Creative Metal Forming

Betty Helen Longhi & Cynthia Eid

BRYNMORGEN PRESS

ISBN 978-1-929565-49-8

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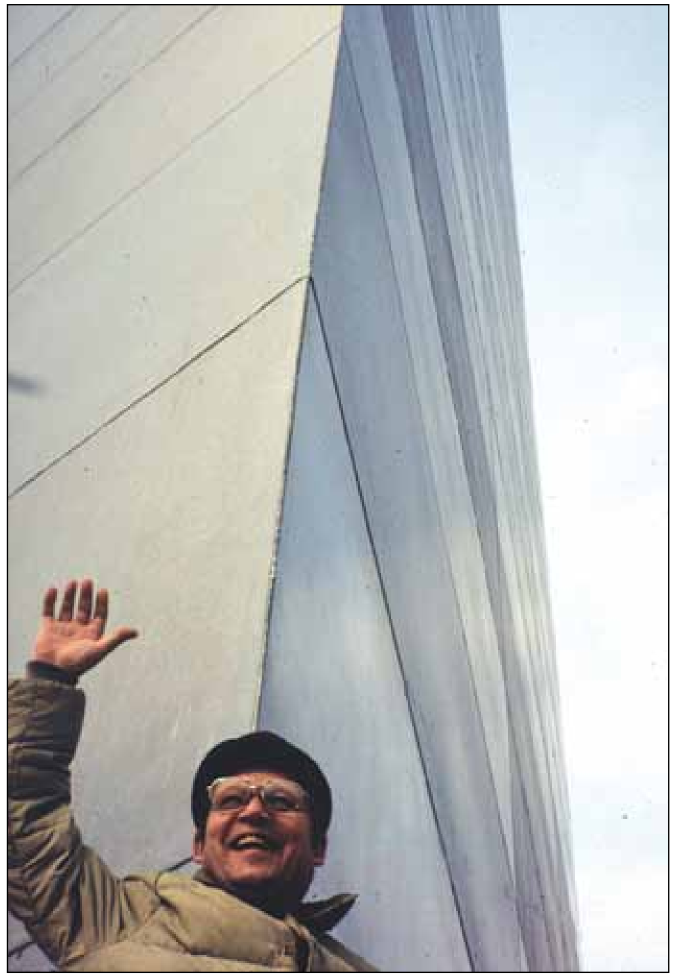
Cover Image
Nancy Linkin
SCULPTURE XIV
Bronze, 10” by 10” by 15”
Photo: Image Construction Co

Printed in Hong Kong.



We dedicate this book to the memory of Heikki Seppä in gratitude for his generosity in sharing the concepts and techniques of shellforming with the world of metalsmithing.

Heikki Seppä, *Bronze Knot with Nickel Silver Inlay*
Bronze and nickel silver
Photo by Paulette Myers

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Foreword

After long and careful study, Cynthia Eid and Betty Longhi have succeeded in assembling the first comprehensive textbook on synclastic and anticlastic forming. The clear illustrations accompanied by precise explanations provide an invaluable manual for beginning and advanced metalsmiths.

Our mutual friend, Professor Heikki Sëppa, revolutionized the field of art metals in the 1970s when he redefined the basic parameters of metal forming. For most of its history, functional forms such as teapots, bowls and other vessels were made almost exclusively using the time-honored traditions of sinking and raising. These were often embellished with repoussé, embossing and engraving, and while the results are lovely, there was little room to expand the basic form.

It was Heikki's monumental contribution of anticlastic forming (aka reverse raising) that freed metalsmiths of these traditional limitations.

Heikki introduced techniques that allow metalsmiths to bend sheet metal freely in every possible direction. As was his intention, he opened the way for craftspeople to use the medium as an art form in its own right, liberating metalsmiths from traditional constraints. In 1978 he published a landmark book called *Form Emphasis for Metalsmiths* in which he not only described his techniques, but introduced his concepts and created a nomenclature for the radically new forms he made possible. As long as we start with a mental construct of "bowl" or "vase," he reasoned, we are subconsciously limiting ourselves to preordained forms. He created a new forming vocabulary, expanding the ideas and developing new techniques, breaking them out of their historical and traditional strictures. From this origin springs the language that you will encounter in this book. You are about to enter a world of synclasting, spiculums and transitions—hang in there and the language will become natural.

