Turning 25
With Stuart Batty

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Learning To Make Perfect Cuts in Woodturning

What are Perfect Cuts in woodturning? Perfect Cuts are consistent cuts made by a wood turner who demonstrates effective tool control, cuts easily and with very little physical effort, and produces any desired shape in any kind of wood – hard, soft, even spalted - all with no torn grain and no catches. Perfect Cuts reflect effective tool control!

Many wood turners around the world work at this level every day – and they are not all professionals! They work with very little conscious thought since the vast majority of their techniques are performed sub-consciously. They have probably been turning like this for many years, and conscious thoughts control only basic decisions like shape, how much wood is removed, and how quickly the cutting takes place. At first even they found that mastery of the tools was difficult since there was so much to learn initially, and all that initial learning was based on conscious thought rather than sub-conscious action. If correct methods are not learned from the start, bad habits are stored in the sub-conscious, and it is very difficult to break these habits and learn correct methods.

I was fortunate in that I was taught correct cutting methods at a very young age. I served an apprenticeship under my father, but anyone can learn these methods from a qualified instructor. My personal quest is to teach others these correct cutting methods early in their woodturning careers so they turn more proficiently and more safely. By refining and breaking down the fundamental cuts into smaller and smaller increments, and explaining them in a way that is easily understood, I regularly achieve that goal. I instruct a small number of students (typically about 5 or 6 students), in sessions that last between 2 to 5 days. One-day classes are not as effective because repeating the fundamental cuts during at least a second day causes the sub-conscious to start to "kick in" and cement the learning into muscle memory (sub-conscious action).

Practice does not lead to perfect wood turning right away, but practicing Perfect Cuts leads to perfection in technique, which eventually leads to greater perfection in woodturning. An imperfect technique may work quite well, at least for a while, but using imperfect techniques long-term is ineffective and fails to foster continuous improvement. Many self-taught wood turners have developed their own styles, but they seldom involve Perfect Cuts, and their proficiency in woodturning suffers as a result.

So what are Perfect Cuts? I will explain in words, but doing so is obviously is not as effective as participating in a hands-on class. But…it is a start. For those who have taken a class with me, these words should serve as reminders of the points made in class.

I believe that the rules I espouse are the only way cuts should be made. I must admit that many wood turners break these rules and end up with satisfactory cuts. I am not interested, however, in "satisfactory" when I know that every wood turner is capable of attaining perfection if cuts are made correctly. The more rules one breaks, the more difficult the effort, and the less consistent the results – and yes, torn grain will be the rule.

To my great pleasure, many world-class wood turners have enrolled in my classes. They already demonstrated an ability to create incredible art, but they wanted to take their art to the next level by making more consistent cuts (Perfect Cuts). What they take away from my class is an improved understanding of techniques and a new awareness used to more critically analyze their own work and the work of others.

Seven Principles That Lead To Perfect Cuts

Perfect Cuts result from practicing seven (7) principles that are summarized below, in order of importance, and then further explained. Very important to understand is that the first six principles must be followed in order to achieve success in the seventh principle – Technique (Push Cut Style) - and make Perfect Cuts consistently.

1. Grain: Side / End / Mixed
2. Chucking: Secure / Accurate
3. Sharpening Cutting Edge: Type / Size / Shape / Angle
4. Tool Rest: Height / Distance / Angle
5. Lathe Speed: Fast but safe
6. Stance: Position of feet
7. Technique (Push Cut Style): Straight / Concave / Convex

GRAIN (orientation of grain or grain direction)

Woodturning is challenging because of the many types of material turned. Materials may be very soft, very hard, or in between. Grain is the only common denominator – all woods (with the exception of burl or burr wood) have side grain and end grain.

Bowls can have either a side or end grain orientation. A side grain bowl has mixed grain (a combination of both side and end grain), while end grain bowls are pure end grain. If mixed grain, the grain is mounted perpendicular to the lathe bed so that the wood turner is presented half the time with side grain and half the time with end grain. If end grain, the wood turner is presented with only side grain, as in spindle turning, and end grain only is hollowed.

We try to avoid cutting into mixed grain directly since doing so tends to cause catches. Most importantly, we never cut directly into end grain. We focus on making slicing or peeling cuts (a gouge can slice and peel at the same time). Cutting end grain with the cutting edge facing uphill will invariably produce a catch. If the cutting edge of the tool is parallel to the floor or pointing downhill, then scraping, rather than slicing or peeling, is taking place.

