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KEYWORDS: Craft, craft theory, craftverb, blacksmith, tacit knowledge, taxonomy, technique, forging.

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Understanding Through Blacksmithing Techniques

By Gustav Thane

DESCRIBING THE BLACKSMITH'S CRAFT

Ten words.[1] That is the number of named techniques listed in *The Blacksmith's Craft* (Rural Development Commission (RDC) 1997, vi; see Figure 1). Is that all there is to it? As a traditional master blacksmith, I am pretty sure I have wrought metal in more ways than that. Of course, I did not read books to begin with; I learned the metal craft in a forge, observing and talking to others, trying things out myself. I do read the books now though, in order to see how others describe the blacksmith craft. I am used to talking about *craft activity* as naturally as I talk about the crafted *objects.* I have looked into how metal craft can be described verbally, as an activity, separate from its resulting shapes. This, however, does not allow a complete picture of how metal craft is generally described. I propose an alternative way. As a contemporary blacksmith and a practice-based researcher, I am in need of a way to describe my craft. I look for a language, relevant to a post-industrial context, capable of housing the specific concerns and meanings of a craftsperson in action—a craft theory. If practitioners fail to contribute to craft theory, we are confined to using concepts and methods put forward by non-practitioners, with the risk of us adopting an impractical view on craft. But I do not assume to invent it; theory is already used within the field. In this chapter I attempt to extract that theory and articulate a feature of this craft logic to be illuminated and made possible to critique.

Ulf Linde, Swedish art critic, wrote about *the aspect of the artefact* (1968), the objects intentionally wrought by a human hand, not the materials used, the object's function, form or shape, but the act of cultivation—the work. He described it as human time spent. That is the main value of an object: days and years of someone's life. Linde referred to traces and hammer marks in Neolithic stone

Verb
Taking a Heat
Drawing Down
Bending
Upsetting
Jumping Up
Hot Cutting
Punching
Drifting
Fire Welding
Heat Treatment

Figure 1: The 10 craft-specific verbs listed in the introduction of *The Blacksmith's Craft* (RDC 1997, vi).

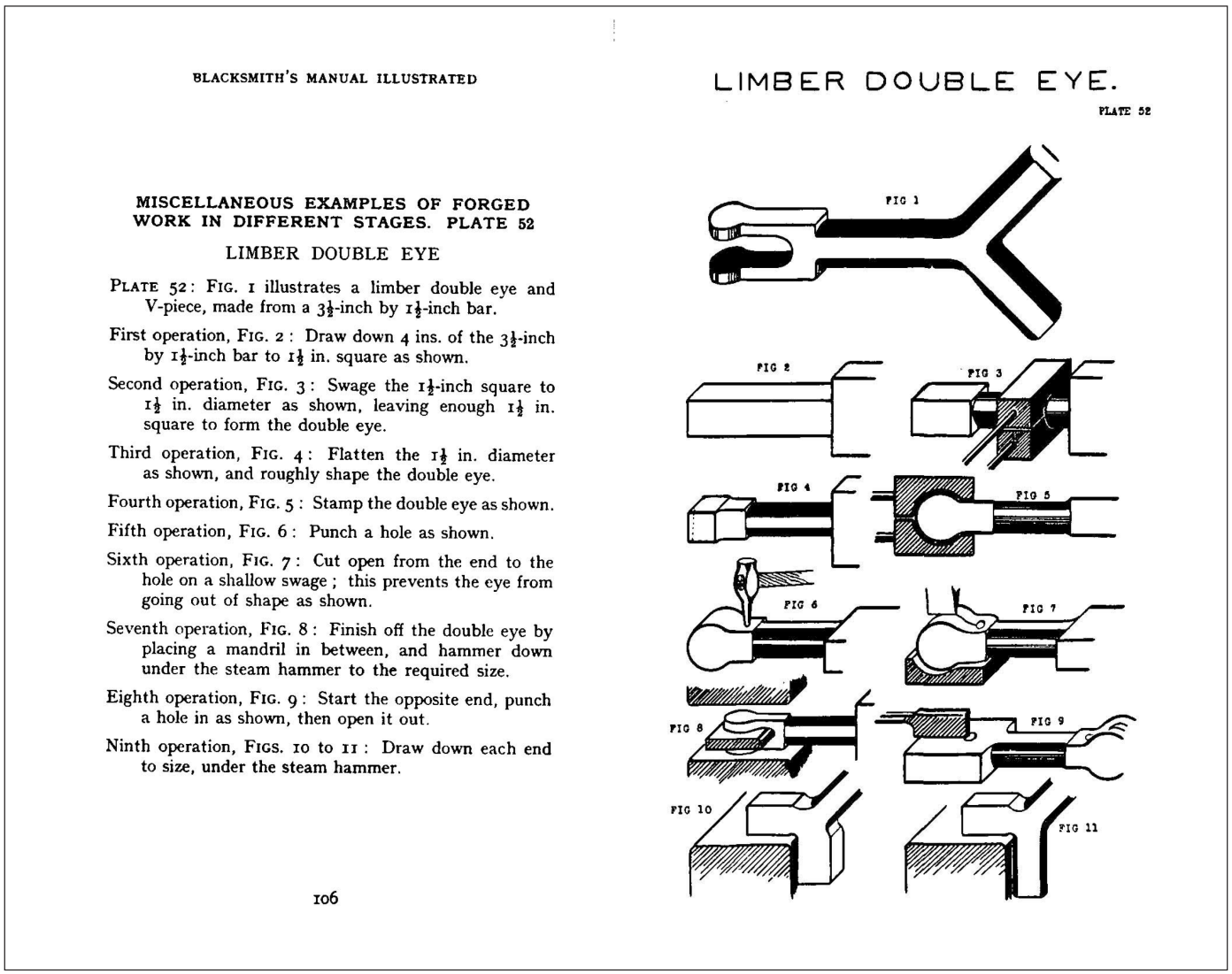
axes, but the marks led him to the acts, skills, and prior training of an experienced maker. Linde's role as a critic allowed him to trace hammer marks. I am one of those making the marks. My interest in his writing is the shift away from the form, shape, and function of objects into a debate about human time and engagement (Linde 1968, 15, 18).

