Knife 301 Workshop

Outcome

1. A complete knife via Forging (mostly)
2. Knowledge of materials and consumables used
3. Safe use of a Forge, small Belt Sander, and a 2 x 72 Belt Grinder/Sander to shape, profile and polish.
4. Introduction to basic Heat Treating and Tempering
5. Scales and Finishing
6. Sharpening

There will be a fair amount of Homework (which can be done in the Makersmiths facility). This is due to the limited number of some tools. This workshop will require you to do work outside of the workshop time for you to complete your knife. We will meet a second time for Scales and to review and finish the project.

Assumptions

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

No expected knowledge of Forging

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

Safety

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

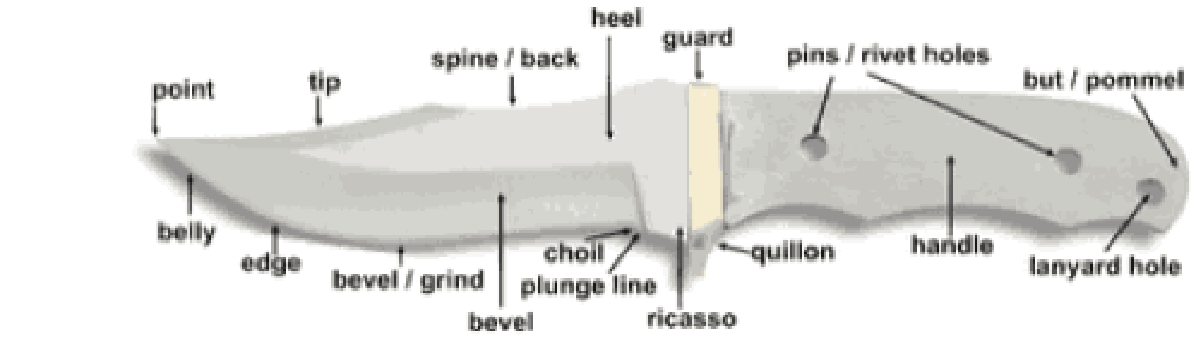
A Dust Mask to protect your lungs from inhaled dust – absolutely !

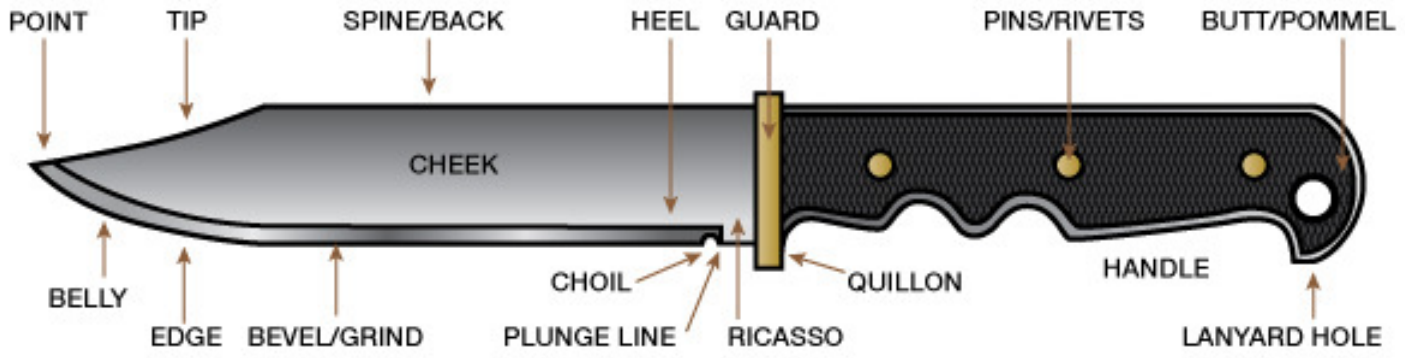
Gloves, heavier, for protecting your hands from abrasives and heat – recommended as the forge will be *really* hot.

Gloves, latex or nitrile, for protecting your hands from epoxy – optional, but recommended.

Hearing protection – optional, but the forging/grinding/sanding can get a little loud.

