Safety, Ergonomics, and Shop Layout

By Dan Nauman and the Educational Programs Committee

Please note: The Educational Programs Committee wishes readers to utilize the *Hammer's Blow* as an open dialogue to share your experiences, ideas and results from these lessons and suggestions. We need your input, positive and otherwise, for the program to progress and excel. We have already received several favorable comments, and wish to thank those people who have contacted us. On another note, we have changed the name of the program from "Forging Fundamentals" to "Controlled Hand Forging," as the latter more accurately defines the nature of these lessons. This change was made in part from observations from the membership.

Before one ventures into hot forging, it is important to consider safety, shop layout, and use of tools. We offer these thoughts as suggestions, and do not claim that all rules pertain to all people, as people come in all shapes, sizes, and with varying opinions. We are offering these ideas from experiences, as well as common sense. They are a place to begin.

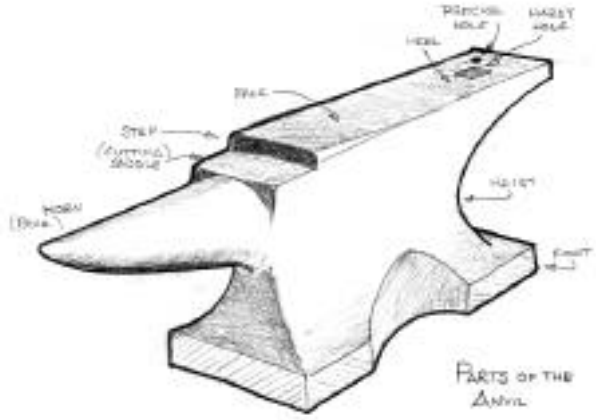
We begin with safety. Protective measures should be taken to prevent burns. Your clothing should not be synthetic, and this includes your shoes. Most synthetics catch fire easily, and often melt right on the skin causing an even worse burn. Preferably, wear heavy-weave cotton or wool clothing, and leather work boots. Do not have cuffs in your pants, as they can catch hot coals. Your pants should cover the top of your boots to prevent coals or molten flux from entering. Some smiths prefer to wear a leather apron to prevent sparks and molten flux from burning their clothes.

Burns will occur. Be knowledgeable as to what first-aid remedies are best for first, second and third degree burns. Have a fire extinguisher, and an OSHA-approved burn kit readily accessible in the work area.

Eye protection is highly recommended. Choose impact resistant lenses with side shields. Many smiths prefer a tinted lens to cut down on glare from the fire. Some safety eye shields cut the ultraviolet rays that are particularly intense from gas and propane forges. Use shields when doing both hot and cold work. You are blessed with only two eyes. Protect both of them.

Ear protection will cut the noise of the anvil's ring to tolerable levels. If you own a power hammer, or any motorized power tool, ear protection will help avoid hearing loss when using these tools as well. Ear plugs and ear muffs are both acceptable.

Preventative measures can also be taken to avoid wear and tear on the body. If you want to be forging well into your later years, work smart. Think about forging as athletic activity. It is wise to stretch and warm up before work, keep loose during work, and cool down after a long forging session. Working smart includes how your shop is set up. *Editor's note: See "Preventing Wrist Injuries,"* The Hammer's Blow, *Vol 9 #2, Spring 2001 for some good wrist stretches and warm-up exercises.*



The parts of the anvil

We will begin the lessons with the five basic tools: the anvil, forge, vise, hammer, and slack tub. Some words of caution to the beginner when collecting tools for your shop: The number of tools for forging can be overwhelming. Do not be overzealous when acquiring or making your tools. Make sure you understand the function and facets of any tool beforehand. Acquire the tools as you need them rather than purchasing and making tools at random. Also, understanding what makes a tool efficient and effective is important before acquisition. Good tools used for the right application make the job easier, and will be reflected in the end product. This may sound obvious; however, far too many individuals use inferior or simply the wrong tool for the job. This is not only unwise, but can be dangerous.

We will be discussing the English pattern anvil in this section. If possible, before you acquire an anvil, it would be wise to learn how to inspect an anvil from an experienced smith. You should be particular about its condition as it is one of your main tools. Consider the following aspects when acquiring an anvil.