Let me try to set the stage: There are four ways that a plane moves in space. First, it remains flat, extending infinitely away from its center. Second, a plane can be bent around its axis, ending in a tight fold. Third, the edges of the plane can be compressed relative to their center whereby the surface curves in the same direction at all points on the plane (synclastic movement). Fourth, the edges of a plane can be stretched relative to their center whereby the curves move in opposite directions (anticlastic movement).

Metal forming, like writing music, is a limitless creative endeavor. When I am working on a sculpture, I am struck again and again with how the forms remind me of flowers, leaves, seaweed, microphotographs of cells. I realize that I haven't created a new form as I push the metal on a stake, but instead I have unintentionally mimicked nature's basic designs. What makes the forms so attractive is their basic familiarity; though brand new, there is something in the structure that we recognize.

If there is a bias in the mission of *Creative Metal Forming* (and I think the authors are truly on a mission), it is that we are still in the early days of Heikki's revolution. Using the basic language of the medium, unfettered by historical precedents, artists in metal can continue to expand and develop the concepts presented here, adding to our understanding and to the world of art. I consider this book a milestone along an important path and I am confident that students of metalsmithing will welcome it as a guide and reference.

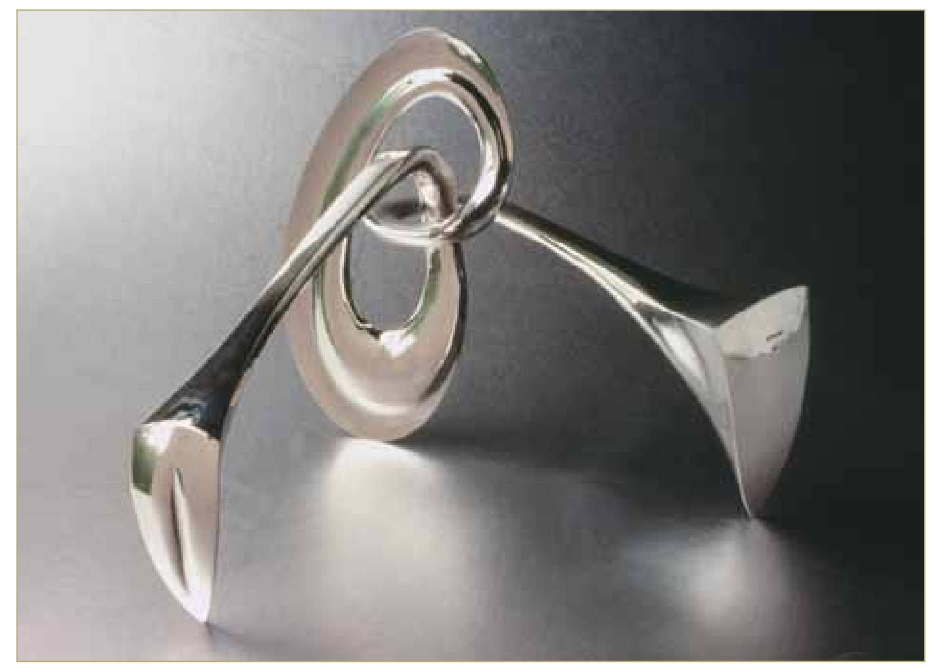
— Michael Good, designer & metalsmith

Historical Perspective

> To spend time with Heikki Seppä is to know the joy of silver— its plasticity and responsiveness to the hands of innovation. Seppä has spent his life as a pioneer and revolutionary, helping define the Modernist aesthetic of metalsmithing while exploring its sculptural realm… He has been successful in this endeavor, serving as a role model for a whole new generation of silversmiths.
>
> Elizabeth H. Warshawsky
> *Silver Magazine*
> Jan/Feb. 2004