Knife Parts





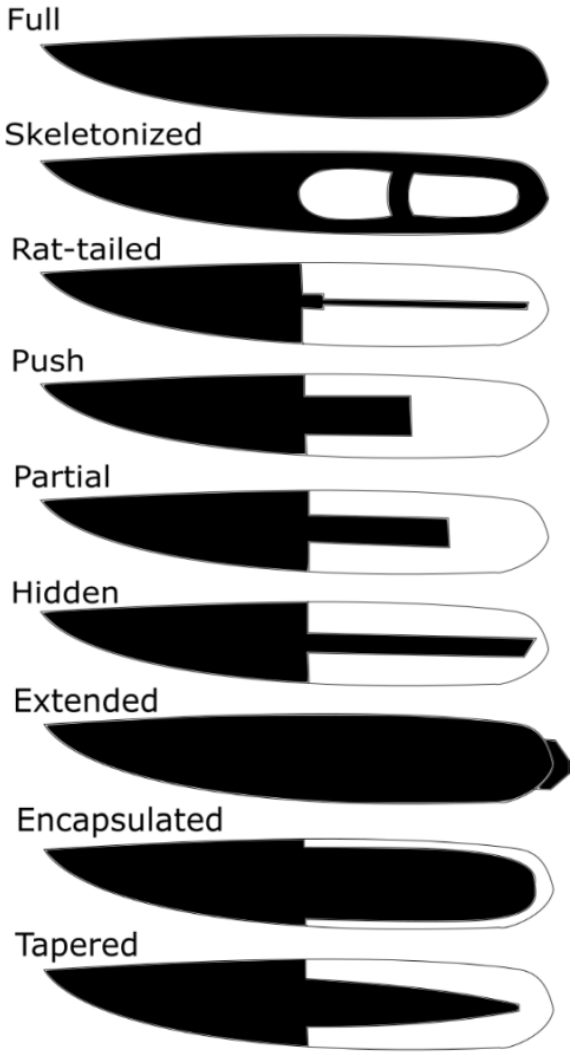
A Bolster is a fattened section of the blade between the blade and the handle

Tang

Handle is also called the Tang

It can have many different forms

The back, or spine of the knife can have decorative 'back work'