The size and weight of an anvil is largely a personal choice. Ideally, the anvil face (main working surface) should be flat, with few nicks, dents and chips. Put a straight edge over the entire length of the anvil to check for a "belly" (depression) in both axes of the face. Forging a bar on a face with a belly will cause the bar to bend radically. Any nicks, cracks, chips, or other imperfections on the working surfaces will be mirrored in the metal worked on those surfaces. The edges of the face should be uniform, and again, with few dents, nicks or chips. The edges of the face should have a radius of about 3/8" from the horn end and decrease to approximately a 1/64" radius at the opposing end, on both sides of the face. Although it is ideal to own an anvil as explained here, an anvil which has obvious wear can still be used and work well in many instances.

The horn (also known as a bick) should be free of dents, nicks,

and chips. The horn, unlike the face, is of a soft material. Check the entire anvil for hairline cracks. Usually, a good anvil will have a resilient "ring" when hit by a hammer. The hammer should seem to leap off the anvil when bounced on the face. The anvil face should have a round hole (pritchel hole) and a square hole (hardy hole) and both should be free of chips, dents and other obvious wear.

The "table" of the anvil (the surface between the horn and the face) should not have any blemishes. The use of this surface is widely debated. It is to some smiths a cutting surface. This is not a good use for this or any surface of the anvil, as once it is blemished by cuts from the cutting tools, it is worthless, as it will mirror these blemishes in the work piece. If you wish to cut a bar on the anvil, use a small piece of copper, brass, or even mild steel to protect the face of the anvil. The table is most often slightly crowned (convex). For this reason, many smiths believe it was intended as a surface to straighten bars.

Many smiths will tell you that the correct height for your anvil is knuckle high when standing erect. An anvil that is too low can tire you out and may cause back problems. Many smiths work at an anvil which is about at thumb knuckle height, or about two inches above knuckle height. The point is to work at a height that is comfortable after hours of work, but still allows a full stroke of the hammer. Some advanced smiths have several anvils at differing heights for more specific work.

The anvil should be placed on a solid and secure base. Some anvil bases are buried as much as three feet into the ground. If the anvil base is not buried or anchored to the floor, make sure the anvil does not rock, slide or pitch. The horn is most often faced to the left, but that is more personal preference. Some right-handed smiths prefer the horn on the right, keeping the hardy to their left.

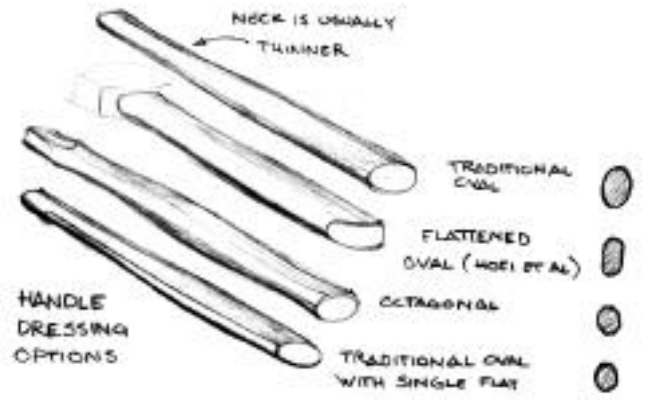
One word about the hardy, which is a tool used for cutting and fits in the square hole on the anvil face. When you are finished using the hardy, remove it at once. A smith can cut or sever fingers from accidentally bringing the hammer hand down upon the hardy while performing another forging operation on the anvil.

We will be discussing the cross peen hammer for these lessons, which has a peen perpendicular to the hammer handle. The act of forging can lead to many ailments, but an overly heavy hammer will do more damage sooner. Force = mass x velocity. A light hammer with a long handle can provide all the needed force one needs to forge. The added bonus is continued accuracy. A hammer that is too heavy can tire one out rapidly, thus making blows erratic. Ultimately, the weight is a matter of preference. A hammer which can comfortably be used all day is best for you. Likely, this will be 1.8 pounds to 2.25 pounds. Advanced smiths have a range of hammers with various weights for various work. Not all work requires the same weight hammer. Ailments from too heavy a hammer include carpal tunnel syndrome, tendonitus in the wrist, elbow and shoulder, damaged cartilage, and torn ligaments.

