Tacit record: augmented documentation methods to access traditional blacksmith skills

Gunnar Almevik, Patrik Jarefjäll, Otto Samuelsson, Department of Conservation and Steneby School of Design and Crafts, University of Gothenburg, Sweden

http://www.craftlab.gu.se

Abstract: Traditional craftsmanship is a specified domain in UNESCO's Convention for the Safeguarding of the Intangible Cultural Heritage (2003). During 19th and 20th centuries, museums and archives in the western world have been collecting a considerable amount of artefacts and producing records of trades, workshops and manual procedures referring to threatened traditional crafts. What potential value is embedded in the records on traditional crafts? To whom and for what purpose may this documented heritage be of interest or have value? We find these questions critical to the subject of museology and to general safeguarding strategies of intangible cultural heritage. How can we develop augmented documentation methods and displays of traditional craftsmanship?

This paper critically investigates film making of traditional craftsmanship, and experimental methods as an appropriate way to elicit tacit dimensions and multisensory aspects of craft skills. The text is grounded on a case study of a documentary from early 1970's, recording two old blacksmiths making a wrought iron scythe. This documentary has generated several research questions: How instructive is this documentary as a learning resource for blacksmiths today? What meaningful information dwells in the colour and sound of the work process? How does the discontinuity of the edited film effect the intelligibility of the process in action?

The tacit dimension of craftsmanship has been investigated in philosophical and pedagogical research (Gamble 2002; Mayer 2003; Polanyi 1958; Schön 1983, 1987), management and organisation theory (Agyris 2003; Kolb 1984), and recently in the emerging field of craft research (Adamson 2010; Niedderer 2009). However, the peripheral focus on documentation methodology to elicit the tacit dimensions of traditional craftsmanship is not extensively examined. Peer research to this study is performed at The Art and Design Research Centre (ADRC) at Sheffield Hallam University (e.g. Hjort-Lassen & Wood 2013; McCullough 1997; Wood 2006; Wood, Rust & Horne 2009) and the Craft Laboratory at the university of Gothenburg (e.g. Almevik 2012; Jarefjäll & Sjömar 2011; Karlsson 2013) exploring the use of film record and time-geography in the documentation and display of craftsmanship.

The documentary is scrutinized through a time-space path and a procedure analysis. Setting out from the data and interpretation of the film record, the craft procedure has been re-enacted by the authors. The re-enactment gives a critical reference to the documentary, exposing discontinuities, lacunas, misinterpretations and hideouts of tacit blacksmith knowledge. Core problems in understanding skills and judgements made by the old blacksmiths relate to qualities lacking in the documentary concerning colour and authentic timeline. One sub-experiment concerning the judgment of colour in the process of hardening and welding is conducted through visual and IR measurement.

The general outcome of this investigation, concluded at the end of this article, contributes to a documentation methodology for heritage craft skills. We present a set of craft protocols along with a critical discussion on documentation practice to meet the agenda of "living" cultural heritage. The conclusion, with respect to museum collections and exhibitions, is that crafts people need to become involved in the work in heritage institutions, not only as objects or informants but also as work-companions and agents of generic knowledge.

Keywords: Documentation, traditional craftsmanship, blacksmith, tacit knowledge, time-space geography, craft protocol, process analysis, re-enactment, craft science

"Das Programm der Aufklärung ist die Entzauberung der Welt"[1]

(Theodor W. Adorno 1947)

Introduction

Traditional craftsmanship is a specified domain in UNESCO's Convention for the Safeguarding of the Intangible Cultural Heritage (2003). During 19th and 20th centuries, museums and archives in the western world have been collecting a considerable amount of artefacts and producing records of trades, workshops and manual procedures referring to threatened traditional crafts. What potential value is embedded in the records on traditional crafts? To whom and for what purpose may this documented heritage be of interest or have value? We find these questions critical to the subject of museology and to general safeguarding strategies of intangible cultural heritage. How can we develop augmented documentation methods and displays of traditional craftsmanship?

This paper critically investigates film making of traditional craftsmanship, and experimental methods as an appropriate way to elicit tacit dimensions and multisensory aspects of craft skills. The text is grounded on a case study of a documentary from early 1970's, recording two old blacksmiths making a wrought iron scythe. This documentary has generated several research questions: How instructive is this documentary as a learning resource for blacksmiths today? What meaningful information dwells in the colour and sound of the work process? How does the discontinuity of the edited film effect the intelligibility of the process in action?

The documentary is scrutinized through a time-space path and a procedure analysis. Setting out from the data and interpretation of the film record, the craft procedure has been re-enacted by the authors. The re-enactment gives a critical reference to the documentary, exposing discontinuities, lacunas, misinterpretations and hideouts of tacit blacksmith knowledge. Core problems in understanding skills and judgements made by the old blacksmiths relate to qualities lacking in the documentary concerning colour and authentic timeline. One sub-experiment concerning the judgment of colour in the process of hardening and welding is conducted through visual and IR measurement.

The investigation shows that the producers and editors of the film do not fully understand the state-of-the-art in craftsmanship. The documentary gives the impression of going deep into the knowledge of making a wrought iron scythe. However essential information related to the craft is absent. It will be exposed in the forthcoming presentation that the old blacksmiths do not carry on a functional tradition, but rather expose a break in the tradition of craftsmanship. The wrought scythes that are made in the film do not have the essential qualities to be used as scythes. A dysfunctional broken craft tradition is presented as traditional heritage.

The general outcome of this investigation, concluded at the end of this article, contributes to a documentation methodology for heritage craft skills. We present a set of craft protocols along with a critical discussion on documentation practice to meet the agenda of "living" cultural heritage. The conclusion, with respect to museum collections and exhibitions, is that crafts people need to become involved in the work in heritage institutions, not only as objects or informants but also as work-companions and agents of generic knowledge.

Fig. 1. *Photograph from the smithy.*

State of the art and beyond

The tacit dimension of craftsmanship has been investigated in philosophical and pedagogical research (Gamble 2002; Mayer 2003; Polanyi 1958; Schön 1983, 1987), management and organisation theory (Agyris 2003; Kolb 1984), and recently in the emerging field of craft research (Adamson 2010; Niedderer 2009). However, the peripheral focus on documentation methodology to elicit the tacit dimensions of traditional craftsmanship, beyond conceptual framing, is not yet extensively examined.

The achievements from the early digital museum projects in the 1990's to contemporary cyber museology are radical and successful in giving virtual access to exhibitions and stored cultural objects as well as archival records. Furthermore, developments in digital museology have opened up the museums to new audiences and learning situations (see Davis 2004; Langlais 2001), and have recently provided new methods for participatory production, heritage design and "co-curating" of history (Atkinson 2011; Allen & Lupo 2012; Stappers 2006). New approaches in virtual learning environment (VLE) and computational biomechanics in comparable craft-like fields such as physiotherapy, surgery and sport science are exploring augmented documentation methods (e.g. Holmberg 2008). The use of animations and virtual settings such as VR cubes or measurement-driven body models may capture performances and make the representation mobile and transferable, both to parties not present and to future generations.