In sum, there are only three ways to remove wood:
Slicing (like a skew): There must be bevel contact (floating rather than rubbing) to create a slicing action.
Peeling (like a parting tool): Only side grain can be peeled – trying to peel end grain will cause the tool to self feed and catch. Note that when peeling side grain the bevel does not always have to be in contact, but without contact scraping is taking place, and the cutting edge dulls very fast.
Scraping (many tools): A scraper is not the only tool that scrapes - all tools can scrape if the handle is in the incorrect position. There are three main ways to inadvertently scrape: (a) the handle is too high, (b) the front of the tool is being pulled with the left hand, (c) the left hand / thumb is being used as a fulcrum during the cut.
Note: A gouge is the only tool that can peel and slice at the same time. The tip of the gouge creates the slicing action, and the wing produces the peel. A bowl gouge shape is better at this combination cut than a spindle gouge because of the differences in cutting surfaces in the respective flutes. A spindle gouge has a radius flute, while most bowl gouges have either a vee or elliptically shaped flute. A skew chisel can slice or peel, but not at the same time. A key disadvantage of the skew chisel is that only a small amount of wood may be cut at one time, so cutting with a skew is very time consuming.

CHUCKING (mounting the wood on lathe)

Wood must be mounted both securely and accurately to prevent vibration from occurring during the cutting process. Vibration creates spiral patterns on the surface of the wood as cutting takes place. The shape of a tenon or recess for gripping in a chuck – and most importantly – the seating of the wood against the chuck jaws - are critical to accurate mounting and a more secure grip.

SHARPEN CUTTING EDGE:

Four factors must be considered before sharpening the tool:
Type of Tool – Using the wrong type can be dangerous.
Size of Tool - For example, blade diameter for a gouge, and the length of the handle.
Shape of Cutting Edge – For example, wings of a gouge ground straight across for straight cuts and wings ground back for cuts with more shape and detail.
Angle of Cutting Edge - 40° for most gouges and chisels (but there are exceptions).

First select the correct type and size of tool for the grain orientation and size or shape of the turning. Example - do NOT use a roughing gouge (sometimes called “spindle roughing gouge”) on a side grain bowl – you will be breaking Principle #1 (Grain) by cutting end grain, which will result in a major catch that may snap the tang off the roughing gouge (and hurt the wood turner in the process). Another example – do NOT use a skew for roughing a spindle down, despite what you may have seen in a video – the correct tool is the spindle roughing gouge. Using a skew in this manner is dangerous.

When selecting a tool, it is also important to take into consideration the length of the blade plus handle. These concepts involve overhang ratio and gouge diameter overhang (see below).

In general, spindle turning rarely requires a long handle and blade because the cutting edge is not usually hanging off the tool rest very far. Bowl turning can require use of much longer handles, especially for the inside of the bowl when the overhang can become considerable.

Overhang ratio depends on whether one is cutting, scraping or negative rake scraping.

Cutting requires a 5 to 1 ratio (for example, if the cutting edge of a gouge is extended 3 inches beyond the tool rest, then there must be at least 15 inches of blade / handle length behind the tool rest, and the wood turner must be holding the end of the handle to preclude loss of leverage.

Scraping requires a 7 to 1 ratio (see above example).
Negative Rake Scraping requires only a 3 to 1 ratio (see above example) and requires the least amount of leverage.

Gouge diameter overhang is important as it relates to the distance the tool overhangs the tool rest. Too small a gouge, or too much overhang, causes the blade to start vibrating. This vibration may sometimes be mitigated by using lighter and / or slower cuts. Below are guidelines:

The shape and angle of the cutting edge are also important. In many books and videos, wood turners espouse different angles for different gouges or chisels. For the vast majority of all gouges and chisels, I am convinced that the optimal angle is 40°, and I know that a 30° angle on a spindle gouge tends to be too aggressive. This is the angle of a chef’s knife, and also of a beaver’s tooth. It is also the angle between a self-feeding cutting edge (35° and below) and a duller angle (45° and above) that requires much more pressure to perform the cut (a 45° angle requires about 4 pounds of pressure, while a 40° angle requires only about 2 pounds of pressure). There are of course exceptions to use of 40° all the time; these exceptions will be addressed in a future article on grinding and sharpening woodturning tools.

Gouge Diameter	Maximum Overhang
1/4”	3/4”
3/8”	1 ½”
7/16”	2”
1/2”	2 ½”
5/8”	4 ½”
3/4”	6 ½”

Note: Gouge diameters might be cited differently in a mail order catalog – the above diameters listed are the physical size of the haft of the gouge, not the European measurement.

