The Kelton Balancer

by Lyn J. Mangiameli

Woodturners who choose to make medium or larger bowls and hollow forms, regularly must deal with out of balance turning blanks. Frequently the imbalance occurs because the initial turning blank is out of round because it would have been awkward or impossible to true the blank fully by means of chainsaw or bandsaw prior to mounting. Even with a perfectly round blank, there is sometimes unbalanced mass. This most often happens when the blank contains wood of widely different density, such as when light sap wood is on one side of the turning while the remainder is composed of denser, heavier heartwood. It can also occur when voids or spalted areas result in uneven distribution of mass within a turning. Finally, there are times when woodturners deliberately mount otherwise balanced wood off center, to achieve eccentric shapes.

A while back Don Watland provided a good description (see Watland, 4/24/02 in the archives of rec.crafts.woodturning) of what occurs when a turner mounts a good-sized, unbalanced chunk of a log on a lathe. In Don's example, he used an unbalanced log big enough to turn a 14" bowl, specified the unbalanced portion of the log to weigh 5 pounds, with the weight distributed on one side somewhere near of the outside edge of the log, and set up the situation such that the log would be rotating at 500 rpm. Put more abstractly, his example was equivalent to a balanced cylinder, to which was added an additional 5 pounds of weight located 7 inches away from the center of the spindle. Putting the 5 pounds of mass, rotating at 500 rpm (the equivalent of a rotational speed of 52 radians/sec), at a radius of .58 feet into the equation for the acceleration of an oscillating system, gives an acceleration of 1,577 ft/sec2.

To quote Don directly, "This circular motion means that hunk of mass moves back and forth in a horizontal plane, while going up and down in a vertical plane, at a clip of 8 1/3 times per second. It must stop moving one way (back, away from the turner), and rapidly accelerate the other way (forward, towards the turner), twice for each of the revolutions at that rate I just mentioned. For comparison's sake, I'll add that the acceleration due to gravity of a falling object is 32 ft/sec2. Since force is equal to mass times acceleration, the oscillating motion of that 5 pound chunk of unbalanced wood, sitting 7" off-center, while spinning at 500 rpm, will become a reciprocating horizontal force equal to the weight of 250 pound person (first backwards, then forwards, vibrating at a rate of 8 1/3 times each second)."

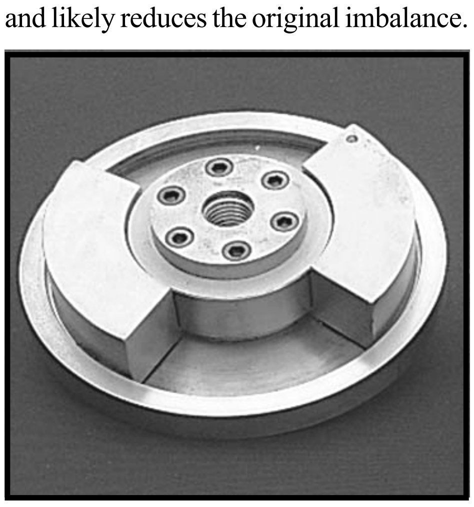
Imbalances in this range are not uncommon when working with larger turnings, thus it is of little surprise that most turners have been forced to deal, in one manner or another, with significant vibration due to such translational forces (this being but one of several different sources of vibration). Of course the magnitude of the translational forces is reduced by lowering the rotation speed, which is why

The Kelton Balancer shown mounted between the lathe spindle and a faceplate mounting for a large bowl blank on the Author's Nova DVR 3000 lathe.

we often begin roughing out a blank at some of the lowest speeds our lathe makes available. Yet, as every turner knows, this is only effective to a point, for if the imbalance is great, even the lowest practical speeds still result in considerable vibrational force, not to mention that low speeds pose other, different problems of their own.

The other common approach to dealing with large vibrational forces is to increase the mass against which they operate. In practical terms, a way to keep one's lathe from dancing about the floor is to either make the lathe (and its attached stand) much heavier than the forces that can be generated by imbalance-which is no mean feat when you consider how the combination of even modest imbalances and speeds can result in substantial forces-or to couple one's lathe solidly to a substantial floor through a rigid stand (in essence coupling these forces to the ultimate available mass, the Earth itself). These traditional approaches can be quite effective when it comes to constraining lathe movement, but they really do nothing to reduce the vibrational forces which arise from the imbalance and are then imposed on the lathe (e.g, the spindle shaft and bearings, headstock casting, stand) and attachment devices (i.e., chuck jaws and slides, faceplate screws, live center, etc.).