Heikki Seppä was a master silversmith who changed the course of modern metalsmithing. Having trained in Finland from when he was a teenager, and later at the Georg Jensen Studios in Denmark, he emigrated to Canada in 1951. After 10 years there, he moved to the United States to attend Cranbrook Academy of Art for one year. After teaching for four years in Kentucky, Heikki moved to Washington University in Saint Louis, Missouri, where he directed the metals department from 1965 until his retirement in 1992. As a teacher, he became concerned about the future of silversmithing in a world where traditionally hand-made hollowware could not compete with industrially produced items. In order for the profession of silver-smithing to survive, he felt that metalsmiths needed to find a new direction, moving beyond traditional liturgical and presentation objects into art metal and sculpture. He perceived that traditional techniques and tools stood in the way of genuine innovation. Using his experience and training as a master metalsmith, Heikki developed new tools that offered greater flexibility in creating forms and, perhaps more importantly, he created a new vocabulary of form. The names of forms and the processes that he established freed metalsmiths' minds from stereotypes about form and function and allowed them to think in new ways. Using this radical approach, Heikki Seppä created unique sculptures with volume and strength. Heikki referred to the forms as shells—from this, the objects became shell structures. As a result of his explorations, a whole new world became available to metalsmiths. This new and innovative system of forming was his generous gift to the metalsmithing community. Heikki Seppä died in May 2010 after some years of declining health. His loss was felt by metalsmiths around the world—such was the length of his shadow.

Heikki Seppä, *Sculpture with Tesselation.* Sterling silver, gold



Heikki Seppä, *Expanded Form: Knot*
Sterling silver
Photo courtesy of the artist

Acknowledgements

We would like to thank our husbands, Tommy Winnett and David Reiner, and Cindy's son, Eric Eid-Reiner for their patience, help and forbearance through the process of writing this book. Tim McCreight from Brynmorgen Press had faith in us and gave us time and encouragement. Tevel and Sarah Herbstman of Allcraft Tool and Supply have our thanks for their enthusiasm, generosity and support—Allcraft donated many of the hammers used in this book. Thanks to Nancy Linkin for helping with the sections on open-seam spiculuims and for demonstrating her techniques, and to Michael Good for his enthusiastic support and demonstrations. We would like to thank Lois Betteridge for information about hammer handles, and Brian Meek for contributing the section on making steel sinusoidal stakes.

Thanks to Andrea Kennington, who found us tool sources and information, and to Sally Pierce and Sumner Silverman for use of their home on Martha's Vineyard for a week of peaceful and productive writing in beautiful surroundings. Iola Hanaoka, who gave us helpful comments about areas that needed clarification. And thanks to Roxie, Brandy, and Sera who were always ready to give a furry face lick of love and to take us for a walk when we needed a break.

The authors want to publicly thank each other for the support and friendship that have characterized this endeavor. It has been a long journey. In additon to becoming better metalsmiths, we have learned a lot about ourselves. We treasure the relationship we have built together, a friendship that has grown through sharing and laughter.

Introduction

All forming is related. The more you know about each type of forming, the richer your personal vocabulary of methods of forming becomes. To teach and to learn, we compartmentalize the different techniques. As we add each technique to our mental toolbox, as well as our studio, we can combine them.

Proper metal forming is not simply a matter of learning to hammer skillfully. It is also important to learn how to choose the correct hammer and the appropriate stake in order to create the desired form. The goal of the following exercises is to help you develop this knowledge. Many people feel that lack of success is due to incorrect hammering, when actually the problem more likely comes from incorrect tools or failure to set up the circumstances that will allow the form to develop. For instance, the synclastic depression in a wood block may be the correct tool, but if it has a bump in the bottom or the depth is not appropriate, the results will be disappointing.

Always and Never

We rarely say "always" or "never" because situations vary so widely that every rule seems to have its exceptions. There are always variables: the size and shape of the metal, the tools available, the artistic effect that is desired, and personal physical abilities and preferences.

Scale

The exercises in this book are generally smaller than the palm of a hand. This is usually the easiest size to learn in, but all the techniques in this book can be scaled up or down. Working very small or very large usually adds difficulty and needs specialized tools, but there are artists who find these challenges rewarding.

Terminology: Sinking & Synclasting

These two terms describe the same process. Sinking is a traditional term that generally means making a vessel by hammering with a rounded hammer into a depression in a tree stump or piece of wood. Heikki Seppä developed the term synclasting to describe the same process, but also to encompass a wider range of forming techniques that can produce a domical form. An advantage of the word synclast is that it describes the type of form but has no connotation of scale, product, or choice of tools used.