A similar thought is mentioned by Paul Klee in his diary and elaborated upon by anthropologist Tim Ingold (2010). Klee's reflection, that work is life and its resulting object is death, sounds to me like an urge to stay in a creative process—an acknowledgement of a maker's perspective. Ingold chose to highlight the part about life and death, reasoning about the connection between a maker and the making process. When it ends the work dies. He seems to imply that art theory, based on analyses of art pieces (objects), is building a case on dead material. When I make an axe, I sometimes try it out before delivery, but the axe will live out its life in the hands of woodworkers. To me, as a blacksmith, life with an axe is really *life with a hammer*. When the axe emerges, it is no longer part of my life as a blacksmith. The craft leading up to an axe is not the axe itself, even if the two are connected and hammer marks can be traced (Ingold 2010, 91–93).

I believe craft theory can be based on the act of cultivation. Ingold describes this act of cultivation as life; the making processes. The words describing these processes hint at a conceptual framework, or theory of the workshop floor indigenous to craft practice. One way to approach this theory is to look at the language that allows a craft to be understood as activity first, as human time and engagement, rather than objects. The class of words known as verbs[2] define that feature. They do not describe forms and shape, but actions, manual-gestures, and activities, as they are used in a workshop. Such a vocabulary and theory might be suitable in order to process a sort of knowledge and content active in a creative process. And even if it is not, my experiential knowledge of a direct and relevant theory, indigenous to craft, might just lead to a reflection which is useful for observing ontological value within the craft sciences.

Reading *The Blacksmith's Craft* a bit further, it becomes obvious that the authors writing for RDC use a larger variety of technique verbs in the text; they were simply listing the ten basic techniques—a sort of simplification. The book is targeted at beginners. Another book, J. W. Lillico's *Blacksmith's Manual Illustrated* (1997), clearly targets experienced blacksmiths, and it engages an extensive craft-specific vocabulary: I counted 49 verbs to describe the blacksmith's craft activity (the words are listed in Figure 3 below). While there are further words describing objects (nouns), the 49 are the only terms describing an action, a technique, a verb separate of its resulting shape… But perhaps I am just greedy. How many words do we need?

In this chapter, I propose that craft verbs reveal traces of an already existing conceptual framework,



BLACKSMITH'S MANUAL ILLUSTRATED

MISCELLANEOUS EXAMPLES OF FORGED WORK IN DIFFERENT STAGES. PLATE 52

LIMBER DOUBLE EYE

PLATE 52: FIG. 1 illustrates a limber double eye and V-piece, made from a 3½-inch by 1½-inch bar.

First operation, FIG. 2: Draw down 4 ins. of the 3½-inch by 1½-inch bar to 1½ in. square as shown.

Second operation, FIG. 3: Swage the 1½-inch square to 1½ in. diameter as shown, leaving enough 1½ in. square to form the double eye.

Third operation, FIG. 4: Flatten the 1½ in. diameter as shown, and roughly shape the double eye.

Fourth operation, FIG. 5: Stamp the double eye as shown.

Fifth operation, FIG. 6: Punch a hole as shown.

Sixth operation, FIG. 7: Cut open from the end to the hole on a shallow swage; this prevents the eye from going out of shape as shown.

Seventh operation, FIG. 8: Finish off the double eye by placing a mandril in between, and hammer down under the steam hammer to the required size.

Eighth operation, FIG. 9: Start the opposite end, punch a hole in as shown, then open it out.

Ninth operation, FIGS. 10 to 11: Draw down each end to size, under the steam hammer.

106

LIMBER DOUBLE EYE.

PLATE 52

FIG 1

FIG 2

FIG 3

FIG 4

FIG 5

FIG 6

FIG 7

FIG 8

FIG 9

FIG 10

FIG 11

Figure 2: A spread from J. W. Lillico's book, *Blacksmith's Manual Illustrated* (1997). Verbs are used to describe the techniques to use; illustrations are used to describe what shape to end up with.

a specific understanding of metal craft which is based on how it has been described by experts within the craft itself (commercial craft, craft education, artistic and virtuosi craft practice). The metal-craft verbs, and the way of reasoning, I propose, make up a sort of family tree—a taxonomy of human activity. Through the lens of such a system, an understanding of craft is separated from step-by-step description of craft procedures as well as descriptions of crafted objects. This focus may allow an analysis of metal craft activity which is relatively independent of otherwise closely related things, such as artistic expression or the functionality of an object.