Gripping the hammer properly is also important. Although there are several ways to grip a hammer, it is widely accepted that placing one's thumb on top, or in line with the hammer handle, can lead to injury of the thumb and wrist joints. Wrapping the thumb around the handle is considered to be a better method of holding the hammer. Some smiths prefer to hold the thumb at a slight angle (about 10:00 to 11:00), with a somewhat relaxed grip. This is still better than straight up at 12:00. The proper grip can help avoid the above-mentioned ailments.

Some smiths prefer a short handle on their hammer. While we do not condemn this practice, we must note that to achieve a heavier blow, either a heavier hammer head or heavier blows must be used with this shorter handle. Plus, when working larger bars, the hand is more susceptible to the intense heat radiating from the bar. A longer handle when held at the end will provide more velocity, thus more impact. One rule of thumb suggests that a proper handle length for you is to outstretch your hand with the elbow at 90 degrees. Balance the hammer head at the end of your fingers. The handle length should equal the distance from the bottom of the hammer head to the inside of your elbow.

The handle can be customized to fit your hand by rasping. Many smiths like a handle pared down so that when gripped, their two middle fingers just touch the fat part of their thumb. Some smiths trim down the first 3"-4" beneath the hammer head to provide some flex to the handle, which absorbs some shock from the impact.



Different handle shapes and dressing options

The shape of the cross peen hammer head is most often square or octagonal and has a flat face with all edges radiused. The peen should be flat at least 3/8" to 1/2" wide with its edges radiused. A sharp peen does not spread metal as well, and produces deep impressions which can be difficult to remove. New hammers almost always have sharp cross peens and sharp edges around the face, and consequently require dressing (reshaping). *See Dressing a Hammer,* The Hammer's Blow, *Vol 8#3, Summer 2000 for more information about hammer dressing- Editor*

The forge used by many advanced smiths is a coal forge, with a

fire pot at least three to four inches deep. A deep firepot produces a better fire for most applications. The fire pot should have a device to break the clinker (the hard mass that collects at the bottom of the coal fire) as well as an ash dump. That being said, fine work can come from forges that many advanced smiths find inferior. The forge, after all, is simply the way the metal gets hot as efficiently as possible. It does not shape the material. Thus, do not be stymied if your forge does not meet the above specifics. You will come to understand why certain tools are better for specific work. As often is the case when starting out, the best tools may not be readily available. As you grow as a smith, you will make or purchase the best tools for your applications.

The height of the forge should be what is comfortable for you. Adjust the height of the forge to avoid stooping. Simply modifying the legs of the forge will create the perfect forge height for you.

The air blast provided to the forge may be a double-lung bellows (single-lung bellows can suck hot coals inside and cause a fire), a hand crank blower or an electric blower. All devices should be made for the job of blowing air into the firepot. The blast may be regulated by an adjustable air gate or by a rheostat for electric blowers. Whatever the device, the blast should be controllable while tending the fire.

There should be enough space on the forge hearth to conveniently hold a few tools for the task at hand. Do not clutter the forge hearth with tools. Another surface to hold additional tools should be near the anvil.

The forge should be outfitted with a chimney to properly vent smoke, fumes and ash. Improper ventilation of carbon monoxide, smoke, ash and soot can cause chronic health problems, even death. Exhaust must be removed from the room completely.

Fluxes of any kind can be a health hazard when used incorrectly. Many fluxes contain materials like borax, and silica, which when inhaled repeatedly can cause chronic health problems. Use fluxes in well-ventilated areas. To prevent inhaling the flux, wear a suitable protective breathing mask. The fumes of flux can also be noxious, so make sure your ventilation system is functioning properly. A breathing mask by itself may not be enough to eliminate harmful fumes.