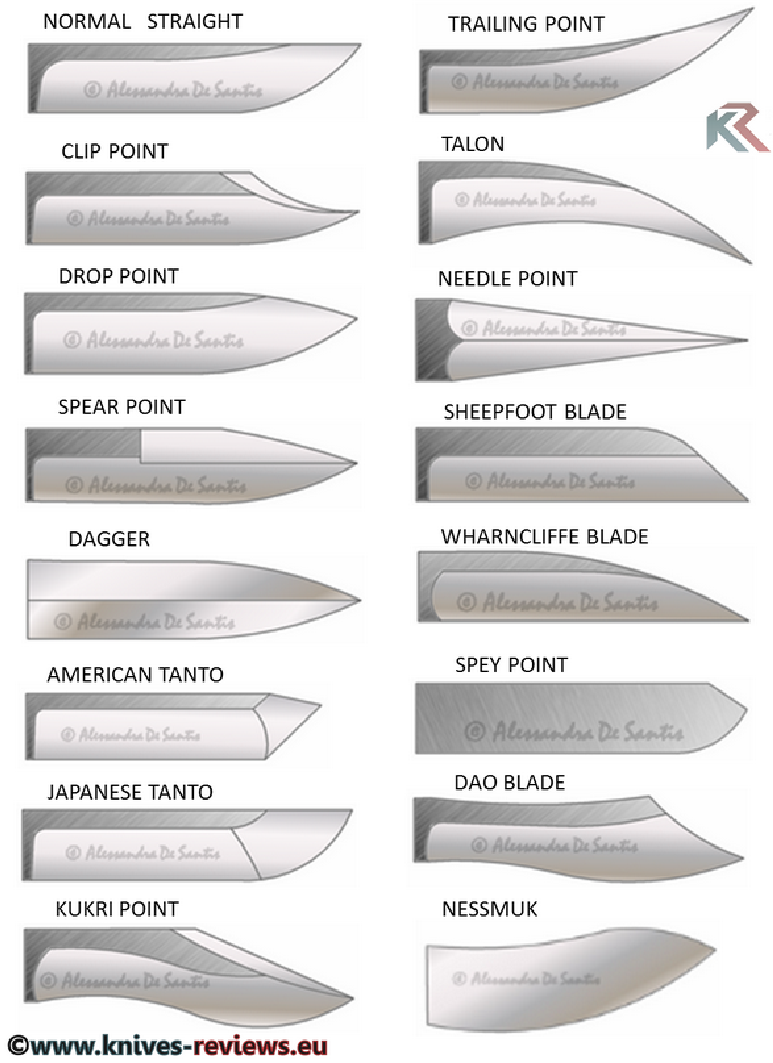


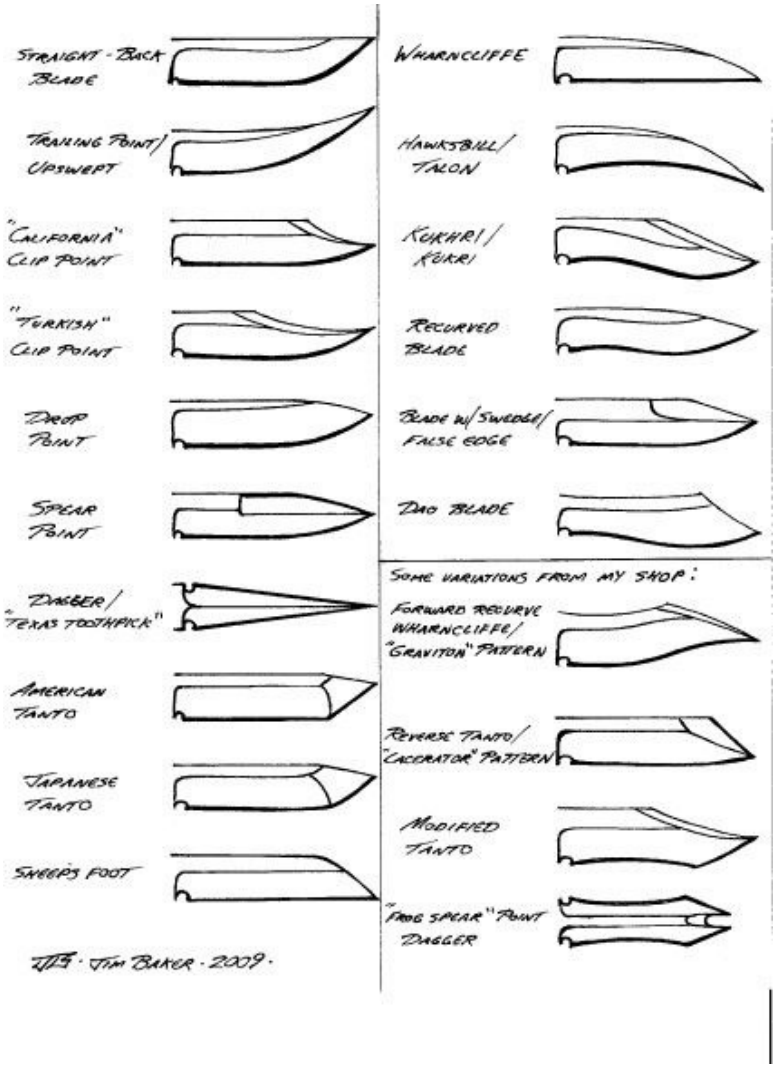
Knife Styles

There are lots of recognized styles, and many many more unique, fantasy, exotic, and original styles. Anything you can imagine.

And, there are different interpretations of the styles.

Knife Styles





Knife Blank

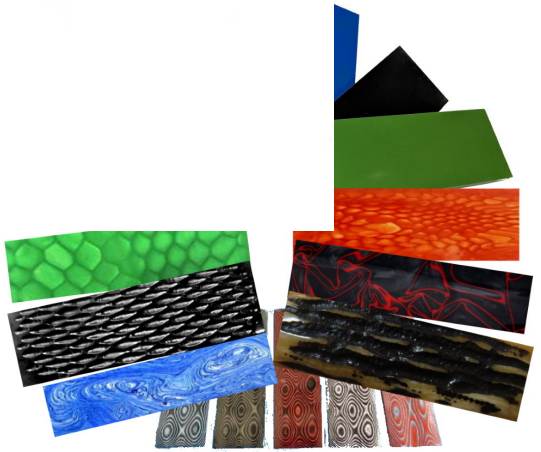
Basic blank of Knife Steel

Scales

Scales are the pieces of material used to fatten up the handle to make the knife easier to hold and wield.

