

∞ EUGENE 5160 CLUB ~ JUNE 2013 ∞



JUNE MEETING

The 5160 Club will meet the 6th of June at 6pm – at Woodcraft of Eugene in the Delta Oaks Shopping Center just off Delta Hwy and Beltline Hwy in North Eugene. Come share your latest work, ideas, and experience.



MAY MEETING

Wayne Goddard opened the meeting with a review of his process for the mustard finish. This is a forced patina that protects the blade and provides a mottled camo finish – as exemplified by Wayne's “Edwin Forrest” and classic clip point style Bowie knives which he shared with the group. Those are the knives featured at the top of this newsletter.

For the mustard finish, you daub on spots with your finger – let it sit overnight – clean the blade and lightly steel wool it in warm water – then apply another coat – repeat until you have the effect you want – maybe three coats.

The mustard finish is not just decorative but also protects the blade. As it is applied, each layer is scrubbed lightly with steel wool and warm water. Wayne noted that as the last step he treats a mustard finished blade with WD-40.

Wayne has run into one cheap mustard that don't work. Albertsons and French's were brands that were cited as working well. It is the salt and vinegar that does the work – prepared mustard is just a mode of delivery.

Wayne noted that the steel's finish is key – a hand-rubbed finish (*I'm guessing 400 to 600 grit from his comments*) then take a fine stone to the bevel surface and do some irregular markings on it. This probably helps the salt and vinegar in the mustard interact with the steel to create the patina.

Here's a photo of how Wayne spaces the dollops:



Wayne paused to take his 6:00 meds – noting that with Parkinson's you can't count on anything, and that he'd

spent hours looking for something that was right there on his work bench. There was general consensus that if this means you've got Parkinson's we're ALL in trouble...

...and it reminds me of my Dad as he got older "I may not have Alzheimer's but I've sure as heck got Halfheimers."



Wayne moved on to sheath making. He leaned a lot from a saddle maker who had a business on West 11th. He taught Wayne an efficient way to stitch up his sheaths. Wayne brought a wooden jig to the meeting. You sit on with a vertical clamp so that you have the work at belly height.

The method that Wayne showed us was a hand version of how a sewing machine works. You use two threads – one down each side of the sheath – have your holes made first and a line pressed in the leather for the thread to lay in (made with a bone tool or some such) – the 1st thread will always be pulled through a hole, leaving a loop – the other thread will go through that loop – then pull the 1st thread tight (keeping tension on the 2nd thread) until the “knot” is in the center of the leather.

Wayne used an American Sewing Machine standard #2 needle for his hand tool – tempered to blue by setting it on a metal plate on the kitchen stove. It

looked to me like Wayne had ground open one side of the needle's eye (which is in the point) and turned it into a hook – and blunted the tip



and thinned down the sides. This is used by passing it through the hole empty, then pull the 1st thread back through the hole. He set the needle in a nice big wood handle grip:

You want to use a thread meant for leatherwork – like you can get at Oregon Leather. Their local store is at 810 Conger in West Eugene – they also have a Portland store. The <http://oregonleatherco.com/> website is down today but should be restored soon.

Wayne uses a reloading press (but you could also use a drill press) to punch the holes – he makes his punches out of spare Allen wrenches, grinding the tip to his desired shape for the holes.

Wayne has also used copper nails as rivets in sheath making. Here's a copper nail riveted sheath:



And here's a shot of hand file work on a button stud he got from Oregon Leather... and the Spacer-man Bowie



sheath it belongs to:

Wayne shared the story of the rediscovery and the revealing of the Edwin Forrest Bowie (I included a photo of that knife in the last newsletter). This knife was the inspiration for Wayne's Bowie that is pictured at the top of this newsletter. This is quite different from the modern idea of a Bowie knife. It is now accepted that the Sandbar Fight Bowie knife was essentially a butcher's knife of this simple style.

Wayne compared the Edwin Forrest Bowie to a lengthened version of an artifact dug up in Missouri –

a fur trader's blade. He noted that the lack of a guard is actually a positive if you think about going through the woods with the knife on your belt – one less thing to get caught on a branch or bramble. You don't want to get to camp and find that a vine has lifted you knife out of its sheath somewhere back in the forest.

There was general discussion of Jim Bowie's exploits and the current price of the Edwin Forrest Bowie.

Back on knife design Wayne reemphasized his preference for “no straight lines on a knife” and his use of custom platens to achieve that. He shared one of his garage sale finds – a clothing pattern maker's “french curve” that gives you an almost infinite variety of progressive curves to select from.

Wayne then cleaned off the mustard patina example he'd started earlier in the evening. The pattern was light (only an hour rather than overnight) – but the start of the daubed-mustard pattern was obvious.

Craig Morgan passed around a fun knife he got at the OKCA show: a cigar box knife from the 1800s:



You use the round end to cut the paper seal – the notch to pop the box tacks – and the hammer to close the box back up again!

Mike Johnston went to Madras for an auction of horse drawn equipment. While he was there he visited a friend and from *him* Mike picked up this machete – which his friend called a sugar cane knife:



... made by Collins & Co – Hartford. With the original paper label, handle, and thong – unsharpened. The sticker is in both English and Spanish. This is an

unusual combination of handle and blade shapes that I can't remember having seen before.

Mike also brought in the finished knife from one of the 5160 blades he'd brought to the last meeting. It has a mild steel guard. The handle is walnut, red spacer material, black tail deer antler:



Mike shared a sales tip from his experience at the OKCA show. Beyond just being friendly and greeting folks that stopped at the table, he would tell them that you can't just see a knife with your eyes – you have to see it with your hand – and he would pick up a knife he thought might suit the customer and hand it to them. Mike said he wouldn't have sold a knife at the show if he hadn't been doing this. Mike credited Wayne as giving him this tip on salesmanship.

Alan Hershman shared a knife he made with guidance and help from Mike Johnston:



Wayne illustrated the challenge of splitting a piece of fiddleback maple or any such tightly patterned material and re-assembling it for a hidden tang handle: you'll never get the pattern to match right. One way to handle this is to put a spacer between the two halves, creating a visual element and buffering the transition between grain patterns.

I shared my learning experience in putting a brass guard I'd just soldered to my dagger blade into jeweler's pickle. The pickle sucked copper out of the brass and plated my steel blade. It was an impressive embellishment, but not what I'd been shooting for!

Mike shared the hint from Gene Martin of using a swadging tool to help customize wire size to match your design. You can make one by drilling successive smaller holes in a plate of steel. You use it by drawing the wire through the successively smaller holes until you get the size you are shooting for. *I have not tried this but I would not be surprised if you have to anneal the wire between steps.*

Someone asked if anyone in the group had used kerosine as a flux for forge welding – nobody has yet! I gather from on-line conversations that (for obvious reasons) you only use kerosine for the initial flux... if subsequent fluxing is needed then borax is used.

Mike Johnston mentioned a 15-year-old U.K. blacksmith who was forging at the NW Blacksmith gathering. Martin Brandt and Mike were pretty impressed with this kid's ability to forge steel just how he wants. "He did wonderful presentations." He's not interested in knifemaking, mainly because in the U.K. they are not allowed to carry a fixed blade knife. There was some discussion of U.K. knife laws. And discussion of this guy's forging techniques – and Mike & Martin were both concerned that he would be in physical therapy by age 30 unless he changed his fast and furious forging techniques.

From there we closed the meeting and went off into the night – chatting in small groups.



HEAT TREAT NUGGETS

At the OKCA show in April one of my table-mates was wondering why a freshly hardened blade might crack if just left sitting (see "retained austenite" below) – and what exactly happens during tempering.

What follows is based on what I've learned from books and talks by Wayne Goddard, the ABS

instructors in Old Washington, and others, plus the postings of Kevin Cashen, and the public domain PDF document by John Verhoeven.

The following is generalized for simple carbon steels. Alloying elements change the temp and speed at which a steel will change phase, so every steel is a little different and has it's own set of charts.

For a further explanation of phase changes and heat treating – with charts, graphs, photos, and anecdotes I recommend chapters 3 and 4 of Wayne Goddard's 2nd edition of **The Wonder of Knifemaking** or chapter 4 of **\$50 Knife Shop** (revised).

Here's my brief & basic on steel phases & heat treat – starting from ground zero and working up:

You all probably know that steel is iron (Fe) with just a bit of carbon (C). Simple steels has less than 1.5% C and trace amounts of impurities. If you get more than 2% C you are getting into the realm of cast iron.

The **eutectoid point** for how much C you have in the steel is 0.77% C. This is the amount of C that fully occupies the lattice in the austenite phase of steel. More than 0.77% C in the steel is referred to as hypereutectoid, less is referred to as hypoeutectoid. In numbered steels the last digits refer to the 100th of a percent of C. The reference is not exact – so 51**60** (0.56-0.64% C) is hypoeutectoid... while 10**95** (0.90-1.03% C) is hypereutectoid.

Ferrite is the phase steel wants to be in at room temperature. It is like a cubic crystal lattice with Fe atoms at the cube corners. This Fe lattice can hold one C atom in the center of each cube – this structure is called Body Centered Cubic (BCC) – or "alpha iron." Only 0.02% C can be held in the ferrite lattice.

Austenite is the phase of steel (created by heating) that also has a cubic lattice structure, but in this phase C atoms can settle into the Fe lattice at each face of the cube – called Face Centered Cubic (FCC) – or "gamma iron." This allows the Fe lattice to suck in much more C. As mentioned above, 0.77% C can be held in the austenite lattice, and when you include other metallurgical magic, I've read that austenite can hold 80 times the C that ferrite can hold.

Cementite and other carbides are where that extra C wants to live when it can't get into the Fe lattice. Cementite (Iron Carbide – Fe_3C) is harder than the regular steel lattice but softer than other carbides we find in alloyed steels.

The temperature at which steel becomes **non-magnetic (Curie temp)** is 1414°F regardless of the %C in the steel and has something arcane to do with Fe atom's electron's angular momentum and spin.

A **phase diagram** plots % C in the steel across the bottom of the graph, and temperature vertically. Areas of the graph show the phase of steel at that temperature for that % C. Here is such a diagram from Verhoeven's public domain PDF:

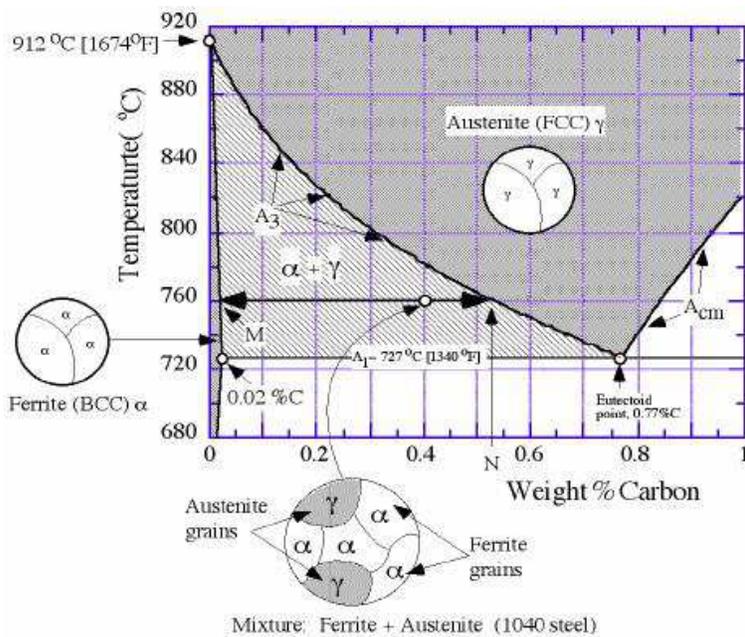


Figure 3.3 Portion of Fe-C phase diagram for hypoeutectoid alloys. (%C less than 0.77%)

The theoretical temp for transforming ferrite into austenite is marked on the phase diagram by the A_3 line for hypoeutectoid steels and the A_{cm} line for hypereutectoid steels. This theoretical **austenizing temp** is lowest at the eutectoid point (1340°F at 0.77% C). The theoretical austenizing temp varies according to %C. As you can see, both above and below 0.77% C the austenizing temp increases.

The recommended real-life austenizing temps are higher than the A_3 and A_{cm} lines. As I understand it, this is to fully transform ferrite into austenite and to allow for existing carbides to dissolve and free up C

to be absorbed into the Fe lattice and/or to reform as new carbides. For instance, a recommended temp for austenizing 5160 is 1525°F even though the diagram's A_3 line at 0.60% C is about 1380°F .

If austenite is cooled very slowly, the C atoms have time to migrate out of the lattice and bind into carbides. In plain steels this will be cementite – which forms pure cementite plates between layers of pure ferrite. This combination is called **pearlite**, and (other than another steel phase that has spheroidal carbides) pearlite is the easiest phase of steel to grind, bend, or machine. When we **anneal** steel we are creating pearlite.

Normalizing (where the steel is soaked at above the austenizing temp and then cooled in still air) is used to relieve stresses in the steel created from the heat and hammering of the forging process. It also dissolves large carbides so that the C becomes redistributed more evenly in the steel. Grain size is also evened out by the **thermal cycling** (bringing steel above the critical temp into austenite, then back down through critical temp again). Normalizing evens out the steel's internal stress, grain sizes, carbide distribution, etc.

If austenite is cooled very rapidly (**quenched**) the C atoms do not have time to get out of the lattice. This causes a stressed lattice structure called **martensite**. The lattice is literally stretched into a Body Centered Tetragonal (BCT) form to accommodate the C that could not diffuse out in time. When quenching for martensite, each steel has a “Martensite Start” (M_s) temp and a lower “Martensite Finish” (M_f) temp.

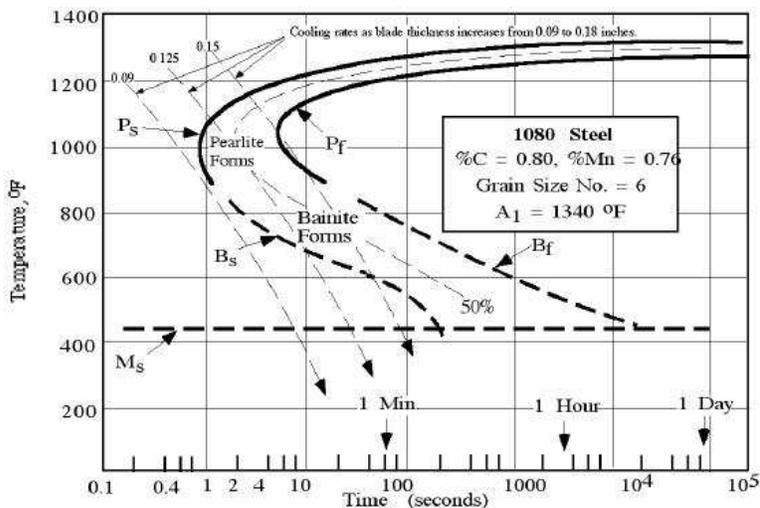
Martensite starts forming at M_s , but you need to reach M_f within the time given in the steel's Time Temperature Transformation (TTT) diagram (see below) in order to get full martensite without retained austenite. Martensite is both hard and brittle due to the stressed BCT lattice. It should also be noted that martensite has a slightly lower density than other room temperature phases – causing a slight expansion of the blade where it is created – an extra 4-5% volume at room temperature.

A **critical temperature** is where a phase transformation takes place. On heating this is where austenite forms. On cooling things get more

“interesting.” The Time Temperature Transformation or **TTT** diagram (aka Isothermal Transformation or **IT** diagram) for a particular steel shows graphically the critical temperature lines where transition from austenite into other phases of steel (pearlite, bainite, or martensite) takes place. The parallel curves indicate the start and finish of the phase transformation from austenite. Both time and temp are critical in these phase changes.

If steel is cooled so that time & temp trace a line through the Ps/Pf (pearlite start and finish) lines above the “nose” of the graph the result is pearlite. If the steel is cooled fast enough to miss the nose and goes through the Ms (martensite start) line at the bottom of the graph you transform austenite into martensite. If the steel is cooled fast enough to miss the nose, but then held at temp to go through the Bs/Bf lines you get bainite.

Here is Verhoeven's TTT chart for 1080 – the Mf line is not shown, but would be a horizontal line at 212°F for this steel. Note that the time scale is logarithmic.



Like martensite, **bainite** is formed by initially cooling austenite very fast – to miss the nose of the steel's TTT diagram, but stopping and holding the temp well above Ms for long enough to go through the TTT diagram's Bs/Bf lines at a constant temp before finishing the quench. This is usually accomplished by the use of a molten salt bath to achieve the fast initial quench and then hold at that temp for the time required to reach the Bf line. Bainite is similar to pearlite in that it is a mix of ferrite and cementite – but in bainite, the cementite

forms in smaller filaments and loose particles.

Actually there are two forms of bainite – upper and lower – with lower bainite having finer cementite structures. Lower bainite can be almost as hard as martensite and can be tougher than tempered martensite with the same Rockwell (Rc).

Retained austenite refers to austenite that does not transform (to martensite or pearlite or bainite) on quenching. In my comments on martensite (above) I noted that if you quenched to a temp between Ms and Mf that you would only transform a portion of the austenite. The rest is retained austenite. Retained austenite is unstable in the long run at room temp and is living on borrowed time. When it does transform it forms untempered martensite. The gradual creation of untempered martensite adds stresses to the steel over time. This might explain stories of an untempered blade “just cracking for no reason” if left on the workbench.

Retained austenite can be forced to transform into martensite by a low-temperature quench. Retained austenite can be transformed to ferrite and carbides during tempering at temperatures above 375°F – whether or not this is into a recognized phase such as lower bainite seems to be a matter of debate among metallurgists.

Tempering is also believed to condition the retained austenite such that some of it transforms into martensite during the cool-down to room temp. This process explains why you want to temper multiple times (to temper the new martensite).

Tempering is primarily used to transform untempered martensite into tempered martensite. When martensite is heated to a few hundred degrees (exact temp varies depending on the steel and the desired effect), some of the C atoms trapped in the martensite will migrate out of the lattice, forming carbides and leaving the martensite in a less stressed state. This adds toughness to the blade, making it less brittle. For simple steels, tempering up to about 375°F causes very little loss of hardness.

As noted above in the retained austenite section – it is general practice to temper three times to get the steel's transformations settled out.

All phases of steel (ferrite, austenite, pearlite, martensite, bainite) are formed of **grains**. Within a grain the crystal-like Fe lattice is oriented in one direction. In neighboring grains the Fe lattice will be oriented in other random directions.

When steel changes from one phase to another (ferrite to austenite, austenite to pearlite, etc.) seed grains for the new phase generally start scattered along existing grain boundaries and grow from there. This is why **thermal cycling between steel phases tends to reduce grain size**. This occurs during phase change both on heating and on cooling. If the steel is not overheated then these new grains tend to remain smaller than the old grains. Overheating causes some grains to consume their neighbors, forming larger grain sizes. The larger the grain size, the easier it is for a local stress in the steel to propagate into crack in the blade.

And there you have the 10 cent tour of my current understanding of heat treatment and steel phases.



I've mentioned the Arctic Fire 2013 hammer-in on the 5160 Club's Facebook page. It was a 4 day gathering in Anchorage, Alaska this week of some very talented sword smiths in the Northern European tradition.

They started with freshly smelted bloomery steel and finished with an "artifact quality" short sword and sheath in 4 days (or 6 days if you count the smelting). The video isn't network quality but good enough. This is a reality show for the blade-addicted.

In the archived live-broadcast videos you get to watch their various teams simultaneously forging the blade (and a backup blade), creating waxes and casting brass fittings, carving antler fittings, tooling leather and brass, and creating the wood core scabbard. Archived videos available at: <http://www.arcticfire2013.com/>

There will eventually be an edited video posted at this site which will contain final clues to the blade's name and the location where it will be hidden.

The first person to correctly guess the blade's name and town where it will be hidden claims the short sword, plus roundtrip airfare and accommodations.

What a hoot!



Keep Well & bring your show-and-tell to the meeting... my bamboo handled dagger is finally as done as my skill level is going to get it – I'll bring it to the meeting.

Your Scribe ~ ~ ~ Michael Kemp