of the surfaces and are critical to making the details (with light and shadow) which set off the large features. As I will discuss further in future articles on design, it is the balance of the details to the large features which constitutes the most critical factor in good design.

Therefore, curves should terminate in sharp lines, and these lines must not be blunted by careless sanding. The intersections do not have to be 90 degrees, but they should be near 90 most of the time. Therefore end point angles should rarely be more than 25 degrees.

Even something which seems complex, can be easily visualized by breaking it down into its individual elements. I hope this article has helped you understand what those elements are and how to see what you are looking at. Nine ball in the corner pocket!

Woodturning's Best Kept Secret

Here is something you won't find in any woodturning books. But it is the most Important element in helping you visualize the reverse curve. I already mentioned that the reverse curve combines both convex and concave parts. Some people mistakenly believe there is a straight section between these two elements. But no part of the curve is straight. The convex and concave portions meet at a place called the inflection point. Its location is shown with regard to its distance from each end of the curve – the distance from the top (C) and the distance from the bottom (D). In this example, the location of the inflection point is above the center of the curve, and (C) and (D) have a ratio of about 2:3. This has the visual effect of making the form fuller and more robust than a curve with the inflection point in the middle.

To further illustrate this point (pun intended), Figure 2 shows three versions of a turning with a reverse curve. The difference is the location of the inflection point. Notice that these turnings do not look at all alike even though the length and diameter measurements are the same. This shows how important it is to pay attention to the location of the inflection point in designing and producing reverse curves.