Journal of Research Practice
Volume 11, Issue 2, Article M6, 2015

ISSN: 1712-851X

Main Article:

Expertise and Tacit Knowledge in Artistic and Design Processes: Results of an Ethnographic Study

Johanna Schindler
Research Fellow, WÜRTH Chair of Cultural Production
Zeppelin University, Am Seemooser Horn 20
88045 Friedrichshafen, GERMANY
johanna.schindler@zu.de

Abstract

Professional experiences and expertise are considered to rely on tacit knowledge, knowledge we use unconsciously and cannot entirely put into words. In the context of artistic research, the notion of tacit knowledge has been invoked to explain artistic practices as well as research and design processes. However, few authors precisely distinguish between an explicit and an implicit dimension of tacit knowledge. This article focuses on different qualities of implicit knowledge and questions its ineffability. It assesses the interplay of latent and manifest forms of knowledge involved in artistic and design processes. An artistic research project seeking to develop new electronic musical instruments was observed over a 5-week period. The results of this ethnographic study show that, against common conceptions of the ineffability of tacit knowledge, it can be conveyed partly in an articulate manner. In addition to models and gestures, researchers need a certain expertise in capturing their knowledge in words. A further conclusion is that merely sensuous knowledge—knowledge related to the five senses—cannot be entirely put into words.

Index Terms: tacit knowledge; embodied knowledge; capacity for action; electronic musical instrument; design process; artistic research; ethnography

Suggested Citation: Schindler, J. (2015). Expertise and tacit knowledge in artistic and design processes: Results of an ethnographic study. *Journal of Research Practice, 11*(2), Article M6. Retrieved from http://jrp.icaap.org/index.php/jrp/article/view/494/421

1. Introduction: Tacit Knowledge in Contexts of Artistic Research

Professional experiences and expertise are considered to rely on tacit knowledge, a concept brought forward by Polanyi (1983). His claim "*we know more than we can tell*" (p. 4, original emphasis) forms a basis for the widely accepted assumption that tacit knowledge is ineffable. In other words, this phrase suggests that we do not need to think while we are carrying out certain activities. Rather, we perform these activities intuitively, which is why we are unable to (fully) articulate the knowledge used in such activities. The most classic example of tacit knowledge is riding a bicycle. Also, playing an instrument or singing can be mentioned among such routinized, implicit practices. A common denominator of these examples is the body, which is why the term *embodied knowledge* is frequently used (cf. Ignatow, 2007). This corresponds to the assumption that corporal senses and experiences are crucial for the development and use of tacit knowledge (Ignatow, 2007, pp. 118-120; Sennett, 2008, p. 178). In relation to artistic craftsmanship, Sennett (2008) claims that tacit knowledge consists of "unspoken and uncodified words, that occurred [in the workshop] and became a matter of habit, the thousand little everyday moves that add up in sum to a practice" (p. 77). Further thoughts have been expressed on artistic practices and the nature of the knowledge they potentially generate: O'Riley (2011) states that artistic research practices are characterized by "provisionality" (p. 2) instead of aiming at a defined "end product." For Martínez (2012), "the gesture of placing the 'maybe' at the core of the real" (p. 46) is central to the arts' challenging our common patterns of thinking and perception, which Borgdorff (2009) describes as "fundamentally unfinished critical reflection" (p. 79). Stimulating human perception through individual aesthetic experiences is paradigmatic for the arts. These experiences go hand in hand with non-discursive, embodied, sense-based forms of knowledge central to both the creation and reception of artworks.

The author was interested in these research questions: (a) how implicit knowledge can be assessed and (b) whether it does entirely remain ineffable. She conducted ethnographic research in the field of *artistic research*. More precisely, she accompanied a team of researchers seeking to design electronic musical instruments. Often, collaborative research projects carried out by teams of artists and scientists can be found in the field of artistic research. The artistic research discourse has focused on: (a) the practical and theoretical implications of such projects (e.g., Caduff, Siegenthaler, & Wälchli, 2009; Dombois, Bauer, Mareis, & Schwab, 2012; Hannula, Suoranta, & Vadén, 2005; 2014; Tröndle & Warmers, 2012) and (b) on the different notions and current formats of artistic research (e.g., Borgdorff, 2006; Buck, Hofhues, & Schindler, 2015; Busch, 2009; Frayling, 1993; Mäkelä, Nimkulrat, Dash, & Nsenga, 2011; SHARE, 2014). Such interdisciplinary projects are challenged by the tension between latent and manifest forms of knowledge. In contrast to the above mentioned provisional, intuitive, and subjective artistic practices, scientific methods are often described as well structured, repeatable, and reproducible. In addition, scientists mostly follow a clear aim formulated in research questions or hypotheses. They produce factual, explicit knowledge conveyed to the audience in a written, that is, discursive manner (see also Klein, 2007, p. 32).