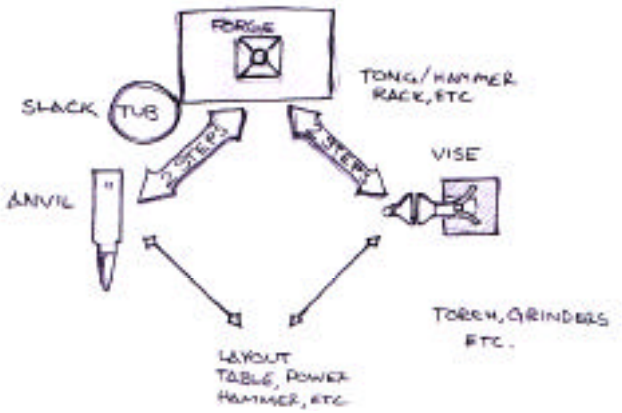
The vise should be a leg vise, otherwise known as a post vise. These vises are made to withstand the impact of the smith's blows. Machinist's vises are often cast iron, and will crack or even shatter upon impact. The vise should be mounted on a solid, well-anchored post of wood or steel. The height of the vise is often the same height as a workbench (about 35" to 38"), but a second vise at a higher height is better suited for filing. Another rule of thumb used by some for bench work is placing the jaw at elbow height. Recommended vise jaw width is five inches and larger.

Leg vises were made for many various trades in many sizes. Vises with jaws under 5" in width were not made for forging. These smaller vises can be damaged from heavy pounding or overtightening. These smaller leg vises may be used for filing, repoussé, and other light work.

The position of the anvil to the forge is generally at a 90 to 180 degree angle from the forge, and about 1 to 2 steps away from the forge. The vise can be at 90 to 180 degrees from the forge, and also 1 to 2 steps away from the forge. The slack tub should be in close proximity to the station, and convenient to quenching hot bars of iron. It should be large enough to quench a bar for safe handling. It should be of non-flammable material (wet wood included). Old whiskey barrels or 30 to 55 gallon drums work well. Clean water quenches better than dirty water.

A glove can be helpful when performing close work, such as chiseling or chasing, on hot bars. However, a glove can be a hindrance when manipulating tongs or the hammer. A glove can be a false sense of security as well. A more severe burn can occur from a burning glove, or from picking up a hot bar with a wet glove.

Stand almost erect when forging at the anvil. If your hat falls off you're stooping too far over the anvil. This might mean that your anvil is too low. Stooping will also lead to a bad back. It also puts your head in the way of a rebounding hammer from the anvil after a missed blow. Keep a comfortable close distance from the anvil. Swing your hammer down, not out. A full hammer swing begins at or above the head and involves the hand, elbow and shoulder uncoiling as a whip. Heavy forging may involve the waist, hips, knees and ankles. Lighter blows start out lower, and require less of the anatomy. Avoid unnatural stances, grips, and approaches. If it feels uncomfortable, rethink what it is you are doing. Most of all, relax.



A possible shop layout

Other tools can be stored outside of the work area, but have them in close proximity so you are not continuously walking across the shop to retrieve them. A cluttered shop is a dangerous shop. Keep unused tools in their place. Place hot bars in a protected place to cool; under or on top of the forge hearth, but not in the open work space. Bar cut-offs should be picked up, especially round bars which can cause an easy fall to the floor. The

anvil is not a table, and should only hold tools used for the work at hand.

Light levels in the shop should be bright enough to perform all facets of the trade whether it be hot forging or cold work. Eye strain from too much or not enough light can cause drowsiness and headaches. It can be unsafe to have a poorly lit shop. Bear in mind that too much light can inhibit one from seeing the color of the metal, which is the smith's way of judging the metal's temperature. Having a vise or workbench at a window can make use of natural light. Brighter light can be switched on at the workbench for close work such as filing, chasing or repoussé.

Although we may not cover the use of gas or propane forges and acetylene torches in the immediate text, they deserve mention in shop safety. These devices can be the most dangerous pieces of equipment in the shop. All fittings should be tested for gas leaks with soapy water. Check valves should be on torch fittings to prevent back-flashes. All gauges should be in proper working order. Check hoses and joints for leaks often, and replace worn hoses. When closing your shop for the night, get in the habit of checking to make sure these devices are shut down whether you used them or not. Similarly, spread the coal fire and make sure it is out before leaving the shop for the night.

Heeding these suggestions can make your forging efficient, less dangerous, and more enjoyable. In the long run, they may provide you with less wear and tear on your body. It is our intent to continually provide you with more suggestions as the lessons progress. With this information, you are ready for lesson #1, which will appear in the next issue.