# Pfriem and Knife Workshop

# Outcome

1. A complete Pfriem and Knife by forging and grinding.
2. Knowledge of materials and consumables used
3. Safe use of a 2 x 72 Belt Grinder/Sander to shape and profile.
4. Introduction to basic Heat Treating and Tempering
5. Finishing
6. Sharpening

There will be a fair amount of Homework (which can be done in the Makersmiths facility). This workshop will require you to do work outside of the formal workshop for you to complete shape and polish your pfriem and knife.

# Assumptions

Basic knowledge of knife materials, parts, knife construction methods and ideally some experience.

No expected knowledge of Annealing, Normalizing, Hardening, or Tempering.

# Safety

Safety glasses or a face shield for eye protection – absolutely !

A Dust Mask to protect your lungs from inhaled dust – absolutely when grinding.

Gloves, heavier, for protecting your hands from abrasives and heat – optional, but the forge will be *really* hot.

Hearing protection – optional, but forging, and grinding can get a little loud.

# Pfriem

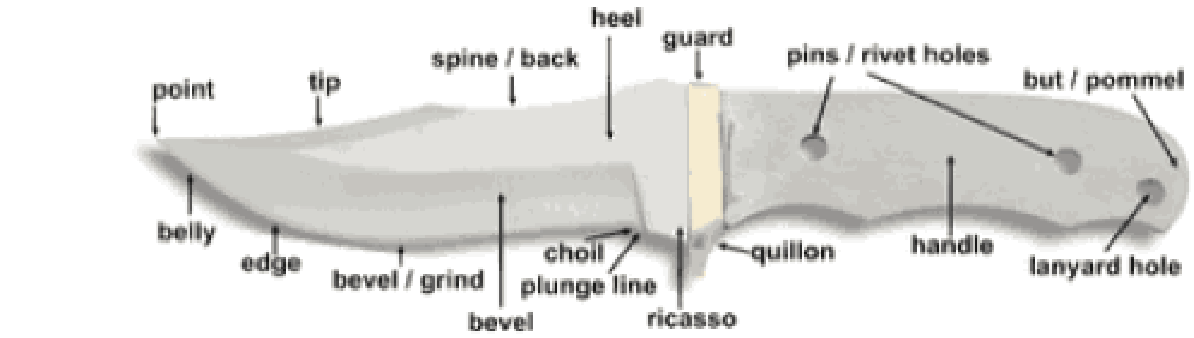
Before forks had 3 or 4 tines, they had 2.  Before that, they had 1.

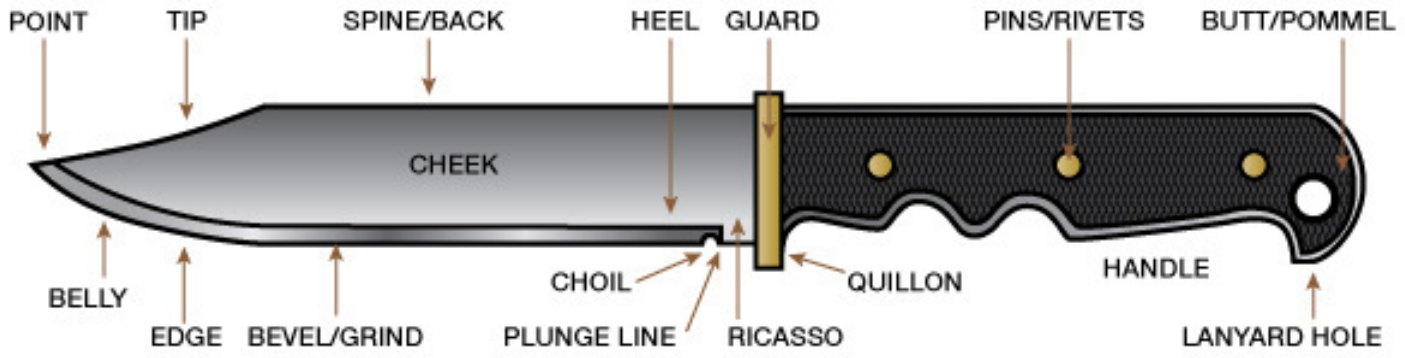
In this Intermediate Blacksmithing Workshop you will make a set of medieval fork and knife utensils, the Pfriem (freem) and Knife.