Feyerabend (1984) demonstrates that the distinction between the arts and sciences in line with the dichotomy of objectivity-subjectivity or theory-practice is outdated (see also

Biggs, 2007, pp. 1-3). However, the potential of collaboration between the arts and sciences in terms of research and knowledge production has been explored repeatedly (cf. Caduff, Siegenthaler, & Wälchli, 2009; Stemmler, 2014; Tröndle & Warmers, 2012). Putting aside the differences and looking at their similarities, one can say that scientific and artistic practices share epistemic potential in that they challenge common assumptions, question installed systems, and criticize fixed patterns of thinking. Against this background, it is not surprising that both fields are interested in discovering each other's methods and topics in collaborative research projects (see e.g., Holert, 2011; Sheikh, 2006; 2009; Steyerl, 2010, which discuss the potential risk of exploiting the arts for the knowledge society's economic and aesthetic purposes). Due to their interdisciplinary nature, artistic research projects are inherently reflexive. The integrative use of artistic and scientific practices demands a high level of communication in order to translate between the disciplines, discuss different perspectives, and develop a common vocabulary necessary for joint work (see also Tröndle et al., 2011). One can therefore assume that artists, designers, and scientists involved in such projects are used to explaining their practices and knowledge to lay people. Additionally, the notion of design is increasingly used in artistic research contexts, and design as a discipline has been investigated for its epistemic potential in parallel (cf. Cross, 2006; for a historical overview see Mareis, 2014). Consequently, projects in the field of artistic research provide an excellent environment to conduct ethnographic field research on the interplay of explicit and tacit knowledge in artistic and design processes.

After a short overview of the literature on tacit knowledge, the methodological setting of the field research study is explained in Section 2. In Section 3, select ethnographic descriptions are quoted and analysed. The results are discussed with regard to their implications for further research on tacit knowledge in Section 4.

1.1. Literature Review

Central to this article are the following research questions: How can tacit knowledge be accessed? Does it remain ineffable or are there possibilities to uncover it? As mentioned above, this specific form of knowledge is commonly considered to be—for the most part—unexplainable. Some authors, such as the communication scientist Loenhoff (2015, p. 24), argue that implicit knowledge is acquired via socialization within a certain milieu and thus based on collective cultural patterns (cf. Mareis, 2012, p. 70).

Others hold the opposite opinion. Ignatow (2007) refers to the term *embodied knowledge* used in cognitive psychology to underline the subjective nature of tacit knowledge. While experiencing a situation, visual, auditory, mobility, and emotional senses are addressed and memorized as representations of these situations. These representations are then abstracted from memory and registered as individual bodily experience (Ignatow, 2007 pp. 120-122).

In sociological disciplines, different classifications are developed. Adloff, Gerund, and Kaldewey (2015) distinguish between a "strong" and a "weak" form of tacit knowledge, the former being ineffable, the latter explicable (p. 13). The paradox resulting from this basic distinction is that tacit knowledge made explicit cannot be any longer considered

implicit. Shotwell (2015) suggests four distinct but linked forms of "implicit understanding: practical or skill-based forms of understanding, socially-situated habitus, tacit but propositionalizable beliefs, and affective or emotional understanding" (p. 172). These precise categories intend to overcome the aforementioned paradox, but the notions of understanding and knowledge are not equivalent (ibid.).

Despite such conflicting conceptions of tacit knowledge, the mentioned disciplines—communication science, cognitive psychology, and sociology—agree with sociology of knowledge and its pragmatist stances on the following aspect. The latter claim that tacit knowledge is acquired via practical experiences and can be considered as a "*capacity for action*" (Stehr, 2009, p. 305, original emphasis) guiding future activities. Accordingly, tacit knowledge is assumed to be represented in routinized practices, which are carried out in a non-articulate manner (Sennett, 2008, p. 50).