There are additional valid ways of dealing with a large out of balance piece of wood. Perhaps the most effective of those, though one less commonly utilized by woodturners, is to redistribute the center of mass of the turning blank so that it coincides with the rotational center of the lathe (i.e, the spindle), thereby bringing the turning blank into balance. If it wasn't that one is trying to turn (cut) the surface of the mounted wood blank, a turner could just screw some weights opposite to, and of equal mass to the "heavy side" side of the blank, thus removing the imbalance. This would be somewhat similar to how a motor vehicle tire is balanced. For turners, though, applying such counterbalancing weight is not nearly so simple. Even if there was not the issue of the weights getting in the way as wood is being cut, there would be such troublesome issues as making sure the weights would be solidly secured (the last thing one would want is to have a chunk of lead or other weight come loose and become a projectile), the depth of penetration into the potential usable surface of the blank by the attachment device, and being able to readjust the amount of counterweight as the roughing out progresses and likely reduces the original imbalance.



The Kelton Blancer can be mounted on the lathe spindle between the headstock and the faceplate or chuck holding the out of balance piece of timber.

Fortunately for turners, Kelton Industries (the same company which bring us the McNaughton Centre-Saver and Kelton Hollowers) offers a device that conveniently, effectively and safely provides a means to apply counterbalance immediately adjacent to the turning blank. Consistent with its purpose, the device is simply called the Kelton Balancer. The Kelton Balancer at first sight appears to be a large, heavy flywheel mounted to the front headstock spindle and to which the log is then mounted via a faceplate or chuck. [see photos] A closer look reveals the Kelton Balancer has two massive movable weights located inside the rim which allow one to redistribute the mass of the combined Balancer/turning blank system so that rotational balance is achieved.

Detailed examination reveals the Balancer to be composed of essentially four subsystems:

1. An internally threaded mounting block that bolts to the flywheel body and allows the Balancer to be fitted to a variety of standard spindle types (custom threadings are available by special order). This mounting block can also be ordered with set screws to lock the Balancer to the lathe spindle (standard for Oneway threading).

2. A 10 inch diameter, over 20 pound, cast steel flywheel body that has channels to hold movable weights. The flywheel has indexing marks provided at 30-degree intervals on the headstock side of the body to assist in locating and recording weight positions.

3. Two circumferential-position, adjustable, 6 pound, mild steel counterweights. These weights fit in an inner radius channel and are retained in position by hex-key screws through their radial axis that, when tightened, forces them against the outer retaining ring of the flywheel body.

4. An externally threaded spindle that attaches in a recess on the front side of the Balancer flywheel body with six bevel-countersunk hex-key screws. This spindle can be chosen to replicate your lathe spindle size and threading, or you can order a different (perhaps larger) size spindle. M33x3.5 spindles (the standard Oneway size) come with a spindle groove for a chuck or faceplate restraining set screw; a groove for other spindle sizes is available by special order (and I recommend it). Traditional faceplates and chucks, as well as specialty devices like the Kelton Angleplate or an eccentric chuck (Kelton also makes an eccentric plate that can combine directly with the Kelton Balancer and has its own spindle).

As the Balancer is quite heavy, you are going to want to mount the Balancer onto the lathe spindle first, then mount your turning blank to the Balancer spindle. I generally use a four or six inch, cast iron Oneway faceplate when working with a large imbalanced piece, and a three inch steel faceplate or chuck for more modestly sized turning blanks-all these work well to attach work to the Balancer.

It is a good idea to start with the counterweights directly opposite of each other for an initial zero balance. Only this way can you effectively judge just how much imbalance you are dealing with, and where it is located in your turning blank. You can use the indexing marks on the back of the body, but generally a quick eyeball is more than sufficient to achieve adequate opposition. The balance weights are unlocked for movement and later locked into position by loosening, then retightening a hex-key screw whose head is conveniently located at the outer periphery of each weight.

By locating the Balancer weights in their neutral opposition, and releasing the lathe spindle to freely rotate, the out-of-balance (or off center) side of the turning blank will rotate down due to gravity. The greater the imbalance, the faster the turning blank will rotate its heavy end to the bottom. One now unlocks and begins to shift the weights in the back of the body upward, away from the heavy side. It is wise at this early stage to try to underestimate the amount needed, rather than overshoot the adjustment-after a few times using the Balancer, one gets a good feel for how much movement is required. Lock the weights in place, then let the turning freely rotate again. Unless you just happened to achieve perfect balance from your first adjustment (an unlikely event), a new heavy side will swing to the bottom, though likely more slowly this time. Through a process of trial and error, repeat this procedure, making smaller adjustments of the weights until there is no tendency for one side of the rotating mass to rotate down. After a little experience with the Balancer, it usually takes only a couple of adjustments to achieve adequate balance (depending on how perfectionistic you are about it). Once balance is achieved, snug down the weight locking screws to prevent any movement and loss of balance during turning. This is an important step, as any shifting of the weights when the lathe is at speed could be most disconcerting, though fortunately I have never had the experience.

Now it is possible that the imbalance within the turning blank is so great that the twelve pounds of weight provided by the Kelton Balancer will be insufficient to achieve an adequate counterbalance. This will be apparent when balance cannot be achieved (that is, one side of the work will continue to rotate down) even when both the counterweights are located fully opposite the heavy side. This will be a rare instance as this represents an unusually large amount of imbalance, but it is possible with very large turning blanks, or heavy turnings deliberately mounted off center. Kelton suggests that when balance cannot be achieved by the balancing weights that you do not operate the lathe. I don’t blame them for their conservative stance, but I find this unnecessarily cautious. After all, we have been turning unbalanced wood for years. How much imbalance you can get by with is a judgment call, but I would suggest you accept about 50 percent less than you would have considered had you not had the Balancer in the system. I suggest the reduction because the imbalance is now located farther from the headstock, due to the intervening Balancer.

During the course of turning, despite near perfect initial counterweighting and resultant balance, imbalance can return as a result of at least three different circumstances. The first is that during the normal course of turning, the inherent imbalance in the wood blank is reduced, and the initial settings of the counterweights now excessive. Should such degradation of balance occur and vibration becomes troublesome, it is quite easy to stop the lathe, shift the weights a modest amount, check for balance, make any further readjustments, and return to turning with a smoothly running work piece. This may need to be repeated several times if the initial imbalance was great and the act of turning will result in further removal of the wood causing the imbalance (as is commonly the case with an on axis bowl or hollow form, but usually not required more than once, if at all, for an eccentric turning). Is this a minor hassle? Yes it is, but a welcome hassle if it makes possible the smooth turning of a work piece that might otherwise not have been feasible to turn. To insure particularly smooth running, one can stop and check the work piece periodically for a heavy side and rebalance even before any vibration is detected.

Two other possible ways for imbalance to develop are usually unforeseen and sudden. In over a year of using the Kelton Balancer, I have never encountered either, but they do represent potential problems. I already made reference to the possibility of weights coming loose, shifting and generating unexpected imbalance. The other situation is to have a work piece which required major counterbalancing break free of its mounting such as following a bad catch. This could result in a “naked” balancer with up to twelve pounds of off-center weight whirling about at relatively high speed. So make sure your adjustment locking screws are tightened down and that your wood is securely mounted (a reason I tend to prefer faceplates).

This brings us to the issue of speed. Kelton recommends the Balancer be used with lathes capable of near zero speed and capable of soft start and stop. They also recommend that initial startup should be done from near zero speed with speed gradually increased to insure that the work is safely balanced and secured (basically the standard procedure for dealing with any large turning blank, regardless of whether or not one is using a balancer). Much of the reason for slowly increasing and decreasing speed is that the rotational mass of the Balancer is considerable (it being almost 40 pounds for the Balancer alone) not to mention the weight of the work piece, thus the inertial load on one’s lathe drive mechanism is considerable.

I use the Kelton Balancer on a Nova DVR. With my older DVR, I can program an extended ramp up in speed to occur over several seconds, but am limited to a 250 rpm minimum speed (later DVR’s go down to 100). I have never had a problem with these settings, indeed, the Kelton Balancer is particularly valuable when used with lathes like the DVR where you can’t reduce the rotational speed to the extremely low, below 100 rpm, levels desirable when turning out of balance pieces. Unlike most lathes, my DVR is almost free wheeling when power is cut. On the DVR, the combined mass of the Balancer and work piece can result in quite a flywheel effect, and result in the work piece spinning on quite some time after power is cut. Having a handwheel to help slow the work piece is very desirable.

You can choose to utilize the Balancer until your turning is completed. This will be standard procedure when dealing with off center forms, as well as those where even in the nearly completed work piece, there continue to be sapwood/hardwood differences in density that cause lingering imbalance. Other times you may wish to remove the Balancer from the system after the wood comes into natural balance after roughing out. Removing the Balancer as soon as possible may be desirable with a work piece that will be smaller at the mounting end and the 10 inch diameter of the Balancer may get in the way; it is also helpful to remove an un-needed Balancer when frequent stops and starts will be required. Again, because of weight, it is best to remove the work piece from the Balancer first, and then remove the Balancer alone from the lathe.