Starting with some high carbon steel square, you will forge both of the implements, finish grind to shape, normalize, harden, temper, and polish.  Skills investigated include upsetting, drawing out, twisting, bending, Normalizing, Hardening, Tempering, finishing.

(The amount of final polishing is left up to you.)

# Knife Parts



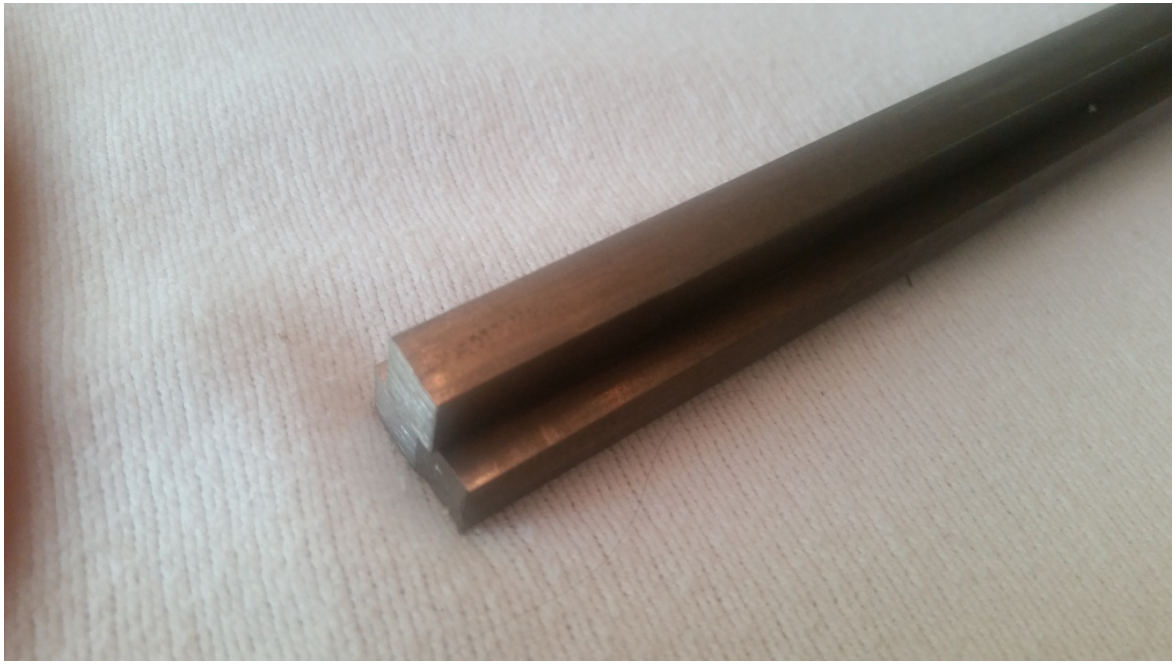




A Bolster is a fattened section of the blade between the blade and the handle

# Pfriem Parts

The handle and the ‘pointy end’.

# Blanks



Basic chunks of knife steel - 1085

# Belt Grinder

You could use files, stones, and sandpaper

A belt sander/grinder is much faster

Absolutely use Safety Glasses and a dust mask, Gloves are optional, but protect hands from abrasion and heat

Common sizes are 1 x 30 and 2 x 72

There are multiple grits of abrasive belt available

Smaller numbers are more coarse

Common Grits are 24, 32, 40, 80, 100, 120, 320, 400, 600, 800, 1000, 2000, 5000, 10,000

Used to shape the blade.

The belt cuts steel at a reasonable rate.

It cuts wood quite quickly.

***It cuts fingers and skin really fast.***

# Belt Grinder

Start with a coarse belt and work to finer grits.

24 grit for basic shaping and profiling

40, 80, and 120 grit for final shaping and smoothing. Cool (dip in water) regularly. Avoids changing the make up of the steel and burned fingers.