Building upon Polanyi (1983), Dewey (1934), and Schön (1983), the idea of tacit knowledge becoming manifest in routinized activities has been further developed especially with regard to artistic practices and design processes. For example, Zembylas (2012) emphasizes that in artistic practices, sensory, non-linguistic aspects are predominant, which are not necessarily observable but indicate whether an action is perceived as successful or unsuccessful and thus constitute meaning (p. 203; cf. Tröndle 2012b). In accordance with this assumption, Zembylas (2012) also shows that artistic and design processes—"design" here alludes both to the German term *Gestaltung* and to design as a discipline—are marked by directed attention on a specific activity on the one hand and by intuitive actions on the other. The latter cannot necessarily be described or justified, since only parts of such processes are carried out in a conscious and focused manner. Rather, terminological knowledge, experiential knowledge about artistic material and practices, sensory impressions, and artistic-practical knowledge are crucial for the development of ideas (p. 207). Furthermore, in practice-based design research, tacit knowledge is considered to be inherent in the master-apprentice model and to be a constituting aspect of authority, since it can only be conveyed by examples and imitation of an expert (Mareis, 2012, p. 67). Rust (2004), on the other hand, gives several examples from the field of design enquiry proposing strategies to access tacit knowledge in arts-sciences-collaborations (pp. 82-84).

Recent publications on tacit knowledge in artistic research use attributes such as "pre-reflective" (Borgdorff, 2009), "experiential" (Mareis, 2012; Zembylas, 2012), "embodied" (Tröndle, 2012a), "sensuous" (Bergen National Academy of the Arts, 2006), "material" (Zembylas, 2012), and "practical" (Mareis, 2012; Zembylas, 2012) to describe and discuss implicit knowledge and its manifold forms (see Biggs & Karlsson, 2010; Caduff, Siedenthaler, & Wälchli, 2009 for an overview). These publications emphasize two aspects: (a) In contrast to the rather static notion of "knowledge," the expression "knowing" is used to underline the processual character of knowledge generation (see also Dewey, 1934) and (b) artistic and design practices are considered to evoke a "different" understanding of societal or scientific phenomena. Only Mareis (2012) takes a critical stance on the concept of implicit knowledge and its frequent use as explanation for tacit elements in artistic and design practices (p. 70). While Biggs (2004; 2007) draws on the notion of quality to underline that knowledge gained through experiences is tacit

and unlikely to be similar for two different people, only Niedderer and Imani (2008) precisely distinguish between an explicit and an implicit dimension within tacit knowledge. They propose a model defining the quality of an experience as the tacit dimension of "experiential knowledge" and the description of that same experience as its explicit dimension (p. 7). In an earlier article, Niedderer (2007) outlines a relational model distinguishing propositional, experiential, and procedural knowledge with regard to their communicability (pp. 9-10).

The results presented in this article are based on the notion of knowledge as capacity for action, on the one hand, and on the idea of embodied tacit knowledge mirrored in concrete practices, on the other. During the observation of artistic and design processes in the field, the author looked for indicators of tacit knowledge reflected in these processes. These will be discussed in the examples of artistic and design practices presented in Section 3.

2. Methodological Setting: Ethnographic Field Research

2.1. Research Setting

In order to assess the interplay of latent and manifest forms of knowledge, the author carried out an ethnographic meta-analysis of an artistic research project initiated by two universities in Germany: Technical University, Berlin and University of the Arts, Berlin. The research team comprised seven artists, designers, and scientists from diverse fields (audio communication, computer science, cultural studies, neurocognitive psychology, product design, sound engineering, and systematic musicology). The overall objective of this project was to design and develop electronic musical instruments using both artistic and scientific methods in an integrative manner. More precisely, the idea was to develop various prototypes of digital instruments with which further research could be performed regarding their playability, performance set-ups, audience perception, and commercial viability. At the same time, the team carried out empirical studies in the field of electronic music and developed a new classification system for digital instruments, which challenged existing systematizations of traditional musical instruments.

For 5 weeks, the author—trained in cultural studies and ethnographic research—carried out participant observation and accompanied the research team during their daily work in the offices, workshops, team meetings, and in more informal settings, such as lunch and coffee breaks. During this time, the predominant activity of three researchers (a computer scientist, a product designer, and a sound engineer) was the revision of an instrument prototype which they had developed in the course of the past year. This included the redesign and further development of sound and mappings, the refinement of formal, aesthetic and technical aspects through the on-going processes of modelling, testing, asking for advice, negotiating, and decision-making. Hence, the observed phase proved useful to uncover the interplay of the various forms of explicit and tacit knowledge involved at various stages of the project.