Nevertheless, these precise representations do not automatically reveal judgments grounded on knowledge in action. Concerning craftsmanship, the substantive contributions in investigating working procedures are rather found in the crafter and maker communities, the so-called Do-It-Yourself movement (DIY). Illustrative examples include Inger Degerfeldt's crafts dictionary with instructional videos and student portfolio database "@tt slöjda" (http://www.slojd.nu) and, relating to this paper, Jock Dempsey's interactive demonstrations of traditional blacksmith techniques "iForge" (http://anvilfire.com).

There are research environments that resonate with the aim and approach of the study presented in this paper. The Art and Design Research Centre (ADRC) at Sheffield Hallam University have focused on suitable methods to reveal and make explicit tacit craft knowledge embedded within the experiential processes of creative craft production. Nicola Wood is a leading researcher, bringing a design approach to the problem of capturing and passing on the skilled knowledge of expert craft practitioners (Wood 2006). She has worked closely with craftspersons in the mission to understand how craft skills may be elicited and embodied in learning resources, aiming at bridging the knowledge gap between novice and master (Wood, N, Rust, C & Horne G 2009; Hjort-Lassen & Wood 2013). Simultaneously facing the dual problems of what is to be learnt and how it will be learnt, she has revealed how master craftsmen do not consistently teach and instruct, as they do themselves in action.

Another research environment that has contributed to the methodological development of craft documentation is the cluster at Norwegian University of Technology and Science (NTNU), cooperating with Sør-Trøndelag University College (HiST), the agency for Norwegian Craft Development (NHU). Harald Bentz Høgseth at NTNU pinpoints methodological issues in relation to the interpretation of craftsmanship (Høgseth 2007). His research is located in the fields of archaeology and building history, and he is trying to understand craftsmanship knowledge and skill by interpreting the physical traces of the historic craft action. The documentation methodology is directed both at the performance and the end product, combining 3D modeling of objects and notation systems of bodily performance.

The Craft laboratory at the University of Gothenburg is a research cluster for experimental research in the field of traditional craftsmanship. The Craft Laboratory has developed methods for self-observation by elaborated craft protocols, film records and visual graphs to elicit the multisensory and performative aspects of craft (Sjömar 2011, 2013; Almevik 2012; Börjesson 2013). Several integrated doctoral projects have a methodological perspective on documentation, seeking to explore the generative aspects and tacit dimensions of procedural knowledge in crafts (Karlsson 2012; Renmælmo 2009). This study directly relates to Patrik Jarefjäll's research, exploring traditional blacksmith procedures using time-space geography, process analysis and self-reflected re-enactments (Jarefjäll & Sjömar 2011).

The case: Documentary of traditional scythe blacksmith

The regional museum in Västerbotten has produced artistically refined records of traditional crafts, cultural environments and livelihood through the film media. The majority of the 60 films from the museum are made either by Sune Jonsson (1930-2008) or Rickard Tegström (1909–1981). Jonsson's documentaries and photography won him the International Hasselblad Prize 1993. Tenström's internationally recognized documentary "Rajd" (1945) captures Sami reindeer livestock. During the latter half of the 19th century he made several records of traditional crafts with ethnological assistance by Katarina Ågren, including deep studies of craft procedures and workshops by basket makers and blacksmiths.

In the film "Liesmide" [wrought scythe] Tegström and Ågren display the work of two brothers, Helmer and Bengt Lundgren in Hötjärn, Lövånger, in the region of Västerbotten. The film dates to 1971 and the fieldwork is carried out during two days in total. The film is 18 minutes long with faded colour and no sound from the actual environment. The applied speaker presents information of the visualised operation and comments on the blacksmith's terminology for tools, procedures and parts of the scythe. The film starts when the two brothers, who have learned the craft of wrought iron scythes from their father, enter the old smithy and start to prepare the iron. The timeline follows the procedure step-by-step from cutting up the iron, forming the scythe, and welding and hardening the steel. In the final scenes the brothers show off the final scythe.

What potential value is embedded in this documentary of traditional blacksmith crafts? What is the purpose of this documented heritage? Who is it of interest or value to? By what methods could a documentary of a craft procedure be analysed?

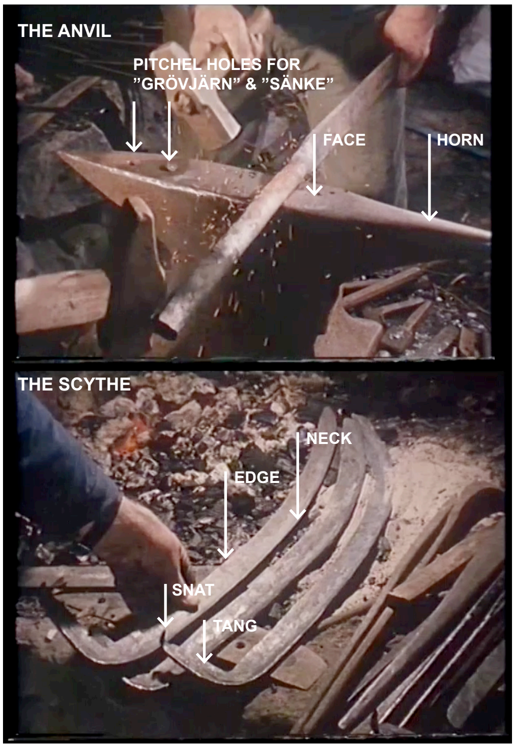


Fig. 2. *Terminology from the documentary “Liesmide” by Rickard Tegström.*

Time-space geography of the documentary “Liesmide”

Our investigation starts with an analysis of the documentary using time-space geography, a method originating in cultural geography. One objective is to test time-space geography as an analytical tool. Beyond this methodological interest, we stress how the discontinuity and the audio-visual information in the documentary are manipulated in the filmmaking and the editorial interventions. The methodology of time-space geography focuses on the movement of an individual, or the so-called individual’s time-space path, correlated in a temporal-spatial environment and visualised in a graphic template. The analysis in this case results in a protocol about the film that is not to be mixed up with the actual craft process. This protocol serves as an interpretation tool as well as comparative material to the procedural reconstruction of the actual craft.

The analysis pinpoints discontinuity in the time-space path. We have counted 151 clips, reducing two days of film shooting to 18 minutes and 17 seconds including text-based meta information and environment panoramas. The average frequency of clips is 7.3 seconds. This is an average for Tegström’s documentaries in general, and also praxis for the 1960’s Hollywood school where he was trained (Jordan E. DeLong et al. 2012).

Time-space geography was developed by Torsten Hägerstrand (2009, 2000, 1991), originally to serve geographical diffusion studies of the migration and spread of new technologies. The method has been modified to the nature of our empirical material and objective.

1. The time-space path is the timeline of the documentary.

2. The space is the visual appearance of space displayed by the film.

Defining concepts of space for a blacksmith is unconventional in relation to how the methodology is commonly used in geography. Spaces like ‘outside’ or ‘interior of the smithy’, and locations such as ‘the forge’ or ‘the anvil’ are easily distinguishable spaces.