Available in natural and man made materials.

May also use wrappings or stacks of various materials.



Guard & Pommel

A Guard is a device to protect your hand from sliding onto the live edge of the blade. Can be simple or elaborate.

A Pommel can be an attached piece to the back end of the knife to help attach scales, for decoration, or as an additional tool.

Pins

Help to attach the scales to the handle. (Used to be they were all that held on the scales. Put through and then the ends fattened. These days we have modern epoxies that hold better. Pins are now mostly decorative.)

Can be plain metal (commonly brass), Chicago screws, or fancy (mosaic pins).

You can also make your own.

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 and the Scales.

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.

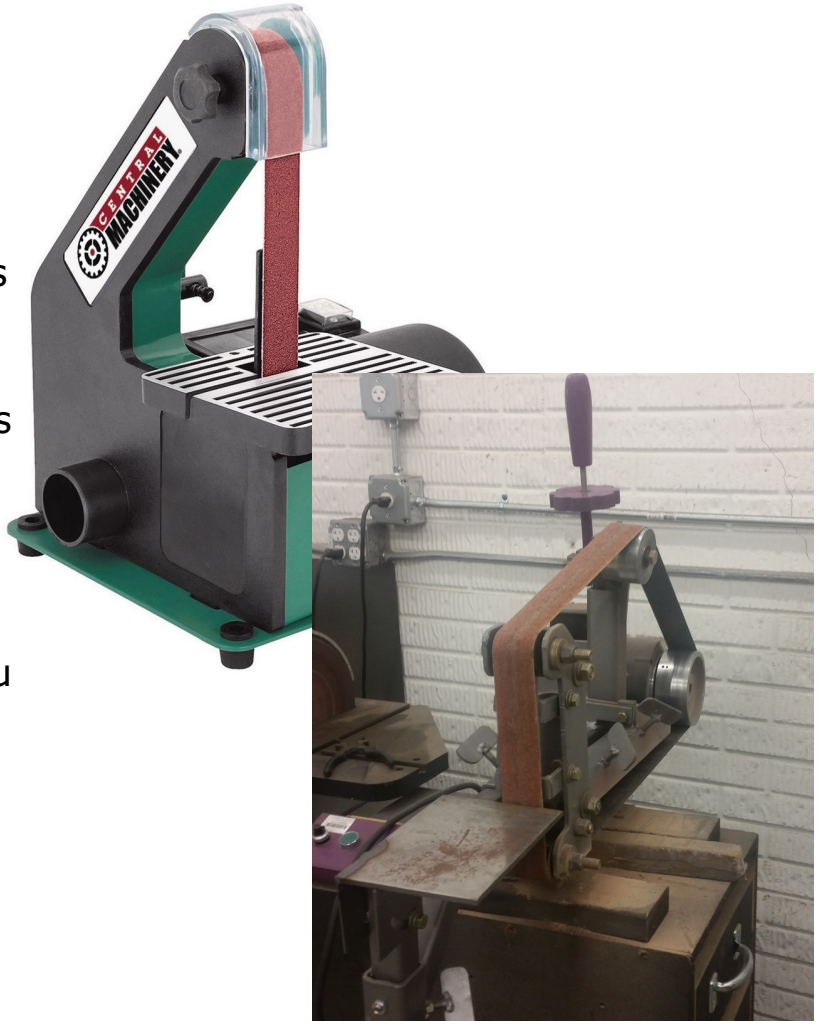
80 and 120 grit for shaping and smoothing scales

Steel sands more slowly than wood. Be careful not to sand away too much wood next to the steel, and be careful about getting the steel too hot once scales are installed.

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

Be careful around polished metal parts to avoid scratching them.

Use 220 sandpaper by hand for final finishing.



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 the wood 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.

Drilling Scales

Use can your knife blank as a guide for drilling holes.

Use a brad point drill and a block under the scale to keep the drill from ‘tearing out’ wood as the drill goes through.

Put both scales together the way they will fit on the handle

Use clamps

The last thing you want to happen is for your blade to get stuck on the drill bit and become a high speed food processor !

Epoxy

Used to attach the Scales to the Handle.