Terminology: Bending, Forging & Forming

Metal can be bent, forged or formed. A tube is made by bending metal, a table knife or spoon may be made by forging a piece of metal, and a bowl is made by forming metal. When metal is bent, a plane or rod of metal is curved or folded in a single direction. Bent metal can be easily unbent and flattened. The purpose of forging is to alter the original thickness and cross section of metal. This is usually done by hammering wire or rods on a metal surface with a metal hammer. Forming transforms a flat sheet of metal into a three-dimensional object by moving the metal in more than one direction. When forming, both the hammer and the stake can be steel, or one tool can be a resilient material, such as wood or plastic. Both forging and forming move the molecules of metal such that it is difficult to return the metal to its original form.

KEY TERMS

Some of the nomenclature used in forming will be familiar but some might be new. We will introduce the terms here and you will also find a glossary at the end of the book.

Air pocket: The space between the metal being formed and the surface of the stake.

Anticlast: A planar form in which the axial and the radial lines are oriented in opposite directions. Anticlastic forms cannot hold water.

Axis: Any curved plane can be described by two perpendicular lines drawn across the surface of the plane. These lines are called axes. Each line is an axis; the plural is axes (pronounced AK-seez).

Axial curve/Axial line: The longer axis of a form.

Bay: The part of a sinusoidal stake where anticlastic hammering is done. When looking at a silhouette of a sinusoidal stake, the bays are the concave curves.

Bouge (booj): [from the French *bouger*, “to move”]: Bouging is the process of smoothing a form and evening out irregularities. It can be in preparation for another course of formin, or prior to planishing.

Compound curve form: A surface in which both the axial and radial lines are curved. A bent tube has compound curves.

Course: The accumulated, methodical hammering from edge to center over an entire piece.

Cross peen: A hammer face that is long and narrow, usually perpendicular to the handle.

Furrow: A type of monocurve in which the long axis of the form is straight, while the short radial axis is curved. Examples of furrows include cones and straight tubes.

Monocurve form: A singly curving surface in which one axis line is straight and the other is curved. A straight tube, for example, is a monocurve.

Planish: The final hammering phase, when both the form and surface are given final form, usually with a steel hammer over a steel stake.

Radial Curve/Radial Axis: The shorter axis is the radial axis or radial curve.

Stake: A tool that supports metal when forming, bouging, or planishing. The form of the stake is a large factor in determining the form of the object being created. Sinusoidal stakes have a series of concave and convex curves designed for making anticlastic forms. They are shaped like a sine wave, and can be made of steel, wood or plastic. In this book we use the terms sinusoidal stake and anticlastic stake interchangeably.

Synclast: A planar form in which the axial and radial lines are oriented in the same direction. A synclastic form can hold water.

Chapter One

Getting Started

From the outset, this book was intended to provide a comprehensive survey of all the ways metal can be formed. The span of exercises runs from a dapped copper disk in the first exercise to a sterling vessel in the last, traveling systematically through more than two dozen widely varied examples. But as full as this list is, there are a few other ways to form sheet metal that should be mentioned as we get started.

Broadly speaking, all the techniques demonstrated in the following pages involve applying force against a malleable metal sheet as it is held against a form of some kind. The force is always delivered through a hammer or mallet and the supports are made of wood, plastic or steel.

Repoussé *(REP oo zay)* is a technique that follows a somewhat similar process but it is specific enough to require study on its own. Repoussé is usually done on a small scale and uses finger-length steel punches to press sheet metal into a semi-soft resin called pitch. It is a venerable category of metal forming that promises great rewards to anyone willing to take it up. Many of the concepts presented here will apply to work in repoussé, just as anyone experienced in that technique will find echoes in the forming techniques presented here. Space does not allow for more than this acknowledgement of a rich technique that we recommend for future study.

