

Steels and Wheels

Quick intro to Hands-On Sharpening Workshop, SC Woodturners

Wells Shoemaker, November, 2019

Steels: Three to remember: Carbon Steel and HSS: M2 and M42

Steel is a crystalline alloy structure made by melting iron together with other metals and minerals. It's shaped, heated, and cooled in deliberate ways (tempering) to achieve different properties. There are thousands of kinds with a huge range of properties.

Steel of different types can be bendable and hold a shape...like baling wire and sheet metal...or go back to its original shape like a spring or a cro-bar. It can be rigid and resist deformity...like a rifle barrel or a ball bearing...or it can be creatively shaped with heat and hammer blows. Some steel is engineered to take repeated impact like a hammer head...while other specialty steels shatter when struck. It can be soft enough to dimple with a punch or so hard it takes a diamond to make a mark...or in between like a nail. It can rust in a day or stay shiny in the face of water, acids, and foods.

Steel for a turning tool needs to be rigid, but not brittle. It needs to be soft enough to be machined into the many shapes we use, but hard enough to hold a sharp edge in the face of abuse. It needs to be moderately heat resistant without changing shape or losing the crystalline structure that yields its virtues.

- There is no one steel that does everything, but turners now have a grip on the virtues and trade-offs, as well as the cost consequences of those choices.

Carbon steel—the hallmark of most of the pre-2000 tools. It can be sharpened to a very keen edge, but it dulls fairly quickly with heat and friction. It's easy to damage the temper with overheating while grinding. It's less expensive for new tools and widely available for used ones, but you must decide how to balance your time. NOTE: Must sharpen carbon steel with stone. CANNOT use with CBN wheels!

High Speed Steel—HSS—is the general term for harder alloys used for cutting tools (e.g. drill bits & saw blades) that get hot with standard use. Iron is smelted with tungsten, molybdenum, cobalt, chrome, or other minerals for specific traits. It's a huge, competitive industry.



- **M2** is the most prevalent and popular HSS alloy for turning tools. It's harder than carbon steel, so it will keep an edge longer, especially with hard, abrasive woods. M2 accepts a keen edge, and for that reason, it's popular for finish cuts. It tolerates heat relatively well and can be machined into all of the popular shapes for our tools. Economical compared to the exotics below.
- **M2** can be treated with super cold "**cryo**" quenching to make the cutting edge even more durable. Cryo adds substantial additional cost—probably worth it for higher volume turning and hard, abrasive woods.
- **M4** is another HSS alloy with several useful features for durability, but enough cost differential that it has not dazzled the marketplace
- **2030 and 2060** alloys were among of the early extra-durable HSS alloys, but they have faded. (Every day I use the Hamlet 2060 bowl gouge I bought 20 years ago).
- **PM**—Powdered Metal—is a high tech alloy which holds an effective cutting edge a long time, a big plus for high volume roughing out, but it does not accept the razor sharpness desired for finish work. CBN sharpens PM better than stone. It's an expensive niche steel, not likely to find a home in the shops of hobby turners.
- **M42**—This new darling alloy quickly took over the market for serious tools for high demand turners. M42 makes a very sharp edge and holds it a long time. It's rather expensive compared to M2, but not out of reach. If time spent at the grinder is an economic issue for a turner's work, it makes excellent sense.

Stainless steel, beloved to winemakers, doesn't possess the features turners demand. It can be formulated stiff enough, but it doesn't hold the edge most of us require. The oxidation and corrosion resistance, compelling for so many uses including kitchen tools and food contact, isn't particularly relevant for our indoors work with wood.

Carbide is not really a steel, but a carbon-rich crystalline metal which is much harder than most steels and holds an edge much longer. In fact, it's used to cut HSS. However, carbide is rather brittle and unsuited for long tools. Its real sweet spot is small cutters attached to steel structures (saw blades and a huge array of newer turning tools). It's very expensive, but it saves time, which can also be scarce and expensive!

- Most turning-specific catalogs feature a range of steels, but M42 is becoming the favorite for the high end. For most of us, that may be the last purchase needed.
- The Craft Supplies online catalog has embedded a succinct, understandable 5' video on the comparisons of different turning tool steels. Open one of the Carter gouges with the Mahoney endorsement, scroll down, and there's a video to click. Link to one example below.

<https://www.woodturnerscatalog.com/p/129/7017/carter-and-son-M42-Mike-Mahoney-Finalizer-Gouge?term=m42&term=m42>

Back to the Grindstone...and True Grit: Stone and CBN

Three main choices for grinding wheels:

1. Inexpensive stone (\$20-40) (hardware store and discount sales)
2. Expensive stone (\$40-80) (catalog and specialty store)
3. CBN—Cubic Boron Nitride (\$100-200).