It is a really strong glue

Does most of the structural work.

Can be colored.

2 parts

Mix 1 to 1 (usually, the same amount of each by volume)

Squeeze out equal parts, about quarter sized, onto cardboard, mix for 1 minute with a tongue depressor.

Apply to *cleaned* tang/handle and scales.

Assemble and use clamps to hold everything in place.

Sets in 5 minutes – so, be ready.

Epoxy is a chemical reaction. It does not dry, it cures.

(Most folks have no allergic reaction to epoxy. But, you can develop a sensitivity to it over time. Be safe, use gloves. Besides, epoxy is thick and sticky and hard to get off your fingers.)

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

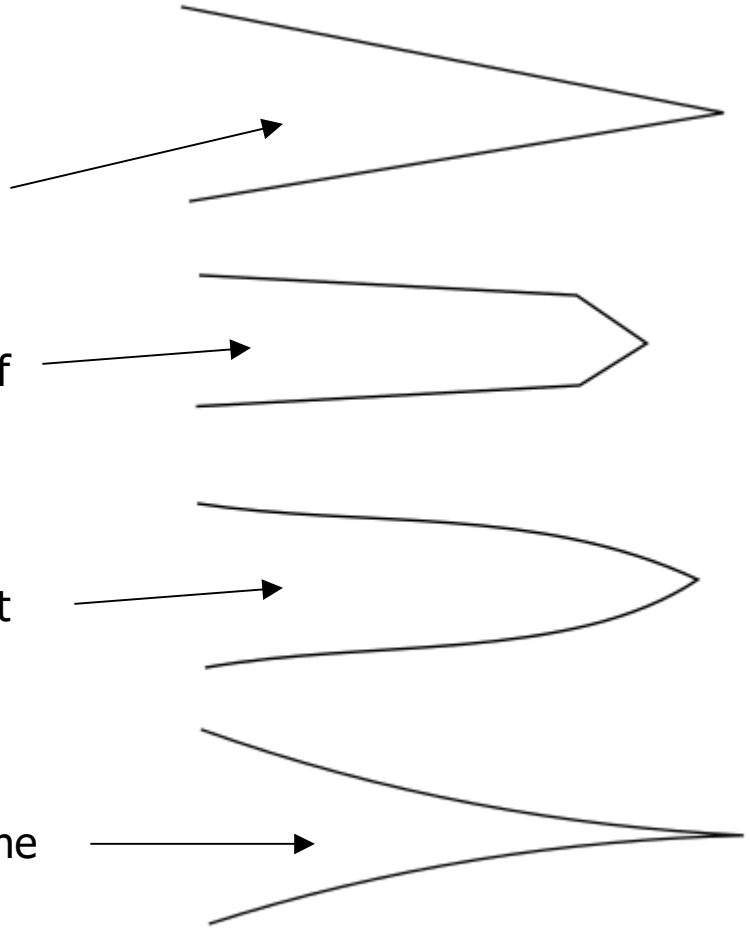
Different grinds on the sharp edge

Sharp but needs regular sharpening, wedges through the material

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

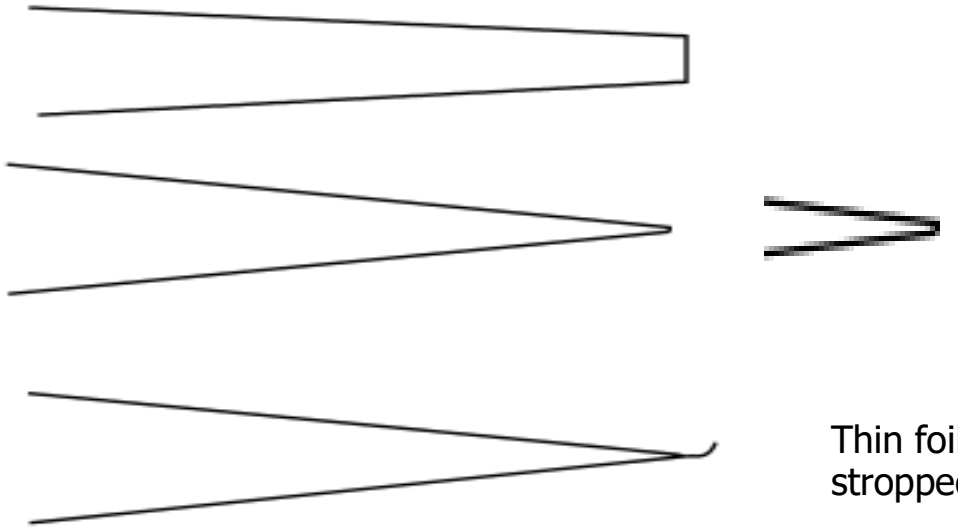
Compromise. A sharp edge and support for the edge