Another metalforming process that deserves mention comes not from antiquity but has a much more recent origin. Hydraulic mechanisms have become common in modern times in everything from large earthmoving machines to car jacks. In the late 1970s, metalsmiths began exploring ways to contain the force of hydraulics in a steel frame that would control the direction and shape of the force. This grew into a field called hydraulic die forming and it represents another significant way sheet metal can be formed. As with repoussé, this family of related techniques is too important to ignore but too large to be included here. Both techniques require a book of their own, and thankfully such books exist.

left: A pitch pot with repoussé punches and the chasing hammer usually used with them.
right: A modern hydraulic press. The jack (red) presses a steel plate called a platen upward where the force is captured by the sturdy steel frame.

How to Use This Book

Ideally, readers will start at the beginning of the book and progress sequentially to the end. Each section and exercise presumes that the reader has absorbed the information in the prior sections. In most metal processes, the exact sequence of actions will depend on the size and shape of the metal, the tools available, the depth and artistic effects that are desired, and personal abilities and preferences.

TOOLS FOR FORMING

Hammers

A hammer acts as an extension of the arm. The length of the handle, the mass of the hammerhead, and the speed of impact all affect the force of the blow. A hammer with a massive head and a long handle strikes a powerful blow. If that same massive hammerhead has a shorter handle, the impact will be less. Conversely, if a light blow is required, a hammer with a small head and a short handle is a better choice.

Types of Hammers

The shape of the hammer face determines the effect of the blow. Rounded hammer faces move the metal in all directions; rectangular hammer faces move the metal primarily in two directions perpendicular to the long axis of the hammer face. To understand how this works, use your hand to simulate hammering. Imagine a lump of clay and in your mind's eye, pound on it with a rounded fist. Notice that the clay compresses under the blow and spreads in all directions. Now chop the clay with the edge of your hand and you can visualize how the clay spreads in two directions.

Hammers used in metalwork are distinguished by the variety of their faces or "peens." The most common are flat peen, ball peen, and cross peen. Hammers are often referred to according to their function, as in planishing hammer, forging hammer and raising hammer. Planishing hammers have one flat face and one slightly rounded face, both polished. Forging hammers usually have one cross peen face and one slightly domed face, while raising hammers usually have two different cross peens.

Basic shapes of steel hammers. From left to right: Forging, raising, forming, planishing and ball peen.

Mallets: Rubber, paper, leather, wood and plastic.

Drop-forged steel hammerheads are the best quality and longest lasting hammers. They are dense and take a good polish. Cast steel hammerheads are softer but they can work well for forming on a resilient surface. They are usually less expensive. Beware of very cheap hammers because poorly cast steel may be porous and brittle.

Mallets

Mallets are some of the oldest forms of tools, going back to the Stone Age. For our purposes, we will define mallets as tools used for hammering with heads not made of metal. The most common materials for mallets are wood, leather, bone, rubber and plastic. Mallets are used for forming because they minimize damage to the surface of the metal.

Like hammers, mallet faces can be flat, domed or cross peen. It is useful to have mallets in a range of sizes, materials and forms. Commercial mallets usually come

with one flat and one cross peen face. Because flat faces are not needed in many sizes, we round some of these to make domed faces with varying curvatures.

Plastic mallets are used for shellforming because of their weight, durability and resilience. Additionally, plastic mallets are easy to make and reshape as needed. Leather mallets, when correctly prepared, provide a soft surface that conforms to the shape of metal when hammering. When purchased, most leather mallets have an uneven surface that is hard because of the glue that holds the coil of leather together. We recommend gripping the mallet face-up in a vise and using a rasp or file to get rid of the hard glue and to true the surface. This can also be done with a belt sander but be sure to have good ventilation and wear a respirator for this process. This is also a good time to round one end of the mallet so that it fits a concave surface.

Like leather, rubber mallets tend to conform to the anvil or stake beneath the blow. As with other mallets, it can be useful to round one face of a rubber mallet for gentle forming, especially where preserving the surface of the metal is important. Rubber mallets are especially recommended for pewter. A mallet made from hardwood is an effective tool, but avoid cheap softwood mallets because they shred and change shape as they are used.

Because small mallets are light, they don't have much power. This strains muscles and affects accuracy. Both leather and plastic mallets are available in weighted versions, with a lead center or with metal wrapped around the middle.

A particular kind of weighted mallets, called *dead blow mallets* have a hollow cavity in the head that is partially filled with metal shot or sand. At impact, the shot's movement increases the power of the blow and reduces the rebound.