400 – 800 grit for final polishing (finer grits if you like)

# Abrasives

A brief word about Abrasives:

When using abrasive products on machines things will get hot (really hot ! )

With Coarser Grits, the heat tends to leave that material in the sparks and grindings

With Finer Grits, the heat tends to stay in the object

You will notice that things get hotter faster at 400 grit than they do at 40. It is easy to burn or overheat things with finer grits.

Dust:

The most common abrasive we use is Aluminum Oxide. It is hard, sharp and does a pretty good job. It is not good, but not particularly bad for you.

Another common abrasive is Silicon Carbide. It is really hard, really sharp, and grinds really fast. However, Silicon Carbide dust is **REALLY BAD** for your lungs. It will kill you. Absolutely wear a really good dust mask.

# Polishing

We use abrasives to polish surfaces

All abrasives remove material but leave a scratched surface

When the scratches get too small to see we say something is polished

You will spend more time with coarser abrasives

Use each grit until scratches from the previous grit are no longer visible

Depending on the material, shiny or reflective starts at about 800 to 1000 grit

Mirror polish is hard to do and will show every defect.  Avoid if possible.  But, if done right, it's beautiful.

If you are going for a shiny reflective surface, a random orbital sander is a recommended tool.

For final hand sanding, wrap the polishing paper around a slat (like a heavy duty paint stirrer) of wood with some leather glued to it.

You can buff with very fine rouge, machine polish, or diamond paste.

# Sharpening

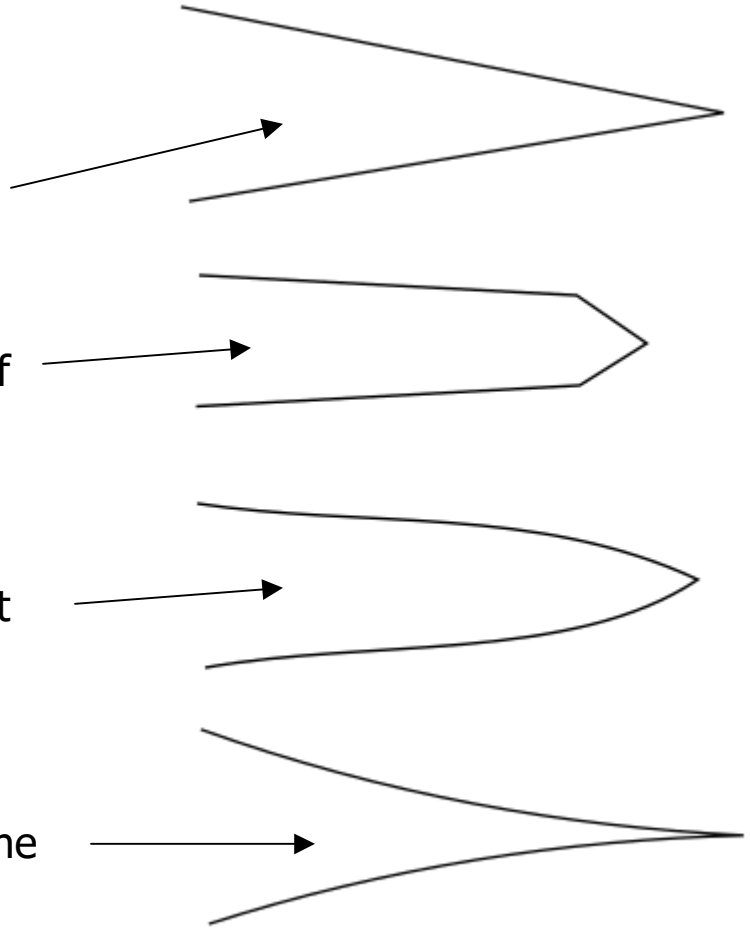
Different grinds on the sharp edge

Sharp but needs regular sharpening, wedges through the material

Chisel, does not cut as easily but lots of support for the edge.