BLACKSMITH CRAFT AND BASIC RESEARCH

Almost 300 years ago, Swedish botanist Carl Linnaeus made a huge contribution to the field of natural science. By gathering and naming specimens of different plant species, he, and later his disciples, organised biological life into a hierarchy of species, families, orders, and kingdoms—a system able to house all kinds of life (Linnaeus 1758). Linnaeus's achievement was to produce a structure for how data could be organised. His work can be considered the foundations on which Charles Darwin based his theory of evolution, followed by a whole field of botanists and zoologists. Back then, several taxonomic systems existed in parallel, but something in Linnaeus's approach made it more productive to his field than the competition. Linnaeus's taxonomy has nothing to do with the blacksmith's craft or verbs; it has to do with logic, systems of information, and basic research within botany. However, that line of thinking, which systematises an aspect of a field in order to gain a focus on some things rather than on others, made sense to me. Systematising a certain aspect of a craft could be a sort of basic research in craft practice as well.

Similar endeavours of systematisation have taken place in the history of crafts at different times. One of the most famous examples is the 1751 *Encyclopédie* edited by Denis Diderot. The *Encyclopédie* differs from several other attempts to gather information in the sense that Diderot himself, being the son of a knife maker, understood the necessity of engaging experienced practitioners to describe what they were actually doing (Knothe 2009). Yet, a major part of his descriptions of craft focus on the tools. He often describes *what tools* to use rather than *how to use the tools*, as if the tool is synonymous with the ability to use it.

Basic research, such as that undertaken by Linnaeus, sometimes holds a key to data. By constructing a taxonomy, Linnaeus enabled some questions to be productive and others to fall out of the academy. If such an important foundation was to be laid for metal craft research, I argue it would have to be found in the *activity of craft* rather than in the literature of nearby fields such as art history, design theory, architecture, or in any commercial, industrial approach (see also Westerlund in this anthology). Below, I will introduce a starting point for one such possible taxonomy of human activity which is not based on *what tools to use*, but on the techniques of metal craft, or, in other words, on *how to use the tools*.

TOWARDS A TAXONOMY OF CRAFT VERBS

The verb of a technique rarely holds a specific meaning in the sense that it describes an activity that could only be done in one way. Depending on the forces applied to a material, the direction of the force, and what stock material to begin with (etc.), infinite variations exist. The whole variation will not be of use in a taxonomy but can be considered akin to the equivalent of individual characteristics within botany. When making a drawing of orchids for a scientific volume, the character of a species is often pictured, or highlighted, rather than a specimen itself. This can be considered analogous to craft verbs, and how they may be understood in a taxonomy of craft activity; all possible variations of the technique *to bend*, for example, can be treated as subspecies or even individual characteristics of the same general principle. The common denominator—the principle on which they are divided in the craft tradition—can, in this craft verb taxonomy, be treated as different species in the same family.

Verb	Occurs	Endings (Comments) Page nr.
Temper	13	-ed, -ing
Forge	12	-ing
Weld	29	-ing, -ing methods
Jump	12	-ing
Harden	23	-ing, -ed
Heat	25	-ed, -ing
Plunge	12	-ing, -ing into water/oil
Bend	40	-ing
Rivet	5	-ed
Punch	23	-ing
Cool	5	-ing off, -ing, - off,
Fuller	38	-ing, -ed
Flatten	18	-ed down, -ing, - down, - out
Cut	76	-ing, - of, - through, - open
Round	10	-ing, - of
Swage	15	-ing
Draw down	106	-ing down, -n down, - out, -n out
Square	8	
Hammer	30	- down, -ing, -ing down, -ed
Sink	3	
Side set	51	-ing, -ed
Taper	11	-ing, -ed
Straighten	2	-ing
Form	4	-ing
Machine	1	-ed
Drill	11	-ed
Stamp	12	p. 106, p. 128, p 158
Turn	2	-ed up (as in bend 90 degrees)
Bolt	1	-ed
Draw in	1	- the circumference
Pull around	2	
Scarf	2	-ing
Joggle	5	-ing
Point	3	-ing
Double	3	-ing, - over
Open out	8	
Split	6	- open, -ing
Set back	1	(as in bending)
Twist	3	
Nick	1	-ing
Spread out	1	p. 132
Raise	2	- to a welding heat
Set	5	-ting the arm (as in straighten)
Screw	1	-ed
Set through	3	p.168, p. 141
Polish	5	-ing, -ed
Dip	3	
Case harden	3	-ing
Anneal	1	-ing

Figure 3: The 49 verbs used on 657 occasions in J. W. Lillico's book, *Blacksmith's Manual Illustrated* (1997). Words are listed in the order they first occurred in the book. All verbs are in the list made into the basic form of a verb, variations of the techniques are listed in the right hand column.

Added	Group	Technique
	Forge	Draw down Taper Point Jump Flatten Round Square Side set Set through Fuller Sink Nick Swage Stamp Spread out Set
	Form/Bend	Bend Turn Pull around Joggle Double Open out Set back Set Staighten Twist
	Cut	Cut off Cut through Cut open Scarf Split Punch
	Machine	Drill Cut (with a bandsaw)
Join		Weld Rivet Bolt Screw
Heattreat		Heat Temper Raise Anneal Cool Harden Plunge Dip Case harden Anneal

Figure 4: The 49 craft verbs listed as they cluster together in groups of similar techniques. To the far left are group names added by me.

