Ideal Surface Ripple on a Metal Shaper

By R. G. Sparber

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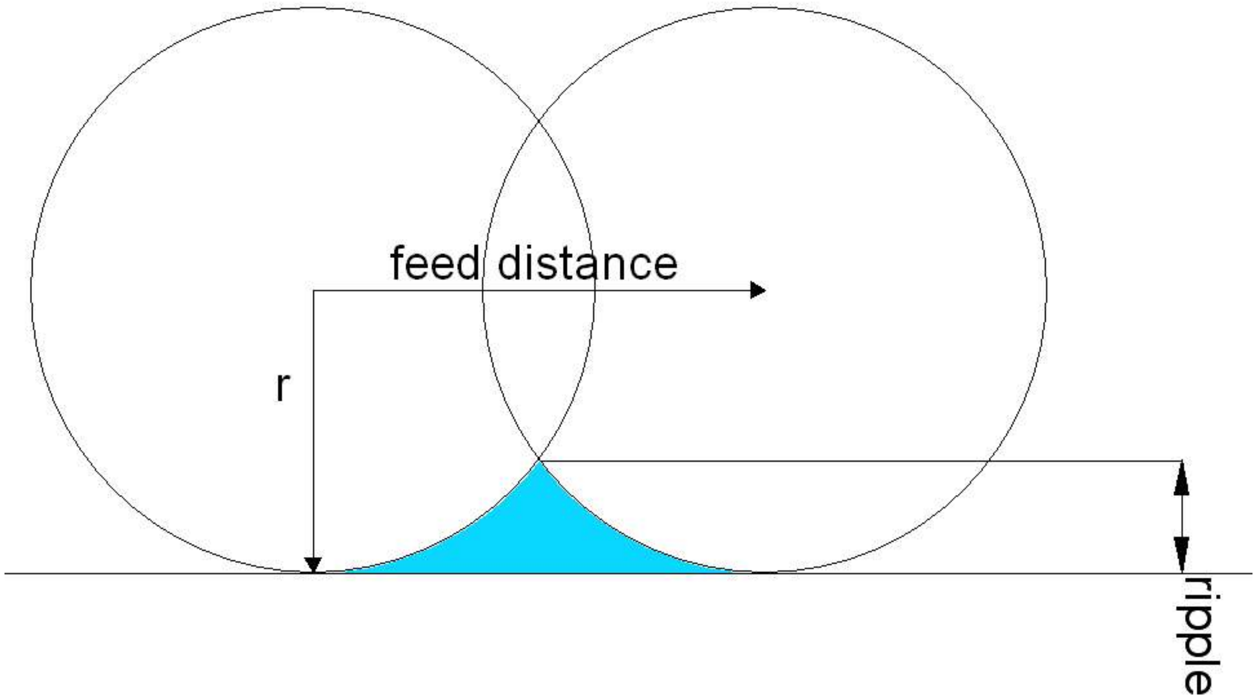
Picture by Neil Butterfield 1