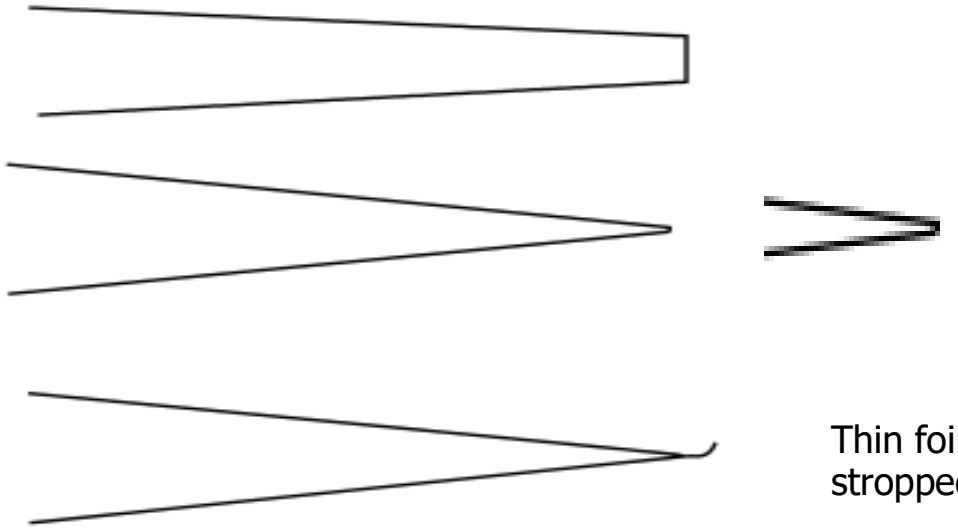
Compromise. A sharp edge and support for the edge

Cuts easily, but not much support for the edge.  Needs to be sharpened often.



# Sharpening

As you grind the edge gets thinner and thinner
At some point, the metal gets so thin you could refer to it as steel foil
The thin foil is not rigid enough to support itself, so it curls up creating what is called a burr.
This burr is stropped off (wiggled back and forth until it breaks) leaving a very thin sharp edge.  This edge can be polished.



# Hard vs. Annealed

Annealing, Normalizing, Hardening, and Tempering.

Carbon is the stuff in steel that makes it hard.

Need at least 0.40 % carbon for steel to be hardenable.

Hard steel is a particular molecular crystalline form of steel, which has many crystalline forms.

Steel that is allowed to cool slowly adopts the softest crystalline form. This is called the Annealed state.

It is easy to work and cut in this form, and thus, easy to shape (easy is a relative term.)

It is also very 'ductile', it can be bent without breaking.

It can be brought to a sharp edge, but because it is soft(ish) it will not hold or keep that sharp edge very long. It would need constant sharpening.

As steel is heated, it changes its molecular crystalline structure.

Some of these crystalline forms are very hard.

Hardness is measured in Rockwell Numbers. Bigger numbers are harder (and more brittle)

# Normalizing

Normalizing is used to relieve any ‘stresses’ that may be present in the steel.

Especially if the steel has been forged, there may be stretched portions under tension that would like to snap back to their original shape – resulting in a curve or bend in your knife.

By heating and allowing the knife to cool slowly in still air for a few cycles, these stresses, to a great extent, can relax.  Warps and bends can be worked out between normalizing cycles.  (It’s not a guarantee that your knife will not pick up a bend or warp when quenched, but it makes it less likely.)

Usually not a problem with stock removal, but you never know how the steel may have been treated before the blank billet comes to you.

# Hard vs. Annealed

If you heat steel up to a particular 'critical' temperature, it will adopt one of these very hard crystalline structures.

It's hard to think about it this way, but hot steel is a solution – like a very hot, very thick liquid.

So, your steel is at this critical temperature, and has adopted the very desirable hard crystalline structure you want.

But, if you let it just cool down slowly from that point, the crystalline structure will slowly change back to the soft annealed state.

So, how to keep the steel in its hard form?

We want to freeze it in that form.

To do that, we quench the steel – cool it very fast so that it does not have the chance to change back to the annealed state.

We how have hardened steel.

# Hardening

To harden your knife, you will bring the temperature up to the steel critical point in the forge, let it 'soak' in the heat for a little bit, and then quench the steel.

We will quench in oil or water – depending on the steel in use. (Just as an aside, there are also 'air' quenched steels – you just let the steel cool in still air.)