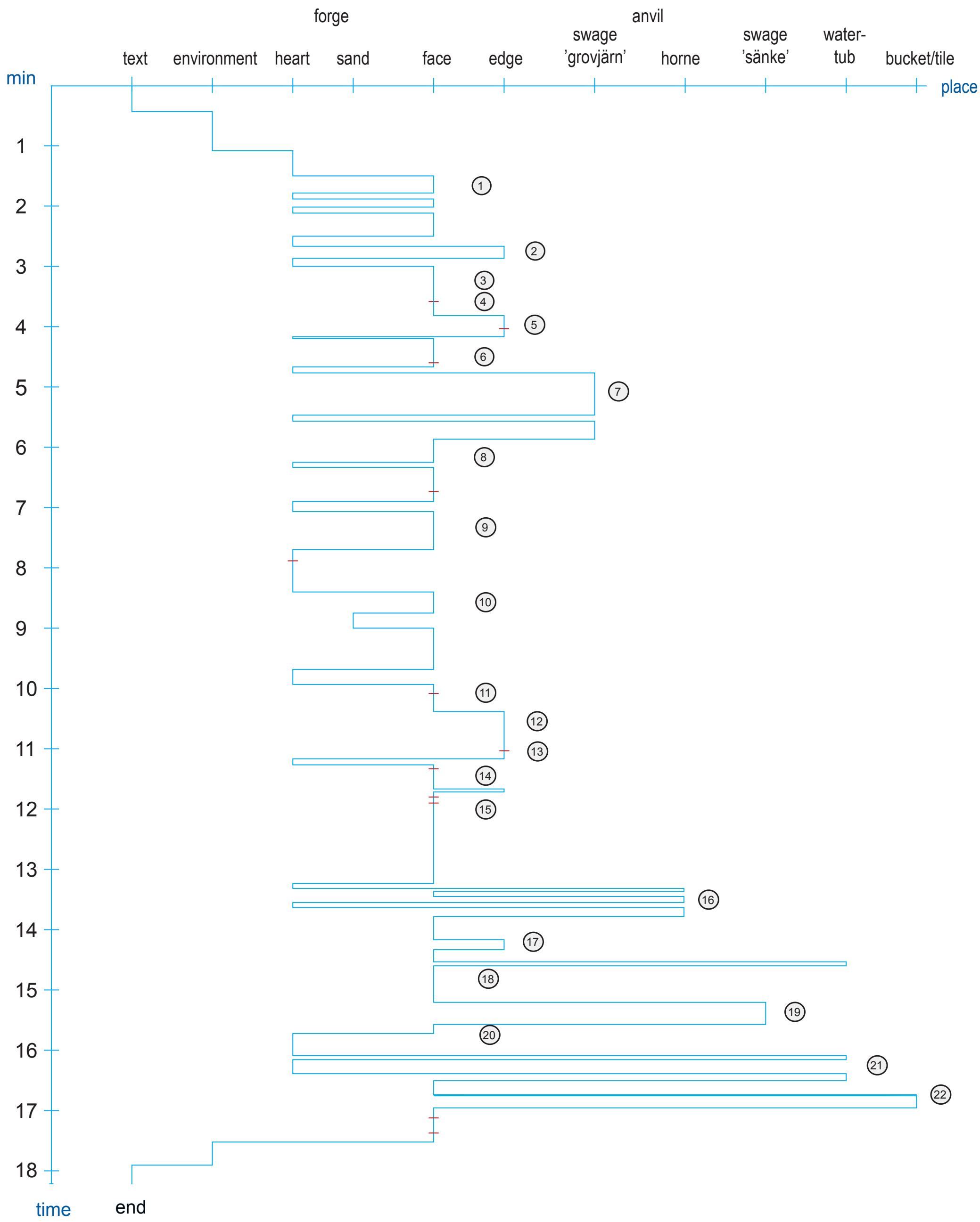


Fig. 3. Time-space path of the documentary. *The blue line shows the time-space path of the edited film. The numbers to the left refers to the procedures in the smith process (see fig 4.). The film visualises 11 different spaces from different angels, edited in 55 movements be tween spaces. The representation of the craft process, from cutting up the steel matter to the final inspection of the scythes, takes about 16 minutes.*

The fast movements of a blacksmith between short-range distances on the anvil - from the horn, to the face, to the heel - or by tools temporarily added to the anvil, "re-space" this micro-environment like swages (or 'bending tools').

The time-space geography exposes lapses in the documentary. The film does not make it clear how many scythes are produced during the film shooting. In general the film follows one scythe, but we see, for instance, three inlay pieces of steel being cut up. At the end of the film two scythes are displayed. Whether there is one scythe in operation or a series edited in one timeline (or the same clip looped to fill a sound-gap for the speaker) is of vital importance for the interpretation of craftsmanship. It is for instance not possible to repeat the final operation of hardening the steel in water that is done in the film. The scythe would crack. We assume, they start off with material for three scythes, one is discarded, and one is preferred to show off. The filmmakers edit clips working with the different scythes serving for a record of the general procedure.

Interpretation of the filmed blacksmith process

The second type of protocol is a conventional process analysis, often associated with industrial production and the application of the measurement-time-method (MTM) for industrial efficiency. The process analysis is an intelligible type of protocol, however, in relation to craftsmanship it may be deviously instructive. The linearly sequenced procedures are, what Michael Polanyi refers to as *maxims*, i.e. rules of the art that may serve as a guide if integrated in the practical knowledge (Polanyi 1958, pp.49-50). The maxims are representations, not to be confused with the actual craft knowledge. The process analysis visualises what could be interpreted as an ended knowledge system (Senneth 2008), but the master craft knowledge is very complex, and rather an open-ended knowledge system (Giunta E., Lupo E. & Trocchianesi R. 2011).

- *The process* may be defined as an action that contains sequenced procedures, aiming at transforming raw material to a distinguished product. In this case the transformation of a piece of iron into a scythe, by a sequence of blacksmith procedures.
- *The procedures* have distinguished causal goal-mean relations. However, it is not possible to fully control the craft situation, and therefore the quality of the result is not predetermined by standard procedures. The craft knowledge involves the continuous feedback and corrections of procedures. Craft depends on, as David Pye claims, “the judgment, dexterity and care which the maker exercises as he works” (2008, p.4).
- *The moments* snapped from the craft actions may uncover the judgments, dexterity and care contained within the procedures.

In the specific case of the smithery in Tegström’s documentary, we have identified central procedures and snapped core moments within the process, with critical comments on material, tools and working methods. This protocol is useful to interpret and prepare for the re-enactment, giving a hypothesis of the actual procedure represented in the documentary.

The film shows in all, 20 procedures within the smithing process from raw material to the made scythe. There are general procedures in blacksmith crafts, like hardening and annealing. There are also specific procedures in scythe making, like the banding of the blade by a concave swage tool. The smith hits the banding obliquely against the neck, making a ridge that preserves the form of the blade while attenuating to the chine. In the moments of actions, variants in performance are exposed, like the use of a snowball in the procedure of annealing the steel.

Judging by the action related to the visible result, the performance is dysfunctional. The blacksmiths in the film work the material very hard - stretching, bending and wielding the scythe - sometimes in too high a temperature, where a considerable amount of steel is burnt off. This is visible by the many sparks of iron around the matter. Thus the work is carried out in cold iron many times. It is not appropriate in this procedure in the craft of blacksmith. The steel in the welding does not always seem to have been fused. The surface looks oxidised and the texture porous with notably enlarged grain (in the material structure). There are visible cracks in the blade close to the tang and to the snat. The scythes presented at the end of the film do not have the required qualities to be used for haymaking.