2.2. Data Collection and Analysis

Equipped with a pen and a notebook, the main method of documentation was to take detailed fieldnotes and drawings (cf. Emerson, Fretz, & Shaw, 2011). Research processes were described in full sentences with official and informal conversations recorded in jottings. When appropriate, and only with the consent of the team members, photographs were taken to document a specific work process or spatial set-up. In three situations, the author was able to assist the researchers with small tasks such as sanding or pinning pictures to the mood board, so that actual experiences confirmed or rebutted previous observations. The fieldnotes were retyped and complemented with the author's reflections on her role, potential influence on, and own experience in the various settings. This resulted in detailed ethnographic descriptions of spatial arrangements and research practices (90 pages).

In this context, an explicit reference to Latour and Woolgar (1979) and Knorr Cetina (1981) can be made. They were among the first to emphasize the social-constructivist nature of data gathered, transcribed, written up, and analysed by a researcher unable to neglect his or her disciplinary socialization. In addition, the level of knowledge about the field the researcher is about to enter plays an essential role for the depth of understanding he or she can achieve. Consequently, impressions and facts presented as results depend to a certain degree on the ethnographer carrying out the field research.

To access the researchers' explicit and tacit knowledge, two simple questions were used: (a) asking them to explain what they were doing and (b) why they were doing it in that specific way. This resulted in a description of the activity carried out and a line of reasoning which could then be analysed. The explanation of the practice itself was used as an indicator for the artists' and scientists' ability to convey knowledge in an articulate, explicit manner. The reasoning indicated different dimensions of argumentation such as aesthetic, technical, useful, individual preference. As tacit knowledge could be observed but not articulated in routinized practices (e.g., etching, sewing, programming, etc.), both questions were repeatedly asked during each activity, so that the point where knowledge could no longer be put into words was reached.

Open coding was used for the ethnographic descriptions (Emerson, Fretz, & Shaw, 2011, p. 175). They were coded according to aspects the researcher encountered in the field (e.g., time, pace, work environment, decision logic, etc.) and those mentioned by other researchers in the team (e.g., spatial separation, pressure, working methods, etc.). In line with the analytic focus of this article, only passages giving descriptions of manifest or latent forms of knowledge are interpreted in the next section. The inserted quotations are excerpts of fieldnotes taken during team meetings to document dialogues between the researchers, during workshop sessions, or after a conversation with the author. They are used to emphasize the results outlined in the following section.

3. Results: Expertise and Tacit Knowledge in Design Processes

During the field research phase, the first instrument prototype brought forward by the research team was further developed. Since the team had been invited to play and present their instrument at an international competition for new electronic musical instruments, they aimed at refining several aesthetic and technical details. The researchers involved in this process were the computer scientist (CS), the product designer (PD), and the sound engineer (SE). Even though each of them was responsible for a specific task, major and final decisions were taken on a consensual basis. Especially aspects regarding the playability of the instrument were discussed in the team, since each researcher had individual experiences with the first instrument and preferred certain aspects to be transferred to or altered in the second version of the instrument. In addition to individual preferences, the researchers' experiences with material, personal musical competences, disciplinary background, and their physical or technical limitations influenced the development of the existing prototype.

Most often, a lack of knowledge, for example, regarding electronic details, could be resolved within the team. However, in some cases, the team's consultation with advisors, for example, from the sewing workshop or design department, implicitly contributed to the change of ideas, shapes, or material. This interplay of preferences, explicit and tacit knowledge could be revealed through the ethnographic field research. The following paragraphs contain the results of the analysis, revealing that the ineffability of tacit knowledge can be questioned and a more precise definition of the quality of tacit knowledge is necessary.

Figure 1 shows the redesigned instrument. It consisted of the following elements:

(a) a Plexiglas box tied to the thigh at the bottom for locating two valves, pressure sensors, two microphones, two encoders to switch the sounds and volume, and four buttons to activate an influx patch;
(b) a latex bellow containing LEDs, light and position sensors; and
(c) the upper 3D-printed part for the electronics (battery, cables, sender), five capacitive sensor surfaces (CapSenses) to play the instrument, and a strap to be fastened to the hand when playing.

Figure 1. The redesigned instrument prototype. © 3DMIN.org.

As the instrument could be connected via Wi-Fi, data gathered with the help of the sensors were sent to a computer and then synthesized into sounds that the team previously developed and mapped with the software programme *SuperCollider*. Five sound patches were pre-programmed:

(a) a *breath patch* amplifying the sound produced via the valves when pulling up an pushing down the bellow;
(b) a *toll patch* initiating rhythmic ticking;
(c) a *saw patch* producing polyphonic electronic sounds;
(d) a *tonal patch* allowing to play an A-minor scale; and
(e) an *influx patch* feeding back the measured signals into the instrument with the help of an algorithm, resulting in an unpredictable sound.