We have both Parks 50 and regular Canola quench oil.

When quenching, keep the blade moving, you don't want a blanket of steam or smoke (vaporized oil) to form a protective blanket around the steel.

The vapor (smoke) from oil quenching may burst into flame above the surface of the oil. It will go out as everything cools. If you remove your knife from the oil too soon it will still be hot enough to burst into flame and burn off any oil on the surface.

(There are 'partial' quenching techniques – beyond the scope of this workshop.)

# Hardening

Generally, you want to get you knife up to hardening temperature

This will vary, but is going to be somewhere around 1500 degrees F

This is a good solid red hot – avoid getting it too hot (orange/yellow – quenching too hot can cause internal cracks)

Quench until the temperature is below 450 degrees, but above 250

(If the oil bursts into flame when the knife is withdrawn, it's still above 450.)

Between 250 and 450 degrees, if you get a warp, you can clamp between flats (like 2 big pieces of angle iron) to straighten. Won't help if the knife temperature falls below 250 – so quench long enough but not too long.

# Tempering

Now…..

Your hardened steel is ‘very’ brittle.

If you drop it, it will likely shatter like glass.

If you stress it, like trying to pry something, it will easily break.

To solve this problem, you will ‘Temper’ the steel.

Place your steel in an oven at a relatively low temperature, on the order of 400 to 500 degrees and allow it to soak at that temperature for a few hours (temperatures and times will be provided).

This ‘draws back’ the hardness.

It allows the steel to keep most of its hard characteristics and at the same time regain some ductile properties – it will bend without breaking.

This gives the ideal qualities for a knife.

Strong, durable, and will hold a sharp edge for a long time.

# Finishing

Your knife will likely be covered in a black scale that you may want to remove.  Or not.

The steel will be quite hard at this point, so any significant shaping will require a lot of effort, and, if the steel gets hot, the hardness may be lost.

Remove the scale if desired from the blade and handle.

Polish your implements to the degree you desire.

Sharpen the edge of your knife.

# Steps

- Select a couple (2) steel blanks.
- Heat the end of a blank, clamp it in the leg vise, and upset the end.
- Forge the upset to a nice tapered shape
- Heat the blank and upset end for about half its length.
- Quench just the very end of the upset, place it in the leg vise, and twist the handle.  About 2 full twists, but as much or little as you desire.
- Quench the twisted end and heat the other half.
- Draw out the point of the Pfriem, square first, then octagon, then round.
- Repeat the upset and twist for the knife blank
- Forge out the knife blade (it will likely be rectangular-ish and ugly – you will fix this by grinding it to final shape)
- When you are happy with your knife profile and blade shape, Normalize and then harden your implements.
- After hardening, temper your implements.
- Grind and shape your knife and pfriem using successively finer grits.
- Remove scale as desired and sand your knife and pfriem to about 120 or 220 grit
- Polish to your desired level of finish.

# Other Tips

Save final sharpening for last.

When grinding steel, go easy and cool the steel very often.
High heat can change the crystal structure of your steel and, if you get it too hot after hardening, can anneal or soften the steel. (That straw, blue, or turquoise color you see on your blade would be a tempering oxide – you blade has been softened with you see that.)

Wood sands faster than metal

Link to 2 x 72 grinder video
https://www.youtube.com/watch?v=AV56w-p8QfY

# Materials

Woodcraft – has a small supply of knife blanks and pin materials.

Jantz Supply – full line of supplies

Alpha Knife Supply – full line of materials

New Jersey Knife Barron – knife steels

Texas Knifemakers Supply – full line of supplies

Smokey Mountain Knife Works – blanks and complete knives

Pops Knife Supplies - full line of supplies

Speedy Metals – tool steels

Tru-Grit – grinding belts

Combat Abrasives – grinding belts

Many others

# Other Workshops

Knife 101 – starting with preformed and beveled blank.  Attaching, scales, shaping, and finishing.

Knife 302 – starting with a *chunk* of knife steel, Forging, grinding, hardening, tempering, scales, shaping and finishing

Sheath – Making a leather sheath for your knife