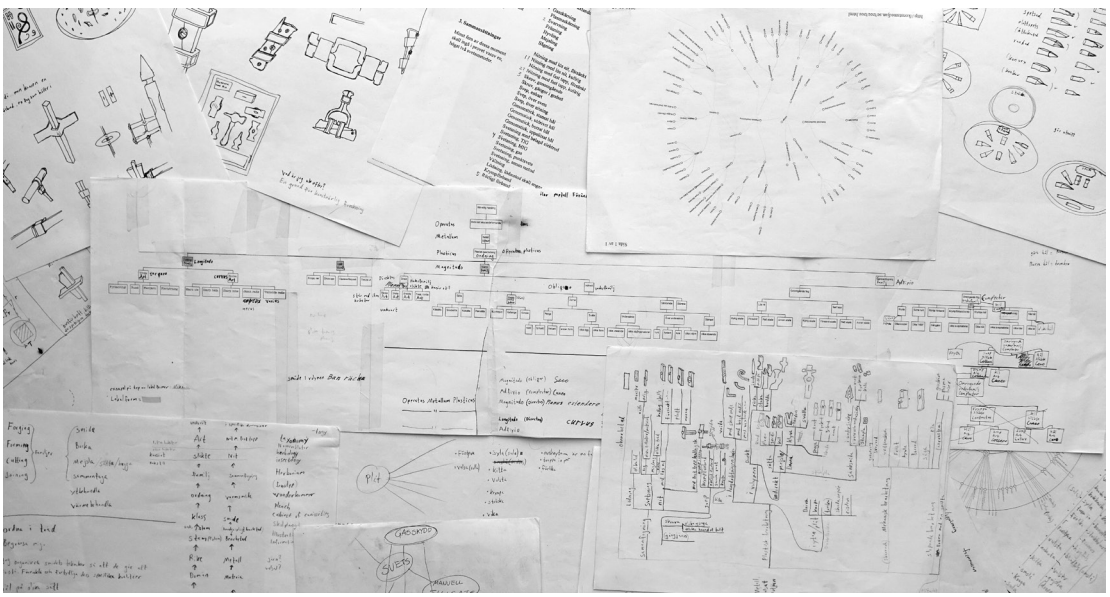


Figure 5: The many words collected in Swedish, arranged and systematised in different iterations.

One of the major contributions of Linnaeus was to name things in a new way. A jellyfish and a shellfish are not various types of fish; they are something else, and their Latin names and positions in his taxonomy clarify this. The same goes within metal craft; to *set back* (1) is a sort of bending, to *hot set* (2) is a way to make the metal thinner and longer. In the present anthology, Tina Westerlund argues that research performed by experienced craftspeople has the advantage of including past experience of craft activity through which to interpret information and put it into context. Based on such experience, I say those two actions, (1) bending metal and (2) making it thinner and longer, are two rather different principles of metal craft. I do not propose techniques to be organised by the way they are named. The taxonomy is instead based on the similarities of *how* they allow a person to engage in materials. The verbs are important though: they are treated as species or subspecies, as principles of how force is applied on materials.

Lillico's intention with the *Blacksmith's Manual Illustrated* was to describe *how to* "complete the job in the most expeditious manner" (1997, vii). In this case, "the job" involved power hammer forging on an industrial scale. He mainly described craft as an activity. If not counting general verbs like *make*, *shape*, or *finish off*, the 49 craft-specific verbs in the book occur 657 times. Some of the verbs have more or less the same meaning, such as *draw out* and *draw down*. Other words imply a higher level of abstraction, like *to bend* which is related to (or the family name of) other terms like *to joggle*, *double*, *set back*, and *turn back*. Grouping the words like this make up at least two levels of abstraction.

Using the verbs from *Blacksmith's Manual Illustrated* (1997), I can see the words cluster together into groups. But four of them describe technique

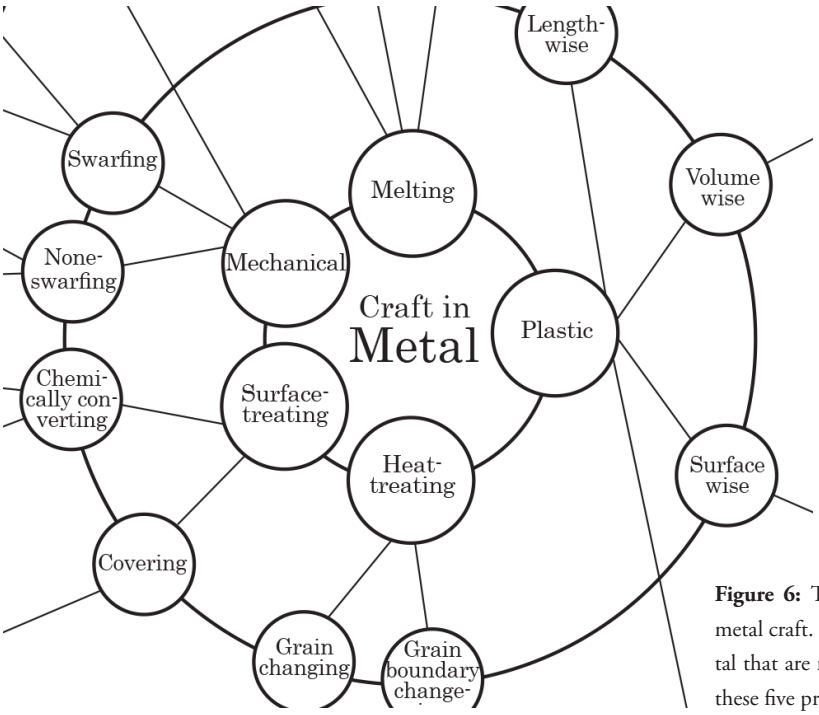


Figure 6: These are the basic principles of metal craft. Few things can be done with metal that are not part of, or a combination of, these five principles.

on a higher level of abstraction: forge, form, cut, and machine. I think of those words as family names or group names. When I add the group names *join* and *heat treat*, almost all of the technique verbs in the book are included in the six groups. But some words fall out of such a clustering: *to hammer* is one such example.