STEP	MOMENT	LOGG	PROCEDURE	INFORMATION
1		01:30	Klyver stålet	Klyver 0-stål till liens egg med varmmejsel i tre lika delar.
2		02:40	Kapar stålet	Kapar ståltenar från 0-stålämnet - längd ett kvarter = 15cm
3		03:30	Räcker stålet	Stålets längd sträcker sig längs hela eggen, och en bit in på låret.
4		03:35	Mäter upp järnet	Plattjärnets längd mäts med 0-stål som mall/1+1 kvarter = 30cm
5		03:49	Kapar järnet	Kapar järnet kallt med varmmejsel. Bockar och bryter av.
6		04:12	Tunnar ut järnet	Tunnar ut ena sidan av halva järnets bredd & 0-stålets längd.
7		04:46	Bockar järnet	Förbockar järnet i mitten med hammarens pen. Många värmningar/dålig kontroll? 4:50 bockas järnet felvänt? 05:06 visas den uttunnade sidan rättvänd
8		06:44	Lägger i stål	Iläggning av 0-stål, kallt
9		07:04	Packning	Stål och järn packas samman med hammare & slägga
10		09:00	Väller-räcker	Förväller stål & järnämne, vidare välls ämnena samman. 9:15 mitten av järnet, 9:24 toppen, 9:33 mitten
11		09:50	Vällning/räckning	Väller toppen med för hög välltemperatur, mellan 09:50-57 brinner stålet i vällämnet, 10:16-24 räcks vällämnets bakände/lår/tjuet
12		10:24	Kapning av vällämnet	Kapar kallt med varmmejsel & bryter av vällämnet från plattjärn. 10:24-10:37 syns en tydlig tvärgående spricka, pga. för hög välltemperatur, ca 15 cm från den avkapade änden-tjuet/låret.
13		10:52	Räckning	Räcker tjuet/ låret. 10:48, 10:55 noterar välltemperaturspricka
14		11:07	Formning	Formar brom/låstappen kontrollerar tjockleken på låret kontinuerligt med fast tolkmått.
15		12:07	Kälning	Med kälsätt & slägga smids en ränna längs hela lieämnet som bildar övergång mellan rygg & blad. 12:12 från varmt till kallt, 12:33 varmt igen
16		13:19	Bockar och riktar	Bockar övergång/böjen mellan liebladet & fästet/låret
17		14:10	Bockar och riktar	Bockar bromen/låstappen
18		14:36	Formar liebladet	Tunnar ut bladet kallt, smider med hammarens ban och pen om vartannat
19		15:15	Formning -pening	Formar en fördjupning med hammarens pen över sänke som ger förstärkning för liebladet
20		15:37	Stämplar lieblad	Stämplar lie två gånger, det är sannolikt två olika liar?
21		15:46	Härdning	Värmer det färdigsmidda liebladet & söker härdtemperatur. Släcker i vattenkar. Härdar och släcker två gånger i sammanhängande följd. Det är sannolikt fråga om två olika liar.
22		16:42	Anlöpning	Liebladet väms upp för anlöpningen, temperaturen kontrolleras med snöboll så den inte blir för hög & härdningen går ur helt. 16:43 syns ett annat lieblad där glödskal/oxider skrubbas bort med tegelsten & får fram den blanka metallytan för att se & följa anlöpningsfärgens skiftningar.

Fig. 4. Process analysis. *Photographs from Tegström 1971.*

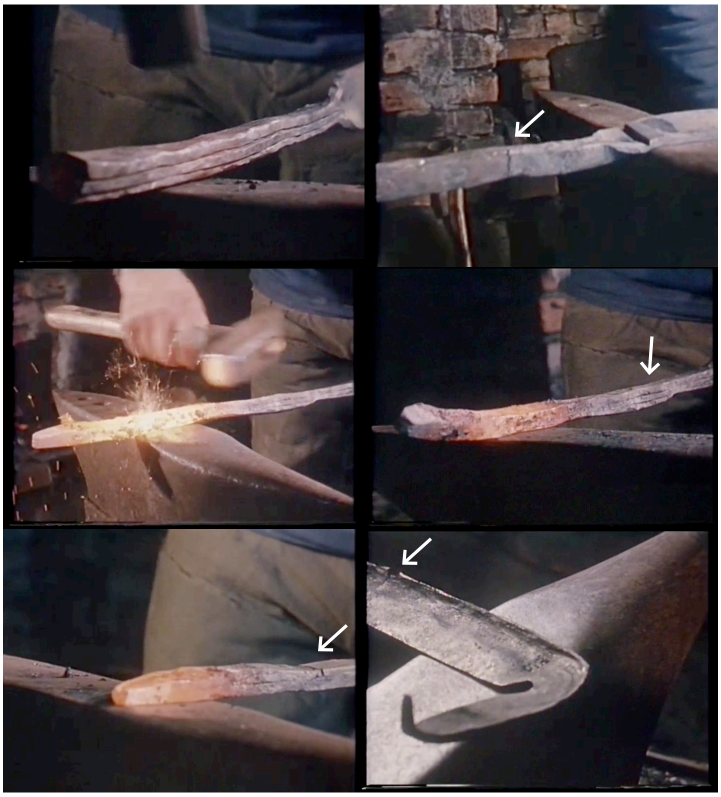


Fig. 5. Example of overheating of the steel when welding, creating massiv oxidation causing fissures later in the forging process (see arrows). Photographs from Tegström 1971.

Plasticine modeling

The information in the documentary did not answer two crucial questions for guidance of the reconstruction: What steel quality and measures of the raw material were used? Steel quality, weight or measures affects both the procedure and the final form and measurements of the scythe.

The measure to start with is important. In the documentary, the smiths use relative measurements and templates that we can only make assumptions of. To test the relation between the form of the raw material and the scythe, a plastic model was made. This is a traditional method in forging, presented as early as 1927 (Metzger 1927). The modelling has a two-folded function. Firstly, to prepare and practice the forging process, obtaining a pre-understanding of the form as well as the procedures. Secondly, the plastic model serves to test the relation between the volume of raw material and the measurements of the scythe.

The raw material is normally reduced during the process of making a scythe; the steel is heated over 200 times. This factor is skill dependent. The material will spark away if over-heated and over-worked, but various types of steel burn off differently. The speaker in the film refers to “zero-steel” which is not a conventional specification. It might be a misunderstanding or a personal or local term. We assume it was an iron of traditional quality with carbon 0.6-0.7%, common during the 19th and early 20th centuries. To imitate the characteristics of low alloye carbon steel. (SS 1770) was used.

Fig. 6. *Plasticine modelling*

Reconstruction

The reconstruction of the process has been carried out by Patrik Jarefjäll and Otto Samuelsson, both blacksmiths and craft readers. The aim is to expose and test the information presented in the documentary. What information is guiding the forging process? What information-gaps are necessary to fill in?

Skill is an issue of trustworthiness in the reconstruction. Skill is a vital ingredient in the investigating method: to reflect in action and over action. The team possesses profound blacksmith skills and can relate to forging praxis and living traditions in the category of wrought sharp-edged tools. However, they do not have extensive experience making scythes. Two scythes were produced in the reconstruction. The first one was more for learning than investigating.