TOOL REST:

Tool rests are critical to effective control of the tool. Height, distance, and angle of the tool rest must reflect the size or type of tool and size of wood blank, as well as the direction in which the cut or scrape is being made, including consideration of the location at which the cut will start and end.

Height:
The standard height for the majority of cuts is approximately 1/8” to 1/4” below center - a little lower for a 5/8” or larger diameter bowl gouge. Lower the tool rest when hollowing the inside of a side grain bowl, but only as the cut gets deeper, to ensure maintenance of an upward angle when cutting.
When planing or rolling beads with a chisel (not needed for gouges) raise the tool rest to above center. The diameter of the wood blank and the size of the chisel will dictate how much the tool rest should be raised.
When scraping, the tool rest is generally fixed above center so that the cutting edge of the scraper is pointing downhill (uphill will result in a catch).
When negative rake scraping, only the negative angle on the top of the blade needs to point downhill - not the actual blade.

Distance:
The distance between the tool rest and the wood is critical to effective control of the tool - too much distance, and leverage is reduced. The tool rest can also be so close to the wood that use of the tool becomes impossible. There needs to be just enough space to place the tool securely on the tool rest, ready to produce the cut, without the cutting edge of the tool being in contact with the wood. Usually 1/8” to 1/4” away from the wood is ideal, possibly further for 5/8” diameter or larger bowl gouges.

Angle:
The angle at which the tool rest is set to the wood is critical for both the shape one desires to produce and control of the tool. One must be able to both start the cut in a controlled manner and complete the cut comfortably.
Most tool rests supplied with modern lathes are not ideally shaped for what wood turners need them to do and often do not allow optimal positioning of hands. For the most part, however, this failure by manufacturers represents an inconvenience rather than a major issue.

LATHE SPEED:

Lathe speed in woodturning is a balancing act. Higher speeds are needed to effectively cut; slower speeds tend to make clean and consistent cuts much more difficult to achieve. With higher speeds there is greater potential for injury, more stress is placed on chucking systems, and unbalanced wood blanks can literally fly off the lathe from excess vibration. Use of variable speed controls on modern lathes has to a great extent made addressing these issues much easier.

Following are guidelines for round wood blanks that are in balance. For square wood blanks, the longest diagonal measurement should be used. The rightmost column is the key to understanding risk.

Diameter of Wood Blank (Inches)	Maximum Lathe Speed (revolutions per minute)	Outer Diameter Surface Speed (miles per hour)
2	2,400	14
3	2,200	20
4	2,000	24
6	1,700	30
8	1,500	36
10	1,350	40
12	1,250	44
14	1,100	46
16	950	45

STANCE:

Stance is the position of one's feet while performing a cut. Stance is an important part of effective and consistent cutting. Positioning one's feet correctly is also critical to producing desired shapes while controlling the tool during the cutting process.

The three stances are:

Parallel Straight Cut: Feet are parallel to the lathe bed (may also be parallel to the cut if the cut is angled – for example, when removing the corner of a side grain bowl).
Oblique Straight Cut: Left foot is forward.
All Curved Cuts: (concave or convex – both directions): Right foot is forward. Longer cuts may require the right foot to be even more forward - for example, the larger the bowl diameter, the longer the curved cut, and therefore the right foot might need to be quite far forward to maintain balance during the cut.

TECHNIQUE (Push Cut Style):

Technique is the way the tool is controlled, both with the type of cut, and with correct use of the hands. Technique is last principle on the list, but technique must be considered before selecting a tool, setting the tool rest, and determining stance.

The Push Cut.
The principal style of cut I use and teach is the Push Cut – a name I assigned to my style after watching other professional wood turners pull the gouge around the outside of a side grain bowl. I call their style the "Pull Cut". Note that this Pull Cut cannot be performed on the inside of a bowl, and also that it is impossible to get into corners using the Pull Cut. The Push Cut should be learned and practiced first to foster use of the most effective woodturning cuts.

Correct Use of Hands:
Assume for the purposes of this explanation that the wood turner is right-handed, and Push Cuts are therefore controlled by the right hand (the one holding the handle).
The key mantra associated with use of the Push Cut is that **CONTROL COMES FROM THE RIGHT HAND!** It is impossible to complete a Push Cut Perfect Cut using both hands. The Pull Cut, and also scraping, requires control from both hands.
What does this right hand and arm do to control the tool during a Push Cut? Only four motions & their opposites are possible:

Lift or drop
Push or pull
Twist (left and right)
Swing (left and right)

Straight cuts use the first two motions (lift and push). If twist or swing is added, the cut will no longer be straight. Note that nearly all straight cuts involve body contact with the handle during the cut.