To hammer is a verb describing an action—not just one action, but almost all actions possible with that tool. *To hammer* is really a noun used as a verb, describing the tool applying force. The verb *to hammer* describes the act of applying force in a different way than other tools or machines, such as *to press* with a hydraulic press, *to roll* in a rolling mill, or *to hammer* with a power hammer,[3] but you can still draw out,[4] bend, or perform most other techniques with either one of those tools. This seems to make it impossible to fit techniques, named after a general tool, into this taxonomy.

I had to decide how these techniques, named after a tool, fit into a taxonomy of craft verbs. Do I treat *to hammer* as a higher level of abstraction, a lower level of abstraction, or as a noun not fitting into the list? First, I tried to put it higher up. In this example, it would have forced me to understand *drawing out by hand* as a different technique than *drawing out in a power hammer, a press, or a rolling mill*. It would make sense since those four imply different manual-gestures, different versions of an action. However, despite the sense it made, I could not find traces of this in the language of metal craft. When describing a technique performed with different tools, generally the same verb is used. On a higher level of abstraction, there should not be a more precise description of the action.

Since the verb *to hammer* is clearly a metal craft activity, it fits in the family tree. My conclusion in this example is to treat it as a lower level of

abstraction—a grandchild in the family—a common denominator of this lowest level of abstraction being its character of applying a technique onto something, with something, or to achieve a specific quality or shape in the material. Those characteristics got to share a level since they are all entangled with each other in a non-linear way. They also allow variations that far exceed the levels above. With this level of abstraction, the way metal craft verbs can be used does not help me in organising a craft verb taxonomy, at least not in a way which is balanced between the various technique groups.

OTHER SOURCES

Originally, I made a simplified inventory of the blacksmith vocabulary in Swedish. Swedish blacksmith literature is rarely written by experienced blacksmiths. My original aim was to see whether the oral descriptions I use and encounter in conversation with other blacksmiths would differ from those in the literature. I expected to find words of local dialect and thought it interesting to map where they are used. I wrote down all of the techniques I could come up with (see Figure 5). I then met and talked with masters and retired craftspeople from different metal crafts, such as sheet metal workers, moulders, welders, jewellers, etc., adding verbs to the list as a result of these meetings. In this work, I discovered the special character of verbs, describing nothing but the activity.

I presented the list of verbs, as far as it went, and explicitly asked the experts to name verbs that they had actually used throughout their careers. I also asked what they assumed would be variations of the same principle and what the family name of that group could be. This is where the idea of a family tree occurred and evolved. The family tree of verbs was presented at workshops at craft schools, blacksmith meetings, and blacksmith forums. Each time I attended one of these places, the list would grow a bit and sometimes groups were rearranged, joined, or abandoned. This far in, oral descriptions were the focus. When I eventually tried to translate the whole project into English, the original problem of verbs lacking in the literature did not seem to be as prominent in the English literature. *The Blacksmith's Craft* (1997) and *Blacksmith's Manual Illustrated* (1997) proved me wrong. My list of spoken verbs, translated into English, corresponded to the verbs used in those books. The list of spoken verbs was longer and included a few more technique groups, but I concluded that verbs have been written down, in English. Consequently, the inventory was reinvented, as described above.

The 49 craft verbs of Lillico are accompanied by more than twice that number found in interviews, workshops, and other blacksmith forums. Subjected to the same sort of logic, they cluster together. Where words neatly fall into place and describe craft in different levels of abstraction, they add to the list. Where verbs do not fit, they are confined to the lower levels or used to reorganise the higher ones. At this point in time, I no longer looked actively for more words, but introduced the process of systematising the verbs into a larger taxonomy, based on my experiential knowledge of craft theory.

THE HIGHER LEVELS OF THE TAXONOMY

Lillico's book and the initial interviews in Swedish offered me the three lowest levels of abstraction, the hands-on levels: the technique group, the specific technique, and the application of the technique. To inform the higher levels of abstraction, I decided to keep looking for concepts within the practices of metal work. All blacksmiths are metal workers but

not all metal workers are blacksmiths. The jeweller, sheet metal worker, and fabricator all process metal, but it comes into their workshops in different formats and leaves it ever more diverse. The division of labour between metal workers often correlates with the techniques named with a verb, at least in an approximate sense. Working with cheat metal demands a larger variety of verbs describing ways to fold metal compared to a blacksmith who would rather focus on the manipulation of thickness in the material. They are all metal processing techniques; they are related, but not closely. The format of the sheet metal, metal bars, dices of metal, etc., became my lowest level above the verbs. It made sense to use metal itself as a top level of all metal craft.

I divided the top level—metal craft—into the smallest number of fundamentally different ways of processing that I could see. My experiential knowledge suggested that there are four basic principles of processing metal by hand. I was long unsure whether surfacing ought to be included. After a closer look, I decided that it should be, so that there are now five basic principles. These principles are all associated with their own trades within the metal work community, and differ fundamentally.

1. *Forging* is based on exploiting malleable features, the ductility of metal, making it thinner and longer.
2. *Heat treatment* uses and eploits the molecular features of metals.
3. *Casting* builds on the possibility of melting and pouring metal into something else.
4. *Surface treatment* often aims to counteract the material characteristics of a metal by preventing rust, etc.
5. Most other activities performed with metal are different sorts of *mechanical* removal of materials, such as abrasive or cutting techniques.

CHALLENGES AND POSSIBILITIES

Most of the levels above help in dividing the metal craft techniques into groups small enough to be understood as variations on some principle of metal craft. Other clusters of techniques are exceptions to that rule. Joining techniques are such an exception. Joining techniques are often described as one of the basic principles of metal work (Aspery 2011). But in this taxonomy, they, as a group, cut straight through the basic divisions of metal craft. Not only do they fit nicely into different groups, but a lot of them also combine different techniques in a specific order, much like objects. They are even referred to with nouns. A mortise and tenon joint (noun) is one such technique. It is common within carpentry as well as in metal work. To a blacksmith, it combines the following actions: (1) to punch[5] a hole, (2) to set down[6] on two sides, (3) to draw out, and (4) to rivet (or wedge), and a rivet is really a bar being (5) upset[7] after having been placed through a hole.

THE EXCEPTION OF JOINERY

Throughout this chapter I have explored traces of a theory, seemingly indigenous to craft. The technique verbs and division of labour are easy to recognise. They imply there is a system, existing before I pointed at it, based on how verbs are used to describe actions. Still, joining techniques are often named with a noun: a rivet, a collar, a weld, etc. Joints are normally achieved by stacking techniques (verbs) on top of each other, just like an artistic expression is achieved or a functional object. And they do have a function: they hold metal bars together. When trying to describe technique without the description of form, shape, and function, some techniques, like joinery, seem more like a function than an action. At first glance I took this as proof

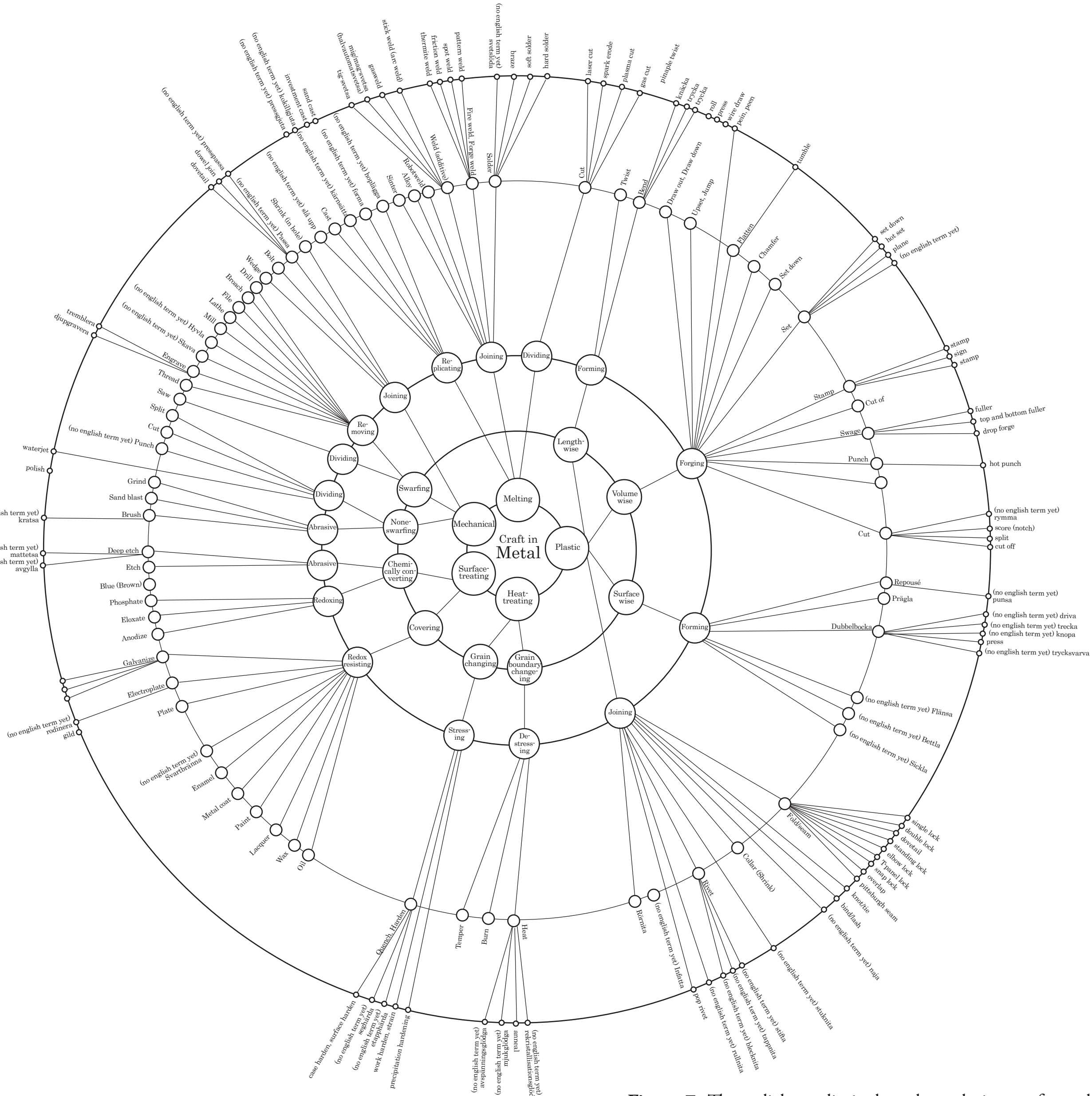


Figure 7: The radial tree limited to the techniques of metal craft. At least this is how the techniques were organised when this text was first published. The tree is crowd sourced and will keep growing and evolving as long as practitioners keep updating the website at at https://craft-research.com/radialtree

that the system I was tracing was not composed in the way I first thought.