Handles

The best handles are oval in the area where the hand grips—it is more comfortable and communicates the orientation of the hammer directly to the grip. Handles that are round in cross section are the least desirable because they are difficult to control and more likely to create fatigue. The size of the handle should be appropriate to the size and weight of the hammerhead. The heavier the hammer, the larger the handle should be. If a handle is too small or uncomfortable, wrap it with tape or tennis grip, or slip a piece of foam pipe insulation over the grip.

A selection of mushroom stakes.

A small selection of T-stakes.

Plastic sinusoidal stakes like this one can be made in the studio or purchased.

Stakes

A stake is a tool that supports metal when forming, smoothing and planishing. The form of the stake largely determines the form the metal will take when hammered. Stakes can be made of cast or forged steel, plastic, or wood. Steel stakes add extra power to the forming process, effectively pushing back against the impact of the mallet or hammer. For this reason, steel stakes are preferred for large scale work and thick metal. Stakes come in a large range of sizes and degrees of curvature.

A *Mushroom stake* has a rounded head on a stem. The domed head of a mushroom stake is terrific for

A full collection of steel sinusoidal stakes. This is more than a beginner would need, but having this wide range of sizes allows forms in almost any scale.

bouging or planishing a synclastic form. The working surface can vary in curvature from flat to spherical.

Some stake shanks are short, wide and straight; they may be held in a matching stake holder, a vise, or in a hole on an anvil. The shank can also be long and slightly tapered to fit in a stake holder; a tapered shank tends to tip in a vise. A variation of the mushroom stake is the anvil head, which comes in many different shapes and is usually held in a specially shaped stake holder.

T-stakes are shaped as their name implies, with a vertical shaft and a horizontal cross piece. They are nearly always made of steel and like other stakes, are available in a wide range of sizes and curvatures. Though T-stakes are primarily useful for the process of angle raising, they also offer curve options for bouging long narrow forms and gentle anticlastic curves.

Sinusoidal stakes have a series of concave and convex curves that are designed for making anticlastic forms. They are shaped like a sine wave, and can be made of steel, wood or plastic. In this book we use the terms sinusoidal stake and anticlastic stake interchangeably. Steel and plastic sinusoidal stakes are available commercially. Wooden sinusoidal stakes are usually made in the

This commercially made stake was designed by the authors and includes bolts and washers to stabilize the stake in a vise. We'll use it here to identify the parts of a sinusoidal stake.

An end-hook stake in a holder designed and made by Michael Good, clamped into a vise.

Most of this collection of wood and plastic anticlastic stakes are handmade; many are Michael Good's designs. Beginners won't need this many to get started, but as the range of forms grows, it is good to know that additional stakes can be made as needed.

Typically, a steel tool is matched with a plastic one—use a steel hammer on a plastic stake or a plastic mallet on a steel stake. Metal on metal allows for faster forming but risks thinning and denting the form.

studio. Sinusoidal stakes function by providing a graduated series of anticlastic surfaces upon which metal can be hammered to create anticlastic forms. To assist in the instructions that follow, we have named the parts of a sinusoidal stake.

Steel sinusoidal stakes can have a smaller diameter than wooden or plastic stakes, so they are better for forming tight curves. Because of the circular cross section, a steel sinusoidal stake is the ideal tool for making small anticlastic forms. For large stakes with broad curves, plastic and wood stakes tend to be more cost efficient.

A variation of a sinusoidal stake is an *end-hook stake*—a steel rod with a bay on each end. The ideal forming tool rack holds a number of end-hook stakes in a progression of sizes. End hooks are simple to make and have the advantage of not needing to work around other bays. Because the hook is made from a cylinder rather than a tapered rod, the diameter is the same on both sides of the curve. This makes it easier to form a symmetrical piece regardless of the direction of the hammer blow.

When purchasing or making stakes, the goal is to find curves that match the curves of the designs you have in mind. A stake is most useful if it is of a scale and type that relates to the designs you want to form. It is important to maintain a smooth finish on stakes because any marks there will show up on the inner surface of a form. As with hammers, it is more efficient to refinish the stake than to remove unintended marks later.