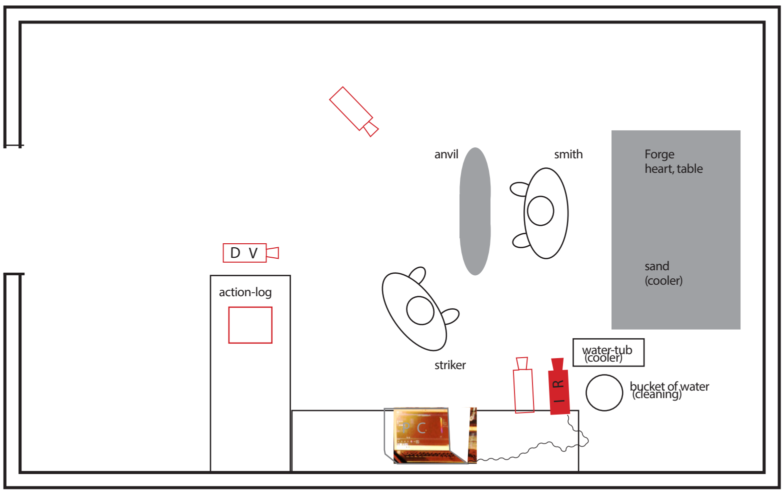
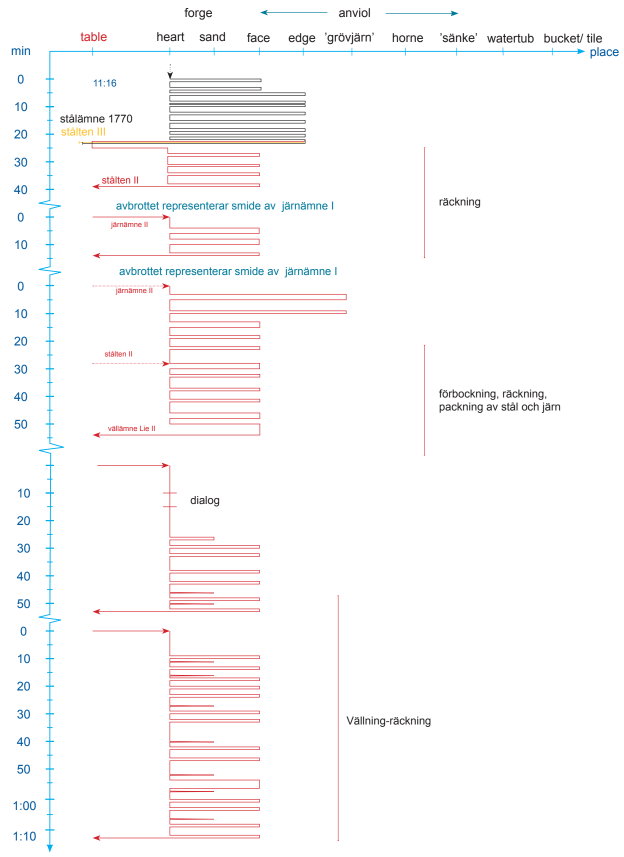
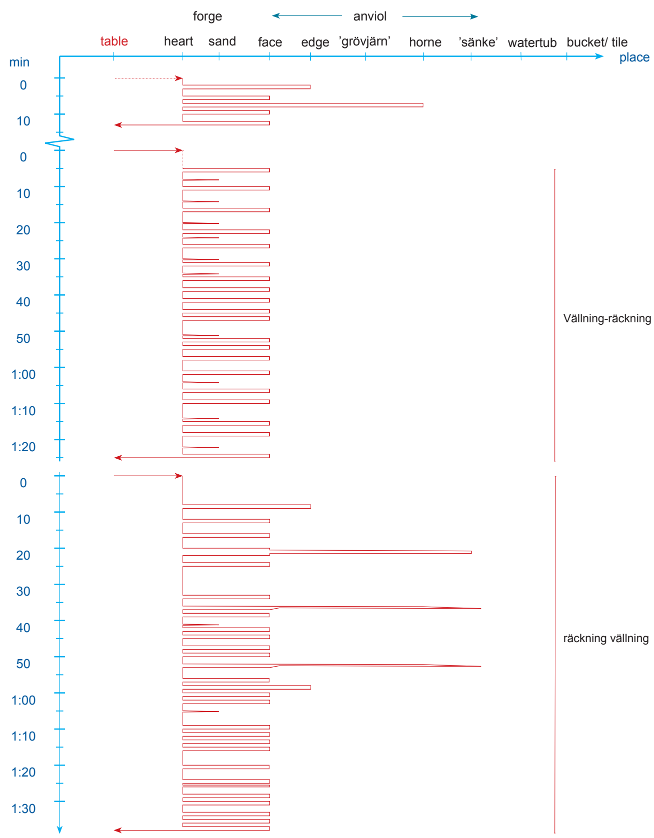


Fig. 7. *Spaces in the time-path of the reconstruction*

The casting of the reconstruction involved one smith and one striker. The smith keeps focus on the process, while the striker, besides working the sledge, also managed documentation. The documentation consists of an event log to frame procedures and moments in the process in time and space. As a back up, a film camera was rigged to capture the whole process. The event-log provides data to the time-space path of the reconstruction, giving a comparable protocol to the documentary.


forge
anviol
table
heart
sand
face
edge
'grövjärn'
horne
'sänke'
watertub
bucket/ tile
min
place
0
10
20
30
40
0
10
0
10
20
30
40
50
10
20
30
40
50
0
10
20
30
40
50
1:00
1:10
11:16
stålämne 1770
stålten III
stålten II
avbrottet representerar smide av järnämne I
järnämne II
avbrottet representerar smide av järnämne I
järnämne II
stålten II
vällämne Lie II
räckning
förbockning, räckning,
packning av stål och järn
dialog
Vällning-räckning


forge
anviol
table
heart
sand
face
edge
'grövjärn'
horne
'sänke'
watertub
bucket/ tile
min
place
0
10
0
10
20
30
40
50
1:00
1:10
1:20
0
10
20
30
40
50
1:00
1:10
1:20
1:30
Vällning-räckning
räckning vällning

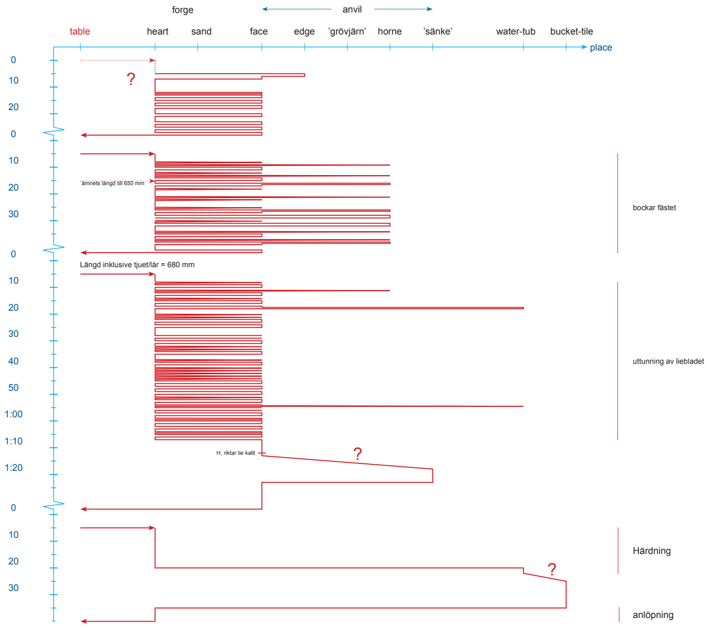


Fig. 8. *Time-space path of the reconstruction.*

The investigation is similar to traditional action research, in the sense that the researcher is a subject undertaking actions that are at the same time the research object. The researcher is directly influenced by the result of the reconstruction. The research contains elements of planning, action, observation and reflection, but not in the line of Kurt Levin's action research spiral (Levin 1946, see critique by eg. Wood 2006). The analytical friction is created by moving between observation of matter, self-observation *in action* and self and participant observation *over action* (see Schön 1983, Molander 1996). The protocols are essentials, serving as documentation and at the same time as hypotheses and displays of results. The dialogue, the reinterpretation of records and the production of craft protocols, build up the level of inquiry, from personal experience, to gaining a possible inter-subjective result.

Documentation is fundamental to the investigation, but it also causes problems. The documentation mission takes focus away from the actual performance. The requirements in research are destructive to the tacit knowledge required in the action, that itself is required in this type of practice-led research. The research questions and focal interventions disturb the flow. The scientific term "observation effect", may be relevant to define this type of problem, when the very observation effects the nature of the object studied. Documentation is important, but the only way is to truly represent tacit knowledge is as craft knowledge.

Another critical aspect of the reconstruction is the difficulty in judging the effect in action of one's own internalised experience. The challenge is to use experiences and skills, and at the same time undertake a performance that may follow another tradition or working method. For instance, the smiths in the documentary packed the steel in the welding process in a way that was causing problems. For craftsmen, it is common practical logic to solve problems in action rather than to question and review the situation from *another* theoretical position than the one undertaken in action. This is logical in the field of practice. Using craft practice as method for inquiry, it is devastating. To follow the exact procedures demonstrated in the documentary was necessary to expose more precisely what aspects of the process were dysfunctional. In this case, a sum of bad decisions: too much heat burning off material; not working the weld enough when correctly heated; working too hard on cold iron; and starting from the tang to the edge causing problems keeping the steel in position.

IR measurement of colour judgment over heat

The documentary has faded colours, and consequently this aspect of the forgery was difficult to assimilate in the reconstruction. The speaker tells us that the old smiths make important judgments of colour when hardening and annealing the blades. Therefore, two sub-experiments were performed, in order to explore problems and possibilities to record and display colour in a useful way for forgery. The test was set up to interpret the problems exposed in the documentary: that the weld of steel in the scythe's blade did not merge. And that the final scythe had cracks in the blade.

The test was set up in a smithy with an infra red (IR) camera.[2] The IR filming was synchronized with conventional filming by two cameras. These were set to give different angels of the procedure, one narrowly focused and one giving the situational setting.

Firstly, a prototype of a weld, similar to the actual scythe was made. The prototype was welded in two different manners. One over heated and another aimed at a optimal temperature. The approximations were measured by the infra red (IR) camera and related back to the result. The over-heated weld was measured to 1030 – 1230 degrees c. during welding, and the test aimed at an optimal temperature of 1000 to 1100 degrees c.

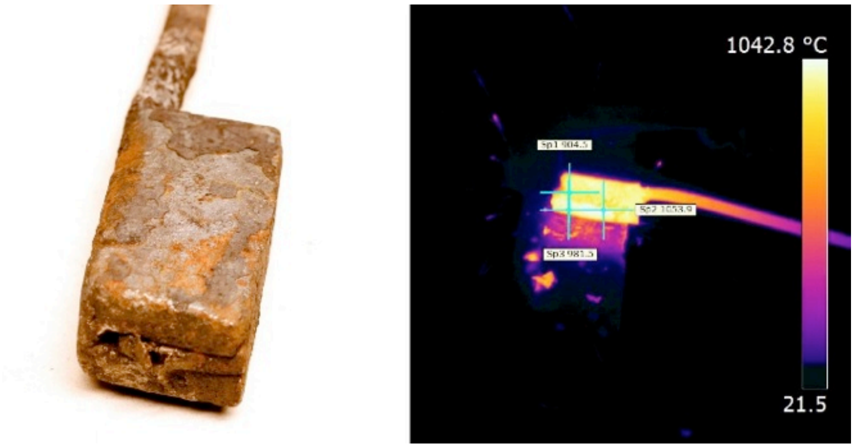


Fig. 9. Weld prototype and film situation. *The sample of welding (left) shows the result when overheating the 0,6 % carbon steel in the middle. This happened because of warming for to long time in the forge. The 0.6 % C steel starts to melt and "burn" and while striking, the material starts to fissure. The 0,1 % carbon steel at the sides are better preserved due to their higher melting-point. (Right) Image from the IR-camera on the welding test. The temperatures measured during the different welding tests shows inconstancies, questioning the use of IR-camera to estimate temperatures while welding in this test situation.*

It is not possible to give an exact optimal temperature. The skill is to balance within a span, aiming at reaching the same temperature on the steel as the surrounding iron, somewhere about 1000 degrees c. On the one hand, the balancing act is to avoid extensive high temperatures, resulting in enlarged granules of steel that deteriorate the quality. Hitting too hard with hammer blows might result in splitting the materials instead of fusing them. On the other hand, the balancing act requires not working the weld in too low a temperature, risking welding cracks in the blade.

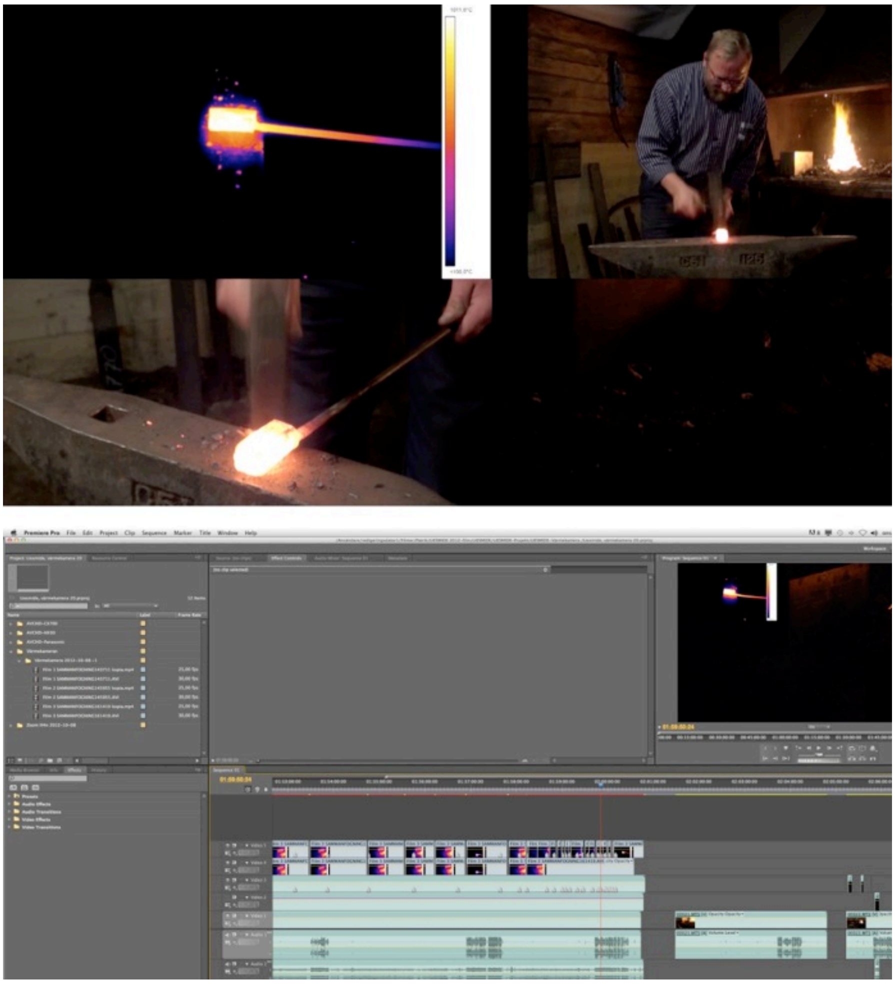


Fig. 10. *An attempt to synchronize the registrations from the IR-camera and the film from the welding tests was made.*

Our interpretation of the welding in the documentary is that the smiths did both wrong. The unusual long weld as in a scythe was sometimes over-heated, and the granule of steel was enlarged and ruined. The weld did not join together. The documentary also indicated that the weld was sometimes worked almost cold, resulting in mechanical cracks.

The second test concerned the hardening. The speaker tells us that “the smiths judge by the colour of the steel when it is the right temperature to harden”. The scythe is heated and, at the right moment, is sunk down into a long narrow barrel of ice-cold water. The blade is held straight with the edge upward, so that it won’t warp. The annealing, when normalising the steel, is made with a snowball. The colours shift, but the smith’s readings of the steel are not examined further in the documentary.

Our last test concerns the judgement over temperature in hardening. The temperature is judged by the colour. The optimal temperature to get a fine and solid structure of the material can vary with different types of steel. The kind of low carbon spring-steel SS 1770 that were used are recommended for hardening at 780-800 degrees c.

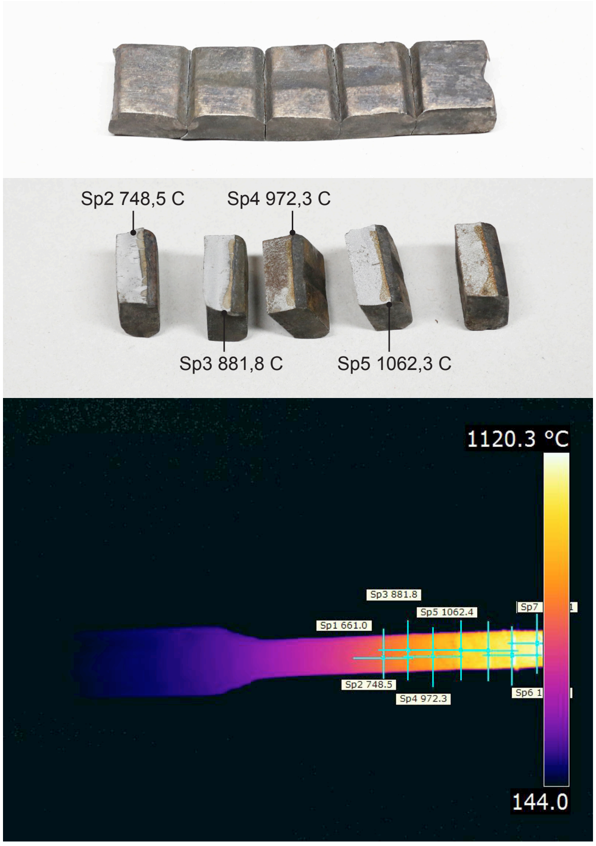


Fig. 11. *The hardening tests show a correlation between measured temperatures by the IR-camera and the fineness in the grain seen in the surfaces of the fractures done in the hardened steel. A finer grain points out nearness to optimal hardening temperature 780° C, cooling in water, according recommendations from manufacturers of the 0,6 % carbon steel, SS 1770).*

A traditional way to test the hardening and to learn the scale of colour, is to make a test with a gradient scale of heat on a piece of steel. The steel is cut up and the optimal temperature can be judged by the granule of the steel. The smith had to memories the look of the right colour.

In the test this traditional way of testing the hardening was made and at the same time filmed with the IR camera. In this way the smith's tacit judgement was tested, both by the nominal scale of temperature and by the granules. The methods were triangulated. The result was surprisingly consequent: the visual judgement of the right temperature was at the second mark (Sp 2), giving the temperature 748,5 degrees c. and a solid steel cross section.

The conclusion is that it is possible to use an IR camera to reflect upon the tacit judgement concerning colour in the craft of forgery. However, there are many shortcomings with the technology. Firstly, the IR camera cannot measure a reflective surface. Therefore the annealing process such as the polished blade is as reflective as glass. Secondly, the IR camera continually self-calibrates in relation to the varying temperature in the room. This implies a shift in the timeline and number of shots when edited to synchronize with the other films. A third problem is that the IR camera gives the temperature at the surface, when in forgery the cross section is the most important.

Conclusions

This investigation is a contribution to on-going experimental and partly heuristic research, to develop an augmented methodology for documentation of traditional craftsmanship. The general result of this case study is the testing of the time-space geographical method, applied on traditional craft performance. The time-space geography is a development of the event-log, and puts light on the discontinuity and the spacing of the craft performance. The method can be used to analyse an existing document, or to prepare for a re-enactment, and possibly also to plan a documentary. The presenting of the individual path from top down corresponds to the reading of a homepage. A further development could be to link audio, motion pictures, guidance and meta-texts to the diagram presented on a homepage.

The testing of triangulating visual judgement of steel colour as tacit blacksmith knowledge, within both traditional analogue tests and digital IR measurement, suggests technological aids for the smith to train judgements on temperature by the colour of iron. Further studies would be interesting, to examine the subjective and possible inter-subjective judgements of steel temperature by colour, and how this could affect a smith's strategy and outcome in processes of welding, hardening and annealing.

The case of the documentary “Liesmide” shows that the producers and editors of the film do not fully understand the crafts. The wrought scythes that are made in the film do not have essential qualities to be used as scythes. The old blacksmiths do not carry on a functional tradition, but rather expose a break in tradition of craftsmanship. In contemporary museum work, trained crafts persons need to become involved in this type of documentation. The aim cannot stop at a nice story, when the needs of safeguarding and enhancement in this type of rare crafts are tremendous.

From esoteric archives into living heritage

Mass production and mass consumption have greatly challenged craftsmanship. Trade structures for crafts have been dissolved, enterprises have been decimated and curriculums of vocational education focus mainly on the qualifications demanded by industry. In some cases centuries-old traditions of knowledge and skills have been lost. Still, in this transcending intersection, small craft-based enterprises constitute a large part of the economy. According to the European association of craft enterprises (UEAPME), the small craft-based enterprises generate one-third of all employment opportunities in Europe (FBC 2011). UEAPME also notes that craft production has different functions and meanings in today's society.