Real Stone—dug from the Earth—has been used to sharpen steel tools for millennia around the world. Judging from the human proclivity to cleave other humans with blades long and short, those stones worked pretty well. Typically those were fine grained sandstones or microcrystalline quartz, such as the Arkansas stones. They are still wonderful, but not for electrically powered wheels running North of 1000 RPM.

“**Stone**” for turners’ workshops is made from sharp-edged, uniform size “sand,” natural or synthetic grit, bonded into the shape of a wheel. They come in red, white, and blue...and gray, pink, and green, too...based on the material. The particles break off with use, exposing new microscopic edges to cut metal. Normal use will slowly reduce the diameter of the wheel, but not significantly in most shop use. More important, uneven wear of a stone wheel can lead to grooves and deformity of the cutting edge of the wheel, which makes it hard to sharpen a wide tool like a skew chisel. (Mitigation: Use a diamond dressing tool to restore a flat surface, cost under \$30, lasts forever.)

Stone wheels can also clog with soft metals (Aluminum) or anything sticky like glue, pitch, paint, or plastic. They’ll rub and rattle, but not cut. Most turners use a dedicated wheel just for their lathe tools.

- Inexpensive stones eat expensive steel. *Just sayin’...*

CBN is the second hardest abrasive available, second only to diamond. The grit is bonded to a metal wheel and does not chip off. A CBN wheel should last a career.

- Ironically, carbon steel destroys CBN...think showers of sparks. Use only HSS or carbide tools with CBN, and avoid inadvertent contact of a moving wheel with mild steel (like the angle gauges for your Wolverine jig!)

Sizes: Wheels are readily available in 6, 7, & 8” diameter. 8” wheels leave less curvature on the ground edge than smaller diameter wheels. If you’re using standard sized tools for bowl and spindle work, that size is best if you’re making a new purchase. Still larger wheels are generally the province of professional shops.

- A 1” wide wheel is easier to use for lathe tools than the narrower wheels often sold with older grinders and garage sale tools. Most grinders purchased in the last 20 years will handle a wide wheel, and all turners’ catalog grinders will assuredly handle it.

Speed: Ideally sharpen your lathe tools on a slow speed grinder (1700 RPM). (Price range \$120-180 Rikon and Jet, up to \$300 for heavy, industrial caliber tools). 3250 RPM grinders are more common but not cheaper...and not great for lathe tools. High RPMs cause too much heat and vibration, and it's harder to control the delicate angles.

Grits: This is the particle size of the abrasive grains in a stone wheel or the bonded crystals on a CBN wheel. Grinding wheel grits are rated just like sandpaper.

- Wheel grits range from 36-600. Lathe tools usually use grits in the 80-320 range.
- Lower the grit number, the coarser the grain, faster the cut, rougher the edge. A magnifying glass will reveal the scrapes made by the grit. They look like parallel rake marks on sand in a Japanese garden. Ask Maarten to show you!
- Higher the grit number, the finer the grain, slower the cut, finer the edge.
- Generally the finer the edge, the shorter the time elapsed before re-sharpening.
- Busy turners may use coarser grit wheels for high-volume roughing out, then fine grit for finish cuts which feature less tear out and require less subsequent sanding. It's convenient that grinders run 2 wheels!
- Honing refers using a very fine abrasive powder or cake to further refine or polish an edge fashioned on a grinder. Fine diamond tools (600 or higher grit) in various shapes, leather or rubber wheels with an abrasive powder, all have their proponents. You can do surgery with the tools sharpened by skilled honers...not recommended in the shop, and definitely not advised as a selfie.

Sharpening Jig. No, that's not a dance to celebrate a perfect edge, but rather a device to present a tool to the wheel at a precise angle and replicable manner. Jigs are designed to make sharpening more consistent, faster, and less stressful. They also waste less of that expensive tool steel, which adds up. More important is the edge performance if the grind is right: more reliable cutting, beautiful ribbons of shavings, less sanding, more pleasing shapes.

- Jigs: Necessary...or a gimmick? Turners who do movements thousands of times achieve natural precision with free-hand techniques. Like everything else in woodwork, tons of practice can trump a gadget. Meanwhile, I use a jig.

Oneway's Wolverine jig is probably the most popular. It costs around \$150, which is the price of one high end modern steel tool. The jig should last longer than most of us will.

Sorby and other manufacturers make jigs which have strong following. Devices using abrasive belts instead of wheels have many devotees.