Each sound patch was modulated via the CapSenses with which a low-pass filter could be activated or chords could be played in the tonal patch. Prior to this redesigned instrument, there were three instruments: two for right-handed and one for left-handed users. The upper and lower parts fixing the bellow were made from wood, and instead of capacitive sensor surfaces, each instrument was played with the help of a joystick for the thumb and four buttons for each finger. The team is currently working on an online manual, documenting each step of the instrument production for the do-it-yourself community to rebuild the instrument. The next step will be to hand the instrument over to external composers and/or musicians to further refine the instrument's playability.

3.1. Experiences With Material

During the first days of the field research phase, it was apparent that each researcher had expert knowledge about material of a certain kind, be it wood, Plexiglas, or specific software. For example, while observing the computer scientist (CS) working on the programming back-end, he used shortcuts, marking and copy-pasting items in a focused and quick manner, so that it was difficult to actually discern the performed changes. Several times, he paused to explain basic functions of the software to the author:

> CS tests the connections of the circuit board for the four CapSenses, on which he had previously soldered pins. Step by step, he explains which pins need to be connected with which resistor cables. After typing a command for starting the data transfer, one of the four streams, which are supposed to result in the same data, differs from the others. Testing the connections again one after the other in a structured manner, he identifies an incorrectly soldered pin and re-solders it. Afterwards, four similar data streams are visible in the back-end. (Fieldnotes, line 801ff)

In this case, material knowledge and expertise eased the process of finding a solution for an unexpected problem. The steps which had to be performed to resolve the problem were clear to the computer scientist. The sound engineer (SE) summarized the expertise of the team members: "The combination of the three of us is a good one. Each of us has some knowledge about the others' fields, but still is an expert him/herself. And programming cannot be learned within a month." (Fieldnotes, line 865ff)

A more detailed description of the sound engineer's experience with etching demonstrated the impact of experience on time needed to proceed with an activity.

> SE explains that the CapSense designs will be printed on transparent film, put onto a circuit board with a UV-resistant surface, and in an exposure unit before putting it into an etching liquid for about 20-30 minutes, removing all exposed parts. "You have to try things out a bit before finding the right workflow with your material." Asking him what he means by "trying out", he answers "I use scales and mix X grams of powder Z with water to get a saturated solution, try it with the board, and if it works out fine, I'll remember it for next time." (Fieldnotes, line 705ff)

> . . . The following morning, we take the elevator to go to the basement and enter a room on the left. I immediately sense an intense smell of chemicals and think that this must be a quite unhealthy working environment in the long run. . . . In the back of the room, there are two tables on which I can see the exposure unit and two flat plastic containers, one containing transparent, the other coloured liquid, and the etching liquid in an upright aquarium-like water bath. I approach the two flat containers. SE: "It's a little toxic down here, don't get too close," so I quickly move backwards. He puts on an apron, hangs safety goggles around his neck, and explains to me in detail which ratio he used to mix powder and liquid for the solutions already

> prepared. He then removes the protective film from the circuit board and carefully puts the printed designs exactly on the board before putting both into the exposure unit. He closes the lid and enters a time of 2.36 minutes. Since he had achieved the perfect ratio for the saturated solutions via a trial and error process, I assume the same for the time span and ask "How much or often did you vary the time until you knew 2.36 worked out fine?" He answers, "Well, during the introduction to this laboratory I was told that 2.36 is a good time." . . . He briefly explains the etching process to the two colleagues, who entered the room in the meantime, correctly puts on the safety goggles and carefully puts the circuit board into the flat containers and the water bath subsequently: the first transparent liquid removes all exposed parts, the coloured liquid serves cleansing the board, and hanging the circuit board into the etching liquid emphasizes the contrast of copper and non-exposed sections of the board. (Fieldnotes, line 869ff)

Approximately 10 minutes passed, from going down to the basement to putting the circuit board into the etching bath. The steps were carried out in a precise, efficient manner and in the correct order, leading to the desired outcome. This demonstrated the sound engineer's experience with the material, machines, and the precautions necessary for etching processes. In addition, he could explain the activity and the composition of the liquids used on a very basic level. A general understanding of the process was gained, even though this does not imply that the author would achieve the same result during an etching procedure.

Nevertheless, there were moