Balcones Forge Dispatch

President's Corner

November 2014

Meeting Date
November 8, 2014

Meetings start at 9:30am

Go to:

www.buggybarnmuseum.com

for directions and information.

1915 Highway 281 North, Blanco, TX 78606   830-833-5708

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November Trade Item

The trade item for November is a.....

HORSESHOE

No store bought shoes allowed. Make your own.

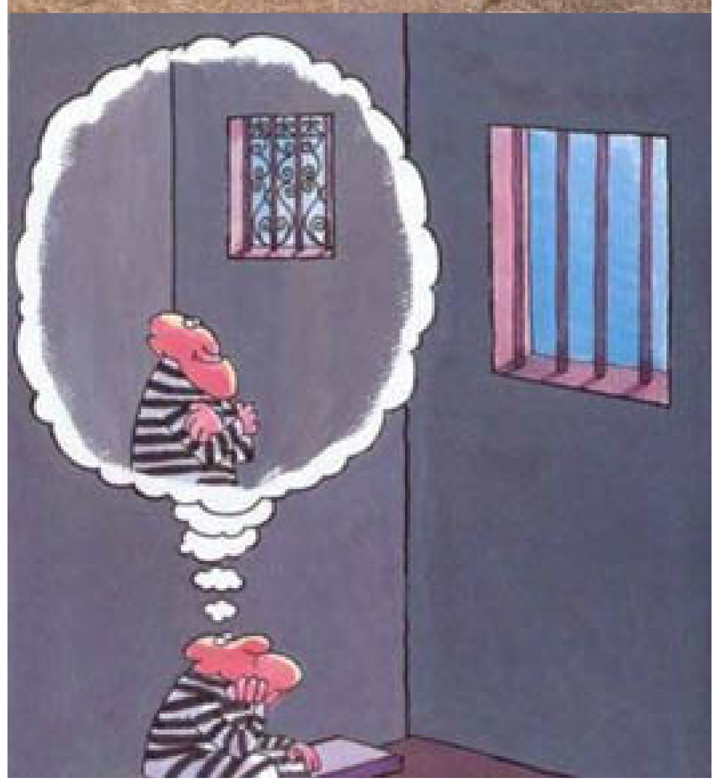
REMEMBER: you gotta make one to take one!

Teaching Stations Update

by John Crouchet

All four crates of anvils, blowers, and leg vises are now sitting at my shop. Currently unopened. (I guess they are in there. The crates sure are heavy!)

Special thanks to Jim Elliott and his son, Dennis, at Texas Outdoor Power Equipment for all the crating and labor and help with shipping. This was a big project!



The *NEW* Balcones Forge Board of Directors

Jerry Achterberg, President
Jerry Whitley, Vice President
Rudy Billings, Treasurer
Tim Tellander, Secretary

John Crouchet
Daniel Harrington, Librarian
Jim Elliot
Vince Herod, Editor
Alan Lee
Jeff Lee

A Great Deal

Balcones Forge has Mark Aspery Books!

All 3 volumes:

- I - Basic Blacksmithing
- II - Leafwork
- III - Joinery

$50 each -- no tax, no shipping, normal price $59

Send your requests to Rudy@BalconesForge.org

October Secretary's Report

submitted by John Crouchet

The October Balcones meeting was held Saturday, October 18th at San Gabriel Park in Georgetown as part of the "Up the Chisolm Trail!" festivities. Balcones members demonstrated for a very interested crowd of onlookers throughout the morning.

In the absence of our President and Vice President, Balcones Treasurer Rudy Billings called the meeting to order. Secretary Tim Tellander was very busy most of the day with a crowd of people interested in his display of fine custom knife work. Rudy asked me to take the minutes for this meeting, so that Tim could continue his very popular knife forging demonstrations.

Rudy thanked the members who showed up to demonstrate for the public. Aaron Tilton, Tim Tellander and John Crouchet brought forges, anvils, blowers, leg vises and other equipment, so we had plenty for everyone. Rudy also thanked Jim Elliott, Daniel Harrington, Jim Schmidt, Tom Leining and Mary Jo Emrick for coming to demonstrate.

Rudy next opened the floor for old business. Jim Elliott reminded everyone that our next meeting is November 8th at the Buggy Barn in Blanco (say that three times fast!).

Rudy explained that October is the month each year when, according to the Balcones Forge bylaws, we must elect the Board of Directors. He opened the floor for nominations to the board.

John Crouchet nominated the following persons: Jim Elliott, Jerry Achterberg, Jerry Whitley, Rudy Billings, Vince Herod, John Crouchet, Tim Tellander, Daniel Harrington, Alan Lee, and Jeff Lee.

Jim Elliott seconded the nominations.

Rudy Billings asked for additional nomination from the floor. As there were no further nominations, Rudy called for a vote.

The nominations passed unanimously.

Next Rudy asked for any other new business. Mary Jo reminded us that Austin Community College is still expanding the classes in the Blacksmithing Department. There is now an Advanced Blacksmithing class taught by William Bastas. Dan Smith is now teaching three blacksmithing classes and classes are now available at more times than before.

Jim Elliott explained that Dorothy Steigler will be our featured demonstrator at the Bluebonnet Demo this year and will be teaching bronze forging classes at Sycamore Creek Ranch on March 24, 25, 26, and 27 before the big demo on March 28 and 29th. This is an unusual chance to learn the art of bronze forging from a true master. Because very few smiths understand bronze forging, opportunities to learn it are very limited. Dorothy is a gifted teacher as well as a very entertaining demonstrator.

John Crouchet explained that because Balcones Forge had spent so very much money this past year on ten full forging stations for our classes that it is very important that we pay attention to our Bluebonnet Auction this year. Treasurer, Rudy Billings confirmed that our bank balance is very low compared to previous years. Hopefully, everyone will work hard to come up with some excellent auction items and we will be able to recover financially at the Bluebonnet Auction.

A new schedule for the "Up the Chisholm Trail!" celebration this year had the demonstrations ending at noon, following the traditional trail drive of the longhorns up the banks of the San Gabriel River.

As it was almost time for the trail drive and there was no further business, Rudy adjourned the meeting.

General Discussion of Heat Treating

Jan Kochansky

Heat Treating is any deliberate process that changes the properties of a metal by the use of heat, whether hardening, softening, adjusting grain size, or whatever. It does not include changes that may result from cold working, welding, or other process, although heat treating may be required to mitigate these incidental changes.

Heat treating of non-ferrous metals is generally limited to annealing after cold working, or precipitation hardening of mainly aluminum alloys or beryllium copper and similar alloys. This category also includes the austenitic (200 and 300-series) and precipitation hardening stainless steels and the high-manganese steels used for their work-hardening capabilities. These are softened after work hardening by heating and then rapid cooling. These classes of metals will not be covered further in this article.

Annealing/normalizing

Other ferrous metals can be annealed by heating to an elevated temperature and slow cooling. How slow depends on the type of steel. Water and oil hardening steels can be normalized by heating to the critical temperature and cooling in air. This is not a full anneal, but does significantly soften the metal. Slower cooling by packing the hot metal in an insulating medium like ashes, lime, or diatomaceous earth gives an even softer result. Air hardening steels must be cooled at ≤20 ºF/hour which is only possible in precision furnaces, usually with controlled atmospheres. These are outside the budget of blacksmiths like us, but the best approximation is to pack the steel in cast iron chips, heat to critical, soak as necessary, wrap in 2+ inches of Kaowool and come back in two days. If the package is still too hot to touch, it's probably fairly soft (hint from Hans Peot).

Hardness

Hardness is the ability to resist deformation. Maximum hardness of steels is roughly proportional to carbon content up to about 0.8%, and is modified by some alloying elements. Increase of carbon above 0.8% increases hardness only marginally, but does increase wear resistance.

Hardenability is the ease of reaching maximum hardness for a given carbon content. It is affected greatly by alloying elements. A low-hardenability steel (like simple carbon steels) needs rapid cooling to harden, and consequently does not harden to a great depth even when cooled rapidly. High hardenability steels can cool slowly and still reach maximum hardness. There are three general groups of steels, with somewhat blurry distinctions between them.

> Water hardening steels require rapid cooling in water or brine, and only harden to a shallow depth (maybe 1/8 inch) even then.
>
> Oil hardening steels, generally medium alloy. Oil is a slower cooling medium than water.
>
> Air hardening steels have higher alloy content and will harden merely by cooling in still air from the proper temperature.

There are various tests for hardenability but the most common is the Jominy test (named for the engi neer who developed it). In this test, a heated 1 inch diameter bar about 4 inches long is quenched on one end with room temperature water until completely cool. The bar is then sand blasted to remove scale, ground on both sides to remove decarburization and provide flat surfaces for hardness measurement, and the hardness measured every 1/16 inch. The plot of hardness *vs*. distance from the end gives a good measure of hardenability. It is obviously not applicable to air hardening steels, which will generally harden to the center of bars up to 5 or 6 inches merely by air cooling.

Hardening of steels is accomplished by heating to a temperature such that all carbon is brought into solution in the hot steel, followed by rapid cooling. How rapid depends on the type of steel. Straight carbon steels containing no alloying elements, or at least only small amounts, require the rapid cooling provided by water or brine, although in thin layers (think knife blade) even they are best quenched in oil. Most low-alloy steels are quenched in oil to give a slower quench. Even higher levels of alloying elements give steels that can harden by heating and then cooling in air. The milder the cooling method, the less chance there is of distortion during hardening. This is the reason why the distortion-prone water hardening steels are little used now. Some, like W-2 and F-2 are essentially extinct, even though they have very desirable properties to a blacksmith. Even W-1 is only easily available in small sizes like drill rod, at least in the small quantities used by blacksmiths (any kind of steel is available from custom mills, if you want a 40-ton heat of it).

The simplest test for the proper hardening temperature is the loss of magnetism. The steel is heated slowly until a magnet won't stick, and then quenched, keeping it in motion in the quenching medium to avoid temperature variations as much as possible. This works for carbon steels and a few alloy steels. The heating should be slow enough to avoid significant overheating, which would coarsen the grain and increase brittleness.

The hardening temperatures of many alloy steels is higher than that of carbon steels, since the carbides of alloying elements like chromium, vanadium, and tungsten only dissolve at higher temperatures than the disappearance of magnetism. Industrially, temperatures are controlled carefully with thermocouples or optical temperature measurements. Blacksmiths use color, as they have for thousands of years. Color, however, is most accurate in the red to low orange ranges; higher temperatures are harder to estimate by eye.

Decarburization

When steel is heated in air, the carbon near the surface 'burns out' leaving a low carbon layer which does not harden properly. If formed, this soft skin ('bark') must be ground off to reach the properly-hardened steel underneath. Steels containing tungsten or high levels of silicon are particularly prone to this.

Several remedies are available. For the carbon and low-alloy steels used by blacksmiths, and the short heating times usually employed, it is less of a problem, since the shallow layer of bark is easily removed by the sharpening needed to ready the tool for use, and precise dimensions are not required.

For other cases, the steel can be heated in a container with a neutral packing medium like cast iron chips (easily found in piles under the brake lathes at your friendly auto-repair shop). The steel is removed from the packing immediately before quenching. In a gas forge, the flame can be adjusted to give a residual oxygen content of 1-4% (depending on the steel) which minimizes decarburization.

In a coal forge, you want a deep fire and just enough blast to maintain the necessary heat. Think a welding fire but not as hot. Air-hardening steels can be wrapped in stainless steel foil for hardening and tempering.

Industrially, controlled atmosphere furnaces or vacuum furnaces are available, but expensive. Controlled temperature salt baths are also used. Heating in baths of red-hot lead used to be employed, but is no longer used because of the toxicity.

Quenching media

For water hardening steels, clean water (free from oil, which interferes with hardening) or salt brine can be used. Even more hardness can be obtained **from mild steels only** with 'Super Quench', invented by Robb Gunter, then of Sandia Laboratories. Composed of 5 gallons of water, 5 lb. salt, 32 oz blue Dawn dishwashing liquid, and 8 oz Shaklee Basic I. Since the last item seems to have been discontinued, it can be replaced with the same quantity of Basic H or7 oz. of unscented Jet-Dry dishwasher rinse agent. Parts must be carefully rinsed after any brine quench, since salt and steel do not play well together. The fastest quenching medium is mercury, but obviously no one uses that any more.

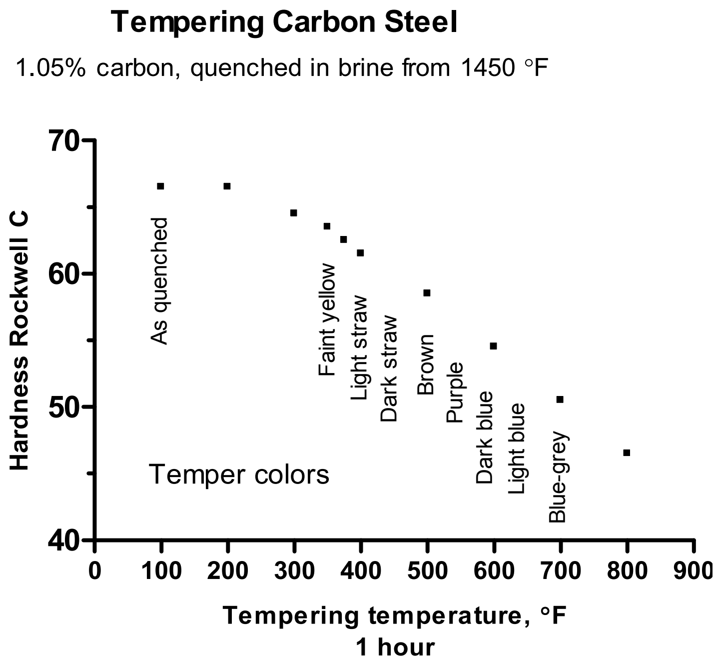
There are various commercial quench oils, differing in quenching speed, produced commercially, and some of them are available online. Improvisational substitutes can be animal/vegetable, particularly peanut oil, or some sort of hydrocarbon oil. Automatic transmission oil is well spoken of by several authorities. Motor oil, particularly used, is not recommended. The additives, and the engine crud in used oil, produce toxic fumes and deposit excessive gunk on the steel. In addition, used motor oil frequently contains gasoline residues, which make the oil much more likely to flash when hot steel is added. I had access to clean used vacuum pump oil from the lab, which works very well. Animal or vegetable oils become rancid with time, and the smell of used fry oil can give you the munchies when used. French fry oil is obviously preferable to old fish fry oil in this regard.

Whatever quench you use, particularly if oil, a metal quench bucket with a metal lid is essential. Hot steel if dropped will melt through plastic. Hot steel placed in oil may cause the oil to ignite. Burning oil will melt plastic. You definitely don't want gallons of burning oil running over your feet and your shop. Keep a fire extinguisher handy. The easiest remedy if the oil flashes is to drop the metal lid on the quench bucket to snuff the flames. Stainless steel buckets (or stock pots) would be best for brine quenchants, since regular steel would rapidly rust out, spilling the contents.

Tempering

As hardened, high carbon steel is essentially glass hard (lower carbon alloys don't get as hard) and like glass is very brittle, and can sometimes break like a plate if you drop it. Internal strains from hardening can be so high that the steel can crack or shatter spontaneously. To prevent this, newly hardened steel must be tempered to increase toughness at the expense of some of the hardness. The extent of this tradeoff depends on the intended use. It is accomplished by heating to elevated temperatures (but much lower than hardening temperature) for times ranging from a few minutes to several hours, depending on the steel.

When carbon steel was the only type available (up to about 1900 AD) the process could be controlled by the observation of temper colors. As a clean piece of steel is heated in air, a layer of oxide forms on the surface. As this layer becomes thicker with increasing temperature, light interference causes colors to appear, starting with a pale straw color, and progressing to darker yellow, brown, purple, blue, and finally bluish grey. Each color appears at a specific temperature. There is some progression of color at a given temperature with extended time, but as used by blacksmiths, the short times used make the colors easily reproducible. The following graph shows the hardness (in Rockwell C units, measured by the depth of penetration of a diamond point into the steel under a standard load — 66-67 is about as hard as steel gets) of a 1.05% carbon steel and temper colors *vs*. temperature.(Hardnesses are from an old Carpenter data sheet for No. 11 Special tool steel, and the colors are from the Wikipedia article on tempering (metallurgical))

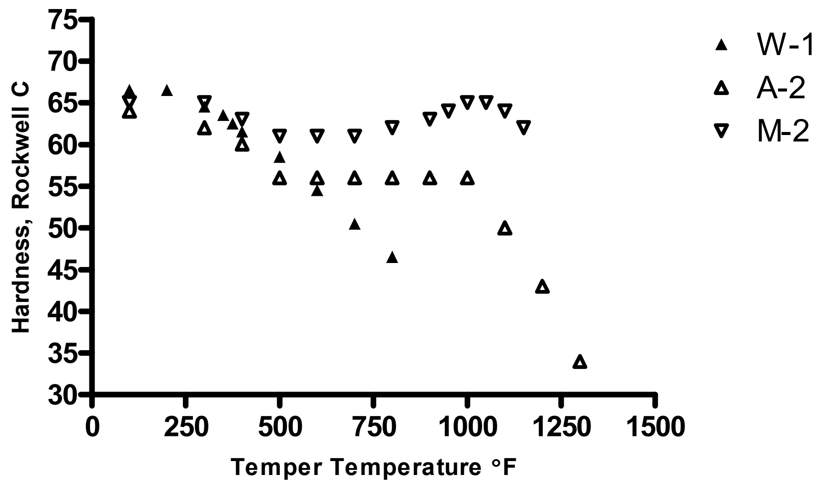


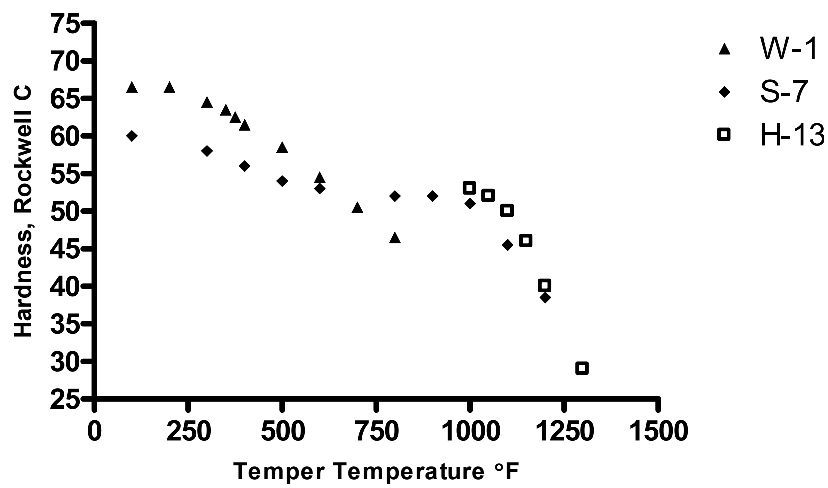
One table of colors *vs*. tool usage follows (also adapted from the Wikipedia tempering article; not all such tables are the same):

Faint-yellow – (350°F) – engravers, razors, scrapers
Light-straw – (400°F) – rock drills, reamers, metal-cutting saws
Dark-straw – (440°F) – scribers, planer blades
Brown – (500°F) – taps, dies, drill bits, hammers, cold chisels
Purple – (540°F) – surgical tools, punches, stone carving tools (depends on the stone)
Dark blue – (590°F) – screwdrivers, wrenches
Light blue – (640°F) – springs, wood-cutting saws
Grey-blue – (700°F) and higher – structural steel

These temper colors work well for simple carbon and some low alloy steels, but can fall very short of required tempering temperatures for some higher alloy steels. The following graphs show how tempering temperatures required can be hundreds of degrees in excess of those required by carbon steels and as indicated by temper colors. Indeed, the 1100 ºF required by some steels is in the dull red range. In addition, some alloy steels (like M-2) actually become harder as the tempering temperature rises, up to a point. Some alloy steels also require more than one tempering cycle to attain optimum properties.

Tempering several tool steels





(Hardnesses are from Carpenter data sheets for the various steels)

A reasonably accurate toaster oven works well for tempering small parts at temperatures up to 450-500 ºF. The best bet for heat treating data is the data sheets for individual steels, in print and online, published by the steel companies.

Heat-Treating Data for Selected Tool Steels

(All temperatures are in °F)

Steel	Forging (start/stop)	Anneal From	Harden From[1]	Quench In	Temper[2]
W-1, W-2	1900–1825/1500–1450	1425–1400	1450–1410	water/brine	300–600
O-1	1900/1500	1450	1475	oil	300–600
O-6	1950/1500	1500	1450–1480	oil	300–1000
L-6	1900/1650	1375	1500–1550	oil	200–700
A-2	2050/1700	1650	1775	air	300–1300
A-6	2025/	1375	1525–1600	air	200–1000
D-2	2050/1700	1650	1850	air	900–1200 (900–960 Rc 59)
D-3	1900/1700	1600	1740	warm oil	400–1300
D-5	2000/1750	1650	1850–1875	air	300–1000

S-1	2100/1660	1475	1750	oil	300–1200
S-3	1900/1700	1375–1525	1600 (1450)	oil (water)	300–400
S-5	1950/1650	1450	1600	oil	300–1300
S-7	2050/1700	1550	1725	air <2½ inch	300–1300
H-13	2150/1650	1600	1850	air	1050–1150
4140	2200/1800	1600	1600	oil	300-1200
5160	2200/2100	1525	1525	oil	800–1300

Notes:

1. Variations in temperature may depend on size, and higher temperatures may give greater hardness at the expense of increased grain size.
2. Higher temperatures give higher toughness and lower hardness. Generally the lowest temperature gives about Rc 60 (when the steel gets that hard) and the highest about Rc 30.

[Adapted from *Machinery's Handbook* and other sources]

Heat treating unknown steels

We all do it — take a piece of old spring steel (or whatever) to make a tool. Based on what the steel was used for it is possible to have an idea of what kind of steel it might be. But it is only an idea. Manufacturers use different steels for a given product, and also make the same product out of different steels at different times. The tables of products and corresponding steels online or in newsletters are not to be trusted.

For example, axles used to be made of carbon steel like 1040. Then oil hardening steels like 4140 or 4340 were used to give higher strength (I have a Mack truck axle made of 4140). Recent discussion on Anvilfire.com indicates that some manufacturers have gone back to 1050 or 1455H, which are water hardening, using advanced hardening techniques.

Springs can be made of a chromium steel like 5160, but are also made of high silicon steels which are also oil hardening, but not the same. For a quick center punch, it is pretty safe to assume that a spring can be hardened in oil (small springs like garage door springs are frequently made from carbon steels, but the small sizes, ¼ inch and under, are such that oil will also harden them safely).

If you are making a center punch or some other tool only taking a little time, or if the product won't be heat treated, then junkyard steel can be fine. If the project is complicated or the product is critical, then it is best to use new steel and treat it according to the manufacturer's instructions

Online discussions of heat treating (an incomplete list):

Anvilfire: http://www.anvilfire.com/FAQs/ and go to 'heat treating'.

Wikipedia: http://en.wikipedia.org/wiki/Heat_treating there are lots of links to follow.

Carpenter Technology http://www.cartech.com/ go to Alloy techzone/general search/drill by alloy category. You'll have to register to get access to the datasheets.

Crucible Industries http://crucible.com/index.aspx go to Our Products/Tool Steel Selector, and explore from there.

Latrobe Specialty Metals, now a Carpenter subsidiary http://www.latrobesteel.com/ Go to Product Data Sheets and select the alloy desired. You can also download their entire library of data sheets as a 35 MB .zip file General discussion of heat treating: http://www.latrobesteel.com/assets/documents/datasheets/Bulletin_102.pdf

Timken http://www.timken.com/en-us/Pages/Home.aspx It used to be Timken/Latrobe Steel, but the two have apparently parted ways. They have a data book with extensive (152 pages) information on compositions of current and extinct SAE steels, hardenability, weight, and lots of other stuff. http://www.timken.com/en-us/Knowledge/engineers/handbook/Documents/Timken_Practical_Data_For_Metallurgists.pdf

Books (also an incomplete list):

Heat Treater's Guide: Practices and Procedures for Irons and Steels, by Harry Chandler, ASM International, 1995. This is said to be the authoritative reference, but since it is only small change under 300 bucks, I haven't seen it.**Modern Steels and Their Properties: Carbon Alloy and Steel Bar and Rods (Handbook 2757) Bethlehem Steel Co. various editions. All are now obviously out of print, but readily available through Amazon.**

Tool Steel Simplified, Frank R. Palmer and George V Luerssen, Carpenter Steel Company, Reading, PA. 1960 Out of print, but readily available through the used book market via Amazon. **Carpenter Matched Tool and Die Steels** is similar. A more recent edition was available from Carpenter, but seems no longer to be listed on their website. Previous editions are available through Amazon also, and may be more useful to blacksmiths since they contain data on water hardening steels that Carpenter no longer produces.