At the same time it illustrates the very gain of this theory. It allows a specific line of thinking. When a rivet is not understood as a rivet—a thing, a noun—but as the action— (1) *to punch* a hole, to place a round bar through it and (5) *to upset* it, make it thicker at both ends—it is not an object anymore but a period of human time spent. And not just time spent doing anything, but spent in a way coloured by the prior experience of a blacksmith, the embodied material, and the tools. Describing this process through its various steps—not each individual blow with a hammer, but the

technique, the principles—highlights *how* the craft links a craft person to a material. I believe this to be a perspective best enquired by an experienced practitioner, hence a theory fit for craft research.

The joining technique is often named with a noun and thought of as an object, but the noun can be changed into a verb. It is a lot like the axe I mentioned above. When the rivet has come into being, it is no longer of the blacksmith's concern. A rivet is an object, a noun, just like an axe, but *to rivet* is a verb. A rivet normally applies pressure on both sides of a hole, joining bars of metal, and that is similar to how a blacksmith applies force with a tool. But that function is the result of a rivet (noun), not the action of a blacksmith, not the action *to rivet* (verb). I will call this a *material function* so as not to confuse it with the function of a product, which is supposed to be left out of this chapter. And I will treat technique nouns which can be turned into verbs as actions, at least as long as they have been used like that in actual workshops. It is possible *to mortice and tenon join* even if this specific technique sounds to me like pushing it a bit.

When organising the joining techniques into a taxonomy, I found no reason to exclude those verbs which are more complex than just one action. As mentioned, joining techniques are actually a number of other techniques performed in a specific order, *specific* being the operative term. I concluded that those are still activities acknowledged by the field as such, and since they have been named with a verb, they will fit into the family tree.

They could be placed on the lowest level with its non-linear vastness of variations and where applications of techniques can be found. But *joining* is not without order; it is a feature represented across the metal craft similar to its opposite—to divide material. *To cut* can also be found in different groups. Some of the clusters of techniques have inherent fundamental features, akin to the *material functions* of *to join* and *to divide*, like surfacing, normally either oxidising or preventing oxidisation. And more can be found as opposites all over the tree. Different understandings of these features allow different positions in the taxonomy. I had to make a choice of how to treat those exceptions. After trying several versions out, I decided to treat those material functions (not to be confused with product functions) as a mid-level group. I did this to specify those features above the level of technique groups (verbs), given joinery's status within the field of metal work as an organising system. That is also a good position to take since the joining techniques often include several other techniques. Tying them to a higher level of abstraction makes it easier to find a group where all, or most of them, already belong.

No hierarchical order seamed fruitful to me; between the various techniques of one particular level, none is first and none comes after. The features and material functions implied a horizontal line, connecting at least this level of abstraction all over the tree. Thus, after balancing other levels of abstraction in a similar way, I ended up with a radial tree, which is also rather space efficient.

The Exception of Decorative Techniques Collecting verbs like this is not without problems. Andreas Nobel would say that written language has its inherent possibilities and limitations while craft has others (Nobel 2014, 46–48). Craft research might lose some of its strengths when adapted to written language, adopting new limitations in the process. If so, compared to the crafted objects, the limitations of verbs would seem similarly (or even more) problematic in relation to the activity. On top of that, could organising the words in a taxono-

Figure 8: Small camping axes forged by me (2002). One is silver/copper encrusted, the other two are pattern welded. Photography by Gustav Thane.

my add further confusion? Or even render selective aspects of a craft invisible?

Strictly decorative techniques are problematic. The value of encrusting lines of silver into an axe surface is purely ornamental. When such a technique is described as a five-step joining technique, it might sound like this: 1. Engrave,[8] 2. Cut,[9] 3. Bend, 4. Encrust,[10] 5. File/Sand.

Such a description is not just difficult or even impossible to follow; it also misses the very point of ornamental endeavours. The softer metal, silver, is joined with the harder iron in a specific way, an example of a joining technique. But the purpose of this technique is not to join pieces of metal; it is all about creating a visual, artistic expression. In the taxonomy, the decorative techniques are not described for what they are intended to communicate: art. Instead, they are simply described as a series of actions. Without the illustrations or exemplifications of what shapes those actions intend to create, they do not even allow an experienced blacksmith to follow the technique described if the blacksmith does not already know it. Not only do practitioners need to know how the metal is supposed to move in the different steps in order to work together in the end, this very technique is also dependent on four specific fit-for-purpose tools. The craft verbs are a description in the sense that they line up techniques in an order—nothing more.

This, however, is the very scope of the chapter. Metal craft, when described solely as technique verbs,

captures something different than a craft manual or process description. It focuses on one specific aspect of a craft, an understanding found in the manual-gestures of named techniques, namely its principle, a system of forces, or action in relation to a responding material. When this is described as human time spent, it is a very specific mode of knowledge. It is a mode of knowledge which is commonly used in craft, but theoretically underdeveloped and scarcely represented in other fields of research.