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 since the steel has been forged, there are likely to 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. (It’s not a guarantee that your knife will not pick up a bend or warp when quenched, but it makes it less likely.)

You will want to run 2 or 3 normalizing cycles – red hot, air cooled in still air to the point where you can handle it with your bare hand.

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

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

But, not below about 250 degrees.

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, or straighten it if it has a twist or warp, it will easily break.

If you do pick up a warp, depending on how much, you may be able to clamp the steel between straight edges when tempering, or you may have to take another heat and forge it back to straight. Normalize, and try your heat treat again.

To solve the hardness 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.

Scales & Finishing

Your knife will likely be covered in a black scale that you will need to remove.

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 from the blade and tang.

Do any final shaping, profiling, or beveling.

Attach scales and shape them to your liking.

Apply finish to the scales.

Polish your blade to the degree you desire.

Sharpen the edge of your blade.

Steps

Steps

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Steps

- Decide on the shape of your knife. Make a sketch.
- Transfer measurements to the anvil.
- Place your steel in the forge and heat to orange hot
- You always want to be working the steel towards the final shape you want
- Forge your steel to the general, but pretty close to, your final shape
- Work the steel while it has color. When it loses color, go back for another heat.
- Drill holes for pins in your knife tang. (Be sure you do this *before* hardening)
- If you want back-work, now is the time to rough it in (can be done after hardening).
- If you want a makers-mark, now is the time to stamp/carve/whatever it.
- Thread the end of your tang if you plan on a screw on pommel.
- When you are happy with your knife profile, bevels, and blade shape;
- Normalize and then Harden your blank.
- After hardening, temper your blank.

Steps

- Using a belt sander (and hand tools if you desire) shape your blade and smooth your bevels.
- Be careful of the plunge line and ricasso. Blade should be the same on both sides.
- Allow a shoulder for your guard to sit on if needed.
- Make accommodation for pommel to attach if needed.
- Be VERY careful to avoid overheating your blade. The steel will be quite hard and will grind very slowly. Cool often. It can be helpful to not wear a glove while grinding – when you start to feel any heat, cool in water. If you overheat your blade at this point it will soften the metal to the point where the finished blade will not hold an edge.
- Complete any back-work.
- Create a guard and pommel of suitable material if you desire.
- Fit your guard, scales, and pommel (pommel may be optional) to the handle/tang, adjust as necessary.

Steps

- Clean the knife handle/tang with Acetone.
- Mix your epoxy and apply.
- Glue on your guard, scales and optional pommel.
- Clamp and let epoxy cure.
- Use a belt sander to shape and start to smooth the scales. Start with 40 grit, to remove the bulk of the material and start your shaping. 80 grit to refine the shape, and 120 grit to smooth everything out.
- Use hand sandpaper to smooth your scales and prepare for finish.
- Remove tape.
- Use progressively finer abrasives to polish your blade and scales to your desired level.
- Finish Scales with your choice of finish.
- Sharpen.

Other Tips

Save final sharpening for last.
If your forged blade is not the perfect shape you desire, you can visit a grinder and shape it. When you are happy you can then normalize and temper. The point of this workshop however is to forge a blade, so try to do as much as possible at the anvil. There is evidence that forging refines the grain of the steel and results in a better final result.
When grinding steel, go easy and cool the blade 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.)
High heat is the enemy of epoxy and can cause the glue to fail.
Wood sands faster than metal
Link to 2 x 72 grinder video
https://www.youtube.com/watch?v=AV56w-p8QfY

Materials

Woodcraft Leesburg – 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, other metals for guards, decoration, etc.

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 201 – starting with a cut out blank of knife steel. Grinding, shaping, hardening, scales, finishing

Sheath – Making a leather sheath for your knife