Heat Treatment, Selection, and Application of Tool Steels, 2nd Edition, William E. Bryson, Hanser Gardner Publications, Cincinnati, 2005. Heat treating information on many of the common tool steels, but rather repetitious in style.

Artist-Blacksmith's Association of North America

Training Fellowships Available at the Coubertin Foundation!

The American Friends of Coubertin have announced the availability of training fellowships for September 2015 -July 2016 in woodwork, metalwork, and stonework at the Coubertin Foundation outside Paris, France. Applicants should have at least 2 or 3 years post-apprenticeship work experience in their craft, be accomplished and seeking master skills. The deadline for applying is January 31, 2015, but we encourage early applications and correspondence indicating an intention to apply.
The Coubertin Foundation (www.coubertin.fr) is a registered public charity in France dedicated to the preservation and advancement of traditional crafts by combining education and production and has been in operation for more than 50 years. Training and experience for selected craftsmen is provided through the activities of Ateliers Saint-Jacques, which competes in the marketplace for historical restoration projects as well as new commissions from individuals and corporations, and thus provides trainees with a real working environment.

Curriculum

Fellowships last 11 months (from September to July). Fellows undertake to attend workshop sessions, classes, lectures and other cultural activities. Classes and lectures represent over 1000 hours over the course of the fellowship.
The program includes:
· work in the workshops
· professional training in their relevant trade (technology, drafting, workshop organization)
· classes in French language and general culture open to the modern world
· instruction in how to teach one's own craft
· free-hand drawing, history of architecture and styles
· modeling and casts
· perspective and proportions
· basics of management and accounting
· mathematics and mechanics of materials
· foreign languages (English, German)
· computer skills and CAD
· artistic heritage
· weekly lectures on cultural topics
· visits of monuments, museums, exhibits
· live performances (theater and music)

Material Conditions

Fellows receive room and board on-site at Coubertin. Their productive work in the workshops is paid, which ensures a minimum monthly income of € 500. All fellows without exception receive health and insurance and workers compensation coverage.

General Requirements

Fellows should be between the ages of 21 and 29, and have at least 3 years of professional experience, preferably as part of a workshop or firm, beyond their apprenticeship.
The fellowships are enabled through American Friends of Coubertin, a U.S. 501(c)(3) charitable organization based in Chicago.

The deadline for application is January 31, 2015.

Please consult our website for details and an application form at www.afcoubertin.org
For more information, please contact us at board@afcoubertin.org
Please publish this information in your newsletters and forward it to any interested persons or organizations.

Thank you.
The American Friends of Coubertin
www.afcoubertin.org

Educational Resources
http://abana.org/resources/index.shtml

Insurance Program
http://abana.org/resources/Shop-Insurance.shtml

ABANA By-Laws
http://abana.org/business/bylaws.shtml

Anvil's Ring
http://abana.org/publications/ar/index.shtml

Hammer's Blow
http://abana.org/publications/hb/index.shtml

Contact Us
http://abana.org/business/CentralOffice.shtml

Kirk Sullens, ABANA Member Services
Artist-Blacksmith's Association of North America

Future Balcones Forge Meetings

November 8, 2014: Buggy Barn Museum - Blanco, TX
(looking for volunteers 7th and 9th)

December 13, 2014 Jerry Whitley - Devine, TX

January 2015: Gary Hilton - Hunt, TX
February 2015- Lee Brothers @ Steep Hollow Forge - Bryan, TX
March 2015- Pioneer Museum - Fredericksburg, TX
April 2015- Bluebonnet - Marble Falls, TX
May 2015- Swing Music Fest - San Marcos, TX

Vincent Herod
Spotted Dog Forge
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Paige, TX 78659-4922