Stake Holders

It is important to be able to hold a stake firmly so that the impact of a blow goes into forming rather than shaking the stake. A vise is the most universal stake holder, but there are other options. Another good choice is a cast steel bracket made for this purpose. As with the vise, it is important that this be attached with large bolts to a stable surface. Another time-honored stake holder is a large stump. Drill and chisel holes into the stump as needed, then tap the stake into place. An advantage of a stump is that it can also provide endgrain wood for forming.

Tips for using stake holders:

- If the stake is loose in the stake holder, wrap leather, copper or paper around the shank of the stake to stabilize it.
- To prevent a stake from getting jammed in a stake holder, wrap the shank of the stake with a piece of paper or paper towel before inserting the stake into the holder.
- To loosen a stake from a stake holder, use a coarse work hammer to strike the stake holder, creating a vibration that loosens the stake. This is done using one hand hammering the stake holder and using the other hand to simultaneously lift out the stake at the moment the stake bounces from the blow. Use this trick as a last resort because it can damage the stake holder.

A solid wooden stump is a time-honored stake holder that is versatile and inexpensive.

When a stake is difficult to remove from a stake holder, loosen it by tapping with a mallet at a diagonally upward angle.

Use a piece of straight steel or dowel rod to hit the shank of the stake upward from the bottom. This reaches into the holder and doesn't damage the hammer.

Hammerheads as Stakes

For small objects, hammers can be used as mini-stakes. Simple brackets can be made to hold the hammer firmly without damaging it. To position the hammerhead far enough away from the vise to allow access, secure the handle with brackets. Make these brackets as needed from strips of brass or nickel silver.

METALS FOR FORMING

In this book we will deal primarily with non-ferrous metals, though many of these techniques can be applied to blacksmithing where ferrous metals are used. Listed below are the most commonly used alloys and metals, arranged in order of their formability.

In general, we suggest using NuGold, jewelers bronze or red brass for learning exercises. These are stiffer metals than other choices, but because of their greater strength, thinner sheets can be used. They can be worked longer and pushed further. For more information about specific metals and alloys, see page 248 in the Appendix.

COMPARISON OF COMMON METALS

Very Soft: fine gold, pewter

Soft: 22K gold, fine silver, aluminum, copper

Medium Hard: 18K gold, sterling, bronze, red brass, NuGold, niobium

Rigid: 14K gold, nickel silver, titanium, yellow brass

METALWORKING BASICS

There are a few processes that will be used on all the forming discussed in this book and it makes sense to cover them at the outset. Variations on these basics will come along in the exercises that follow.

How to Hammer

Whether you're flattening a small piece of wire or making a punch bowl, good hammering practices are universal. Hammering can be a satisfying and Zen-like experience when you are hammering comfortably and effectively. Proper alignment of the torso, arm, and hammer improve accuracy and avoid muscle strain. When hammering, keep your upper arm in a relaxed position with your elbow hanging directly down from your shoulder and your forearm perpendicular to your body. Stand straight, facing the work. Once you get yourself into this correct body posture, use your feet to move yourself so that your arm is comfortably bent to slightly greater than a right angle, with the face of the hammer resting on the metal to be formed.

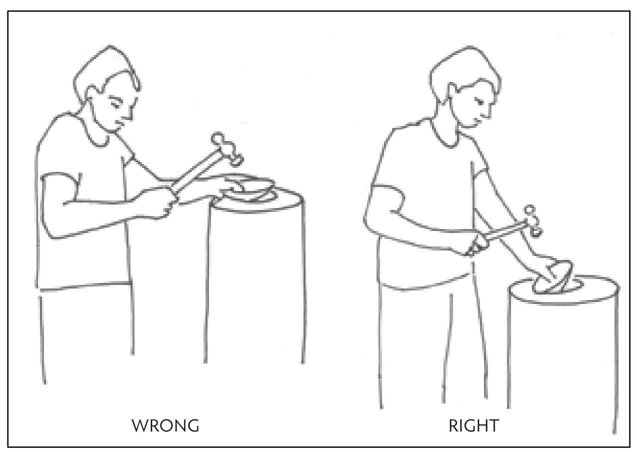
Betty Helen demonstrates the proper stance. Notice how her right shoulder, elbow, and wrist are in line with the work. The proper grip on the hammer is relaxed, with fingers and thumb comfortably encircling the handle.