The forces involved can cause the faceplate/chuck to become very firmly seated on the Balancer, and the Balancer to be firmly seated on the spindle. It is not very difficult to remove even a well tightened Balancer from the lathe spindle because there is so much to grab on to help with removal. However, it can be more awkward to get one’s faceplate/chuck to come free from the Balancer without the Balancer loosening from the lathe. Indeed, sometimes this has become a major difficulty with my early version of the Kelton Balancer, as it is difficult to restrain the Balancer and remove a stubbornly seated faceplate at the same time. Later versions of the Balancer should now be fitted with a couple of holes in the periphery that will allow use of a Tommy bar to restrain the Balancer during work piece removal. One of the advantages of using a Oneway faceplate is that it too comes with sockets to take a Tommy bar. Leveraging both the Balancer and faceplate Tommy bars against each other makes dismounting a work piece a simple task, even when the faceplate has become firmly tightened to the Balancer’s spindle.

I’ve taken a lot of time with the above descriptions because balancers of this nature are fairly unfamiliar to most woodturners (though they are well known to many metal machinists). In actual use the Kelton Balancer is actually uncomplicated to set up and use. I find it to be very well engineered and robust. The Balancer just makes so much sense by reducing the forces at the source, rather than having the lathe and stand attempt to absorb them downstream. It will allow some turners to turn wood pieces they otherwise would not have dared to, and to turn other pieces at speeds higher than could otherwise have been safely achieved. What makes it particularly appealing is the Balancer’s combined ability to extend the range (and type) of possible work pieces that can be fitted to your lathe, as well as ability for you to work more smoothly and safely. I use mine quite frequently and would not care to be without it when turning large pieces.

You can find out more on the Kelton Website. **http://www. kelton .co.nz./**

The Wood-Tradesman is one of the few stocking dealers I am aware for this unit it in the United States. More information about them can be found at their web site at:

http://www.thewoodtradesman.com

SIDE BAR

In the main review, several times I have referred to the main body of the Kelton Balancer as a flywheel. Kelton doesn’t promote their balancer as a flywheel (and it certainly is much more than a flywheel), but it does function as one.

Leo Lichtman has discussed the significance of lathe mounted flywheels in a past post on the rec.crafts.woodturning newsgroup, and I shall provide a slightly edited version of his comments here:

“The question about whether revolving weight on the spindle shaft smoothes out vibration does not have a simple answer. Adding spinning weight to the spindle shaft increases the rotational inertia-sometimes this can carry the wood past a potential catch, and sometimes it can make the disaster worse.

If there is some kind of pulsation or unevenness in the drive, the added rotational inertia (called “moment of inertia”), helps smooth it out. That is what flywheels do. I have never seen a lathe with a flywheel, and I am sure this is because the kind of vibration we encounter is not torsional. A spinning unbalanced load produces translational vibration. Spinning mass has no greater effect in this regard than stationary mass. If you make the headstock, or any other part of the lathe heavy it is going to vibrate less-it is cheaper and simpler to increase the mass of the stationary parts than the rotating parts.”

Thus a flywheel in and of itself does nothing to deal with the translational forces of out of balance wood. A balanced rotating mass (be it a faceplate, heavy motor, or separate flywheel plate) will actually do very little to deal with imbalances in the turning blank, other than the addition of added mass near the headstock (and in this sense it doesn’t make any difference whether the mass is fixed in place or rotating). This is because the “flywheel” weight alone is dynamically balanced and does nothing to diminish the source of those translational forces described in the main review. It is the mounting of the movable weights to a flywheel body that makes the Kelton device a balancer rather than just a flywheel, and thus able to reduce or eliminate the translational forces. Yet as Leo notes, what a flywheel may be able to do is contribute to a smoother, more consistent speed of rotation by increasing the rotational inertia. Thus the effect of motor fluctuations in drive speed, elasticity in drive line components (belts, etc.), and bogging due to application of cutting tools may be decreased at the rotating wood’s surface. On some lathes this may contribute to an increased consistency of cut and resultant smoother surface. Likely the difference is subtle at best, but I have found it to be discernible with some combinations of lathe and work load. Furthermore, with a lathe that has speed control circuitry like the Nova DVR, a heavy flywheel may help smooth out variations at low speeds and makes things easier for the speed control circuitry at those speeds as well.