Lathe Speeds – the effect on the Workpiece

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When a work-piece is spun in the lathe, centrifugal forces act on the piece and kinetic energy is stored in the piece.

What does Applied Mathematics tell us about these forces and how can understanding them help you to become a better turner?

Imagine a weight tied to a piece of string that is spun around your head in a circle. The string applies a radial force inwards to the weight, to constrain it to move in a circle. If the string broke, the weight would travel in straight line, at a tangent to the circle, at the instant that the string broke. This is explained by conservation of momentum – the weight has inertia and will tend to continue on the same path unless acted on by another force, such as gravity or, if you are a small boy, a window pane!

You can extend this example to the rim of a bowl which can be though of as consisting of a ring of weights joined together. The weights are held together by the tensile strength of the wood. You can imagine that if the lathe turned too fast, the outwards force exerted by the masses arranged around the rim will exceed the tensile strength of the wood, and the rim will burst. This could be quite exciting, particularly if you are standing in the path of the fragments, and could ruin your day! This is why it is recommended you stand aside whenever starting the lathe or increasing the speed.

The force needed to hold the masses together (F) is

$$F = \frac{mV^2}{r}$$

Where: m is mass of the rim
V is speed of rotation
r is the radius of the rim

From this you can see that if you double the speed of rotation, the force increases four times. This means that you should think twice about the increasing the speed of flimsy work piece!

Another interesting relationship is the kinetic energy E stored in a moving object:

$$E = \tfrac{1}{2} mV^2$$

Where m and V are defined as above.
(These formulae are simplified, but are good enough to explain the principles.)

This applies equally to rotating work-pieces. If you should double the speed, the energy stored in the rotating mass increases by a factor or four! Then, if the work piece bursts or comes off the lathe, there is four times as much kinetic energy to be absorbed somewhere, probably as some form of plastic deformation. Hopefully the plastic deformation will involve you, because you will be standing aside.

Another interesting effect of the energy stored in the work-piece occurs when the cut is interrupted because the piece is not yet round. You may have noticed when roughing out a work-piece with an interrupted cut, that at a slow speed, it seems too easy to stop the work-piece with a deep cut, whereas at a higher speed, this is not the case. The reason is with the increased energy stored in the rotating object, there much more momentum and energy to carry the tool through each cut and it is less likely to stop. Obviously, on average, you can't exceed the power available from the motor, so this sets a fundamental limit on the maximum rate of wood removal. At higher speeds an interrupted cut will seem much smoother.

Doubling the speed stores four times as much kinetic energy in the work piece, so the slow down from the cut will be less noticeable. However, remember that if something should go wrong, there is four times as much energy in the rotating workpiece to create mischief should something go wrong, so be extra careful.

Stand aside when starting up, and when turning as well, if possible. Use a facemask, or even a fancy combined helmet and facemask (Like the one Triton make) if you think you are at risk.

If you are hollowing out a piece and the wall thickness is becoming rather thin, you may be worried about the mechanical integrity of the piece perhaps due to cracks. As a precaution against bursting, you can wrap some fibre tape around the outside, to resist the tendency to fly apart.