During the industrialization era, many craft fields moved from everyday functional production to artisan products and arts. A recent phenomenon is that traditional crafts use heritage as a means of branding, or more actively seek out the field of heritage preservation and embrace the identity of intangible cultural heritage (ICH) of a nation, region, community or group. There is a risk that these crafts become obsolete, and end up as esoteric archive records.

When a craft is defined as ‘traditional’, one may assume that the tradition is threatened. There is a call for a new museum practice to enhance the capacity of traditional craftsmanship to meet future challenges. An augmented documentation could serve craft persons and communities to investigate a craft-related problem, to create learning resources or experiment new work methods, tools and products. To meet a broader audience and support the all through necessary co-craft strategies in the weak and endangered craft fields.

Endnotes

1. ”The program of enlightenment is the disenchantment of the world”. Translation by the authors. In Swedish *Aufklärung* is translated by the word *trolldomskraft*.
2. The termographic manager was Per Stenberg, KIMO Instrument AB, certified ITC Level II No: 2011SE24N003. The camera used was a FLIR T-640, radiometric collection was made by FLIR Tools+, and editing and export FLIR ThermaCAM Researcher pro. The accuracy is calibrated within +/– 2°C or +/– 2% of reading.

References

Adamson, G. (ed.) (2010). *The Craft Reader.* Oxford: Berg.

Allen J., Lupo E. (ed.) (2012), *Representing Museum Technologies.* Copenhagen: Interaction Design Institute.

Almevik, G. (2012). “Documentation within traditional crafts. From archive to living heritage”. AIHC Conference *Re/theorizing heritage* 12.06.05-09, Gothenburg.

Argyris C (1995). Action science and organizational learning. In: *Journal of Managerial Psychology*, vol 10, no 6.

Atkinson, P (2011). ”Orchestral Manoeuvres in Design”. In: *Open Design Now: Why Design Cannot Remain Exclusive.* Amsterdam: BIS Publishers.

Börjesson, S. (2013). *Smeden och stenen.* Mariestad: Craft Laboratory.

Davis, A. (2004). “Museology and the Intangible Heritage of Learning.” In: *Museology and Intangible Heritage II*. 2004. ICOM International Symposium 2004.

FBH Cologne and IBW (2011). *Identification of future skills needs in micro and craft(-type) enteprisis up to 2020.* URL: http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/files/skillsneeds_final_report_final_180211_en.pdf

Gamble J (2002). Teaching without words: tacit knowledge in apprenticeship. In: *Journal of Education*, vol 28, pp 63-82.

Giunta E., Lupo E. and Trocchianesi R. (2011). "Design research and cultural heritage: activating the value of cultural assets as open-ended knowledge system". In: *Design Principles and Practices Journal*.

Godal, J. B. Martinussen, A. O. & Walker, I. Ö. (1996). Hantverksregistret. Prinsipp og problemstillinger i dokumentasjonsarbeid knytt till hantverk. Lillehammar: NHU, Maihaugen.

Hjort-Lassen, U & Wood, N. (2013). "'Plumb line scribe': Using multimedia to preserve traditional craft skills" In: *Craft Research*, vol. 4, no. 1.

Holmberg, J. (2008). *Musculoskeletal Biomechanics in Cross-country Skiing*. Linköping: Linköping University Electronic Press. URL: http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-76148

Hägerstrand, T. (2009). *Tillvaroväven*. Stockholm: Forskningsrådet Formas.

Hägerstrand, T. (2000). Narratives and computations. Knowing and Doing. On knowledge and in environmental protection. LJ Lundgren, Swedish Environmental Protection Agency, 307-315.

Hägerstrand, T. (1991). *Om tidens vidd och tingens ordning: texter av Torsten Hägerstrand.* Stockholm: Statens råd för byggnadsforskning.

Høgseth, H. B. (2007). Håndverkerens redskapskasse: En undersøkelse av kunnskapsutøvelse i lys av arkeologisk bygningstømmer fra 1000-tallet (Doctoral dissertation, Norwegian University of Science and Technology).

Jarefjäll, P. & Sjömar, P. (2011). "Skärande handverktyg för träbearbetning – en projektbeskrivning". In: *Hantverkslaboratorium* (ed. E. Löfgren) Mariestad: Hantverkslaboratoriet, Göteborgs universitet. URL: http://www.craftlab.gu.se/digitalAssets/1328/1328347_jarefj--ll--2011--hantverkslaboratoriet.pdf

Karlsson. T. (2013). *Ramverksdörr. En studie i bänksnickeri.* Lic. Göteborg: Univ.

Kolb, D. (1984). *Experiential learning.* Prentice Hall, Englewood Cliffs, NJ.

Langlois, D. (2005). Cybermuseology and intangible cultural heritage. In *Intersection conference*.

Lewin, K. (1946). Action research and minority problems. I: *Journal of Social Issues.* 1946:2-4, s. 34-46.

Lupo E. (2010). "Beyond craft Culture. Designing a new contemporary authentic". In: Design & Craft Conference proceedings, Bruxelles.

Mayer, R. E. (2003). The promise of multimedia learning: using the same instructional design methods across different media. Learning and Instruction, vol 13, no 2, pp 125-139.

McCullough, M. (1997). *Abstracting Craft: The Practiced Digital Hand.* Cambridge, MA: MIT Press.

Metzger, M (1927). Dei Kunstschlosserei von Max Metzger. 4 ed, Lübeck: Verlag Charles Coleman.

Niedderer, K. (2009). "Sustainability of Craft as a Discipline?" In: *Making Futures.* Proceedings of the Making Futures Conference 2009, Plymouth: Plymouth College of Art, Vol 1, pp. 165-174. URL: http://makingfutures.plymouthart.ac.uk/journalvol1/papers/kristina-niedderer.pdf

Polanyi, M. (1958). Personal knowledge: towards a post-critical philosophy. Routledge & Kegan Paul, London.

Pye, D. (2008). *The nature and art of workmanship*. Rev. ed. London: Herbert Press.

Renmælmo, R. (2009). "The Skjelter Boathouse (Skjelternaustet)". In: *Living Crafts*, NHU, 2009, pp. 138-148.

Sennett, R. (2008). *The Craftsman.* New Haven: Yale University Press

Schön, D. (1983). The Reflective Practitioner. How professionals think in action, London: Temple Smith.

Schön, D. (1987). Educating the reflective practitioner: toward a new design for teaching and learning in the professions. Jossey-Bass, London.

Sjömar, P. (2013). *Försöksverksamhet med hantverksinriktad forskarutbildning*. Duplic. Department of Conservation, Craft Laboratory, University of Gothenburg.

Sjömar, P. (2011). Hantverkarens kunskap. In: *Hantverkslaboratorium*. Mariestad: Hantverkslaboratoriet, Göteborgs universitet.

Stappers, P.J. (2006). “Creative Connections: User, Designer, Context, and Tools”.. In: *Personal and Ubiquitous Computing*, 10 (2-3).

Tegström, R (1972). *Liesmide.* Film. Umeå: Västerbottens museum.

Wood, N. (2006). *Transmitting craft knowledge.* Diss. Sheffield: Univ.

Wood, N., Rust, C., & Horne, G. (2009). A Tacit Understanding. In: *International Journal of Design*.*Jordan* E. DeLong et.al. *2012*