THE BEGINNING OF A THEORY

So, how many words do we really need? I do not know, but the number of verbs in the radial tree is larger than I previously knew. I do not think of metal craft as a linguistic endeavour, but the possibility to describe it, as an activity, might lead to meaningful exchange within the crafts. As a teacher I will be more able to describe the fundamental principles when there is a word to house its meaning. And the division of the concepts into family groups likewise allows me to differentiate the way I make an axe from the ways that others do it. But I do not think that is the major advance of this chapter. Systematising the verbs offers something else, something similar to a practice-based model or the beginning of a theory. The radial tree is more than just a list; it is a taxonomy of craft activity. It describes things on different levels of abstraction. It organises metal craft relatively independently of the objects normally produced through it. Essentially, it puts the technique verb—a very specific aspect of a craft—in the focus of academic debate.

The radial tree also makes it clear how some techniques speak of a tool, others of a relationship between a craftsperson and metal without any acknowledgment of the tool. A hammer, a press, and a rolling mill are all tools (nouns) which can be turned into vague craft verbs, but the tools can all be used *to forge*, to *draw out*, or *to bend* with (verbs). The technique verb is often the same regardless of the tool used. Those technique verbs are not equivalent to a tool, shape, or function but a set of principles of the forces in a material, the action of a craftsperson, and the related kinematics. Those are the words pointing at the relationship between a maker and a material, the level of abstraction allowing us to enquire into this specific craft aspect of human time spent.

Above, I have illustrated how the taxonomy allowed me to understand and describe craft activity without the need to describe closely related things, such as artistic expression or functionality of the objects produced. In a way, this is the conclusion of the chapter. Collecting and organising technique verbs allowed me to describe a specific aspect of metal craft. At the same time, the circular tree is a database enabling the systematic archiving of craft techniques.

CONCLUSION

This is craft theory. A list of words enabling diverse descriptions of embodied skills. And the argument that practice can be understood as the principles named with a technique verb. Not only could this aid a teacher to describe craft for what it is in the moment of creation, it may also allow a researcher to problematise and critique an aspect of craft, best enquired in action. This potential theory does not intend to lean towards artistic craft nor conservation craft. As a theory it attempts instead to unite the two otherwise separate craft fields into one research practice.

The mode of knowledge I am referring to is primarily observable when craft is described on the second and third lowest levels of abstraction in the

taxonomy. Below this level, other concerns such as aesthetics, tools used, or the functionality of a product affect the descriptions of craft. Above it, materials used and formats of the materials likewise affect the relationships between techniques. But in those words—the craft verbs—I have identified an explicit way to talk about craft activity itself on the premises of a practitioner. Based on the taxonomy, I propose that great detail in metal craft activity can be described in an explicit, propositional way and there is a specific level of abstraction where this possibility ceases. The identification of this specific level, where metal craft activity is the best option to reach knowledge, is an advance of this work. Dialogue more specific than this needs to be illustrated somehow to make sense, just like more general descriptions do. This is a starting point from where to begin asking questions about metal craft, questions that do not speak about metal craft in general but of metal craft as it is embodied in the *movements*—the motor skills of shaping a material by hand.

I am drawing a line here: the line between a piece of work and work itself. It is an attempt to treat human time spent, discipline, and engagement as knowledge. I am not surprised to find a rigorous pattern of theory within the language of my craft. Through it, I suddenly saw my own actions and the practice of teaching them in a new way, as a rivet became the process *to rivet*, a form turned into human time spent. The list of words is published at www.craft-research.com/radialtree and if you know a craft verb missing in the list, feel free to add it.

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ENDNOTES

1. Taking a heat; drawing down; bending; upsetting or jumping up; hot cutting; punching and drifting; fire welding; heat treatment.
2. Verbs are generally used to convey an action, an occurrence, or a state of being. In the basic form (infinitive), you can put the word to in front of it, such as to forge, to turn, to paint, etc.
3. Power hammer, press, and rolling mill are all machines used to apply pressure on the metal to reshape it.
4. Drawing out is the technique where pressure is applied from two directions on a metal bar at 90- or 45-degree angles to each other. This makes the metal thinner and, at the same time, longer.
5. To punch a hole is a technique where you hit a punch (hardened steel tool with a flat top) into hot metal. After hitting the punch almost straight through the metal from the first side, you turn it 180 degrees and allow it to cool down a little (to around 650°C). You place the punch on the opposite side and hit. When the heated material is punched from the first side, it creates a deep cavity, and the material from the cavity is spread out making the rest of the metal swell out. The second time, the now swollen and relatively cold (hard) edges around the cavity hold a thin coin. When hit with the flat top of the punch, it will not bend but will crack along the side edges of the punch. The thin coin will fall out and you have a hole… and a coin, the size of the hole.
6. To set down is a group of techniques where force is applied on metal indirectly in the sense that a piece of heated metal is placed on or between a passive tool (set of tools) such as an anvil or a hot set. Force is applied with a hammer (or press) on the other side of the metal or on top of the hot set making the metal thinner on a strictly limited area, normally leaving the shape of the passive tool as a cavity in the heated metal.
7. To upset, bump up, or jump the material is the technique of making a piece of metal thicker and at the same time shorter.
8. To engrave is to cut a long groove into cold metal with a burin or similar, normally for decorative purposes.
9. To cut metal can refer to several different techniques. In this case it refers to the sort of cutting that is done with a chisel when the metal is cold in order to split a small part away from the rest of the metal.
10. To encrust is the name for the whole technique described but it also refers to its main feature of forcing a softer metal into the fishtail-shaped groove in a harder metal by hitting a punch placed on top of a thread of the softer metal placed on top of the cavity. The softer metal will get locked into the cavity while parts of it that did not fit in there are smeared out in a line on top of the harder metal's surface. Normally this smeared out line is grinded or filed allowing only the metal buried in the groove as a contrasting coloring on the surface of an object.