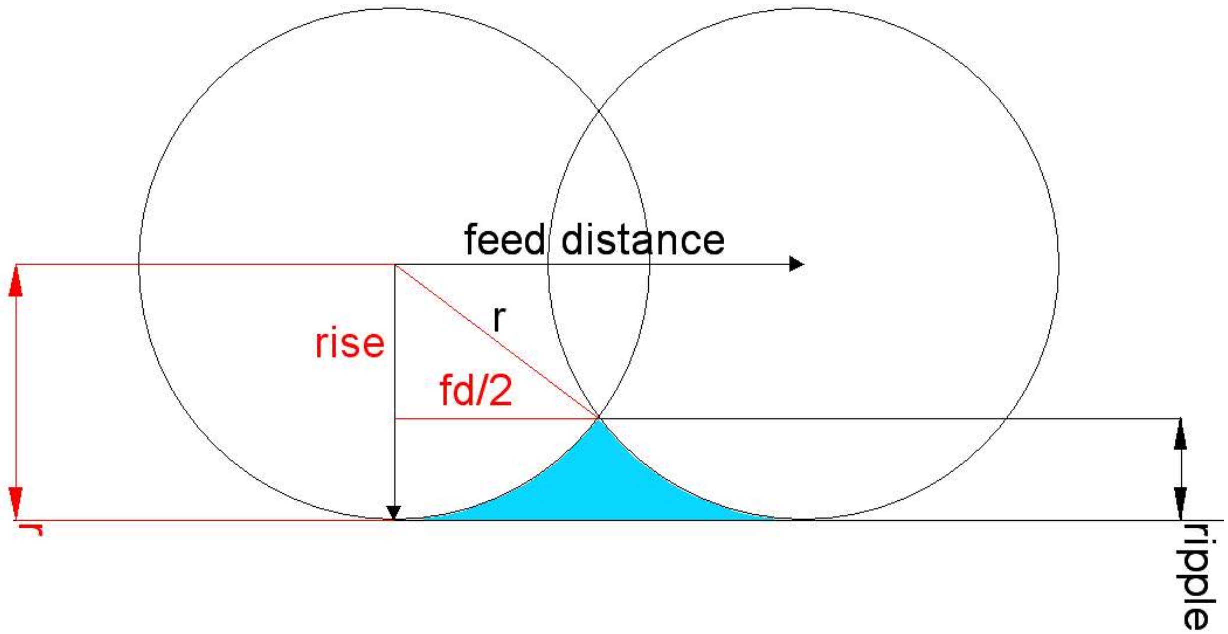
A metal shaper is a rather interesting and unique machine. Rather than having a rotating cutter as found on a vertical or horizontal mill, the shaper cuts grooves. The result is a surface finish unique to shapers.

This article relates the curvature of the cutter and cross feed rate to expected surface ripple.



I am using a shaper cutter that has a known radius on the end. It is commonly called a sheer cutter. Other geometries are also used but I am not addressing them here.

After the shaper's ram moves from back to front and made a cut, it retracts while the table moves over a given distance. Knowing these two parameters is enough to calculate the idea ripple. Other factors can enter into the surface finish such that you never reach the ripple predicted here.



This is the view as I look into the end of the block that was cut. There will be a series of these ripples but I have only drawn one.

I have inscribed a right triangle with hypotenuse "r" and base equal to the feed distance divided by 2. Knowing these two sides of my triangle, I can calculate the rise which is

$r^2 = (\frac{fd}{2})^2 + (rise)^2$ (equation 1)

With some algebra I get

$rise = \sqrt{r^2 - \left(\frac{fd}{2}\right)^2}$ (equation 2)

Note that my ripple equals my radius, r, minus my rise. So I can write

$ripple = r - \sqrt{r^2 - \left(\frac{fd}{2}\right)^2}$ (equation 3)

Let's try out some numbers. The radius of my cutter is about 2" and my feed distance is 0.002". Using equation 3 I can then calculate my ideal ripple:

$$ripple = r - \sqrt{r^2 - \left(\frac{fd}{2}\right)^2} \qquad \text{(equation 3)}$$

$$ripple = 2 - \sqrt{2^2 - \left(\frac{0.002}{2}\right)^2} = 0.00000025''$$

This tiny number is 0.25 millionths of an inch. In other words, other ripple sources within the shaper are going to totally blot out the ripple caused by the cutter. That is not the answer I had expected.

What if we increase the feed rate from 0.002″ up to 0.008″? Equation 3 predicts that the idea ripple will be

$$ripple = 2 - \sqrt{2^2 - \left(\frac{0.008}{2}\right)^2} = 0.000006''$$ or 4 millionths of an inch.

This ideal ripple is still very far from emerging from the random vibration found in my shaper.

My conclusion is that there is no advantage to running at my smallest feed rate. I might as well use the largest and go a lot faster.

I welcome your comments and questions.

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