Keep Your Stance: Move Something Else

Stand so that your hammer, shoulder and elbow are lined up in front of the metal and your body is to the side of the work. This allows the hammer to come down in an arc that is perpendicular to your body.

If you need to sit instead of stand, orient yourself in the same way by moving the chair. Sitting side-saddle or twisted at the waist restricts the limbs from moving freely and can strain your muscles. Many people like to sit for fine work and stand for heavy hammering, such as forming a large vessel. One advantage of standing is that it is easier and more natural to move your body into a comfortable, non-fatiguing, non-straining posture.

Whether standing or sitting, the working height is important. Set things up so that when your arm is bent at a right angle, the hammer is slightly above the metal. If the hammering surface is too high, there is a tendency to hitch the shoulder up, raise the elbow, or stick the elbow out—all of which stress the body and reduce accuracy. A hammering surface that is too low may be hard on your back, but it tends to be better than a surface that is too high. If you find that you need to reach up to hammer, it is best to use a small platform to elevate your body. Quick and easy platforms can be made from phone books, cement blocks, bricks or a few two-by-fours and a piece of plywood nailed together.



Avoid working on a surface that is too high, as shown on the left. This cramps your shoulder and wrist, leading to loss of control, discomfort and possible injury.

Hammer Grips to Avoid

Do not point your finger along the handle like this— in the long term, it can lead to pain.

Do not clench the handle in a white-knuckle grip like this. Also, it is usually better to hold the handle closer to the end rather than choking up like this.

This shows an extreme version of working on a surface that is too high. Notice the extreme bend in the wrist: Ouch!

Wear ear protection to protect your eardrums from the hammer noise and comfortable leather gloves to dampen vibrations, prevent blisters and improve gripping power.

Shake Hands with Your Hammer

A handshake is more than just a polite greeting when it comes to hammers; it's the best way to approach them. When you pick up your hammer, reach out to it as if you were shaking somebody's hand and take hold of the handle. Use a relaxed, loose grip that will let the handle move within your hand. Grip firmly enough to guide the hammer but loosely enough that it can rebound easily.

Avoid putting your forefinger or thumb straight along the handle because this can cause tendonitis. It's generally best to hold the hammer near the end of the handle, but find the place that allows you to balance control with the force of the blow. Gripping the handle above the optimal point is known as “choking up” on a hammer. Though it's best to avoid choking up, there are a few occasions where it is acceptable, such as when you need to have control of a very heavy hammer.

Some people find it helpful to think of the hammering motion as being like the motion of throwing a ball. The whole arm works in one fluid motion. Start by appropriately orienting your body so that the upper arm is in a relaxed and stable position at your side, with a right angle at the elbow. The motion begins by lifting the hammer while holding the hand slightly upward from the wrist. As the hammer motion continues, the lower arm and hand move downward toward the point of impact so that when the hammer makes contact, the hand and wrist are in line with the arm. Avoid letting the wrist bend downward.

After impact, the wrist and the arm bounce up with the rebound of the hammer. At all times, the arm, the elbow, the wrist and the grip should be relaxed. Use your ears as well as your eyes—if you hear a single hit, then all is well; if you hear a double hit, that means your wrist or arm are tense, which is restricting the rebound of the hammer.

As you learn how to hammer comfortably and effectively, maintain this upper body position and relationship to the hammer as your work progresses. Move either the work or your feet, but not your arm/hand/hammer arrangement. Avoid hitting sideways, backwards, or any-other-ways. Hammering should maintain a natural arcing motion.

Think of being a “hammering machine.” The arm, the hammer, and the stake maintain a constant relationship. The hammer keeps going in the same comfortable position while the metal is moved over the stake. Find a rhythm. Some people are like a staccato machine gun: *ratatatatatatatat*. Some hammer in 4/4 time: *bububuBUM* or *HUPtwothreefour*. Your natural rhythm will provide a consistent surface, keeping things even, and increasing your stamina.

Annealing

The first step in forming is to ensure that the metal is annealed; i.e., in its most malleable state. This is achieved by heating metal to about two-thirds of its melting