Curved cuts require use of all four motions to produce a fair curve. Note that all curved cuts do not involve handle contact with the body. The cut may start with the handle against the body, but as soon as the tool moves, the contact will cease since there is simply too much travel in the handle during curved cuts. If the cut is progressing in the opposite direction, then the handle would start away from the body, and at the very end of the cut the handle would either be touching the body or be very close.

What does the left hand do? Think of the left hand as an assistant who adds no controlling action to the tool. The left hand provides assistance in four possible ways, but only one (weight) is essential in all cuts:

Weight: Adding weight to the front of the tool, or down onto the tool rest, is essential in all cuts. Most tools are not heavy enough at the front, largely because the handle is lower than the blade.
Positioning the front of the tool for the start of the cut. The right hand is simply too far back to effectively position the front of the tool. The left hand, at the front near the cutting edge, is much more capable of accurately positioning the tool to start the cut.
Preventing skid. When starting certain cuts, such as an entry cut on the inside of a bowl or cove, the gouge will want to skid / skate to the left because at that point there is no wood behind the bevel. This skidding effect will not take place on a broken surface such as a natural edge bowl or pommel – the tool will simply not skid on air. The left hand can prevent this skid / skate through use of the left thumb on the tool rest (in contact with the rest) behind the gouge blade, with the left hand fingers on the opposite side of the blade pinching the blade between thumb and fingers. A key points is that this assist from the left hand must be momentary only - once the cut has started, and the bevel has wood behind it, the left hand must be moved back away from the rest and used only to add weight. Leaving the left hand on the tool rest often prevents the tool from cutting correctly.
Braking or squeezing. At the end of certain cuts, the tool must be prevented from travelling past a certain point - for example, past the center on the inside of a bowl or box. The left hand is used to squeeze the front of the tool back toward the right hand to counter the pressure being applied to produce the cut – in essence applying a brake. This squeezing technique is also useful while cutting the outside of a side-grain bowl - to reduce the bounce effect typically caused by the left hand adding pressure to the bevel – in effect helping to float the bevel.

The left hand must **NEVER** control the tool or influence the path of the tool. The left hand will destroy any cut if it influences the path, adds pressure to the bevel, or removes the bevel off the surface by pulling the blade. The left hand or thumb must NOT become fulcrum points. The left hand must NOT pull the front of the blade at any time since doing so causes the bevel to come off the wood and the cut to become a scrape, leaving small grooves in the surface of the wood. Scraping will also dull the cutting edge approximately 30 times faster than keeping the bevel in contact with the surface.

Other Aspects of Tool Control:

Understanding Handle Height:
Handles need to be at the correct height for each type of cut. Too high, and the cut turns into a scrape. Too low, and aggressive cuts result.

Understanding the Concept of Bevel Flotation:
The bevel must be in contact to be cutting (if not, one is scraping), however, the amount of contact is the critical issue. The bevel must float (i.e., move across the surface without pressure) rather than rub on the surface.

If too much pressure is applied (bevel rubbing), the cut will bounce. This bounce occurs most often in bowl turning because the grain is mixed (both side and end grain) and the bevel therefore travels over different densities of grain. Any pressure on the bevel will start a very small bounce on the surface, which will amplify in longer cuts – and result in an uneven or rippled surface.
A vivid demonstration of the destructiveness associated with bevel rubbing is attempting to cut a broken surface while pushing the bevel on to the wood – such as cutting a bark-edged bowl or a pommel (the shoulder between the square section and the rounded diameter on a chair leg or baluster). Unlike rubbing the bevel on a solid surface, the effect of placing pressure on the bevel while cutting a broken surface is instantaneous failure of the cut.

U**nderstanding Flute Orientation** (applies to gouges only):
Flutes must be correctly oriented – too open and the cut will become aggressive, and too closed and the tool will fail to cut.
An open flute means that the opening of the gouge faces the ceiling. A closed flute means that the opening of the gouge faces the floor. Since no cuts are possible with the flute fully closed, to achieve a cut the flute must be facing right or left, or more open.
During any curved cut, the flute must be twisted / rotated to enable the cutting edge to re-orient to the grain. Concave cuts start with the flute on its side (left or right) and end with the flute fully open (facing the ceiling). Convex cuts start with the flute fully open (facing the ceiling) and end with the flute half closed (left or right).

The goal of this paper is to improve understanding of what constitutes Perfect Cuts in wood turning. I am convinced that Perfect Cuts are possible for all wood turners. Hopefully the information in this paper will enable wood turners – with some practice – to achieve Perfect Cuts. Practicing the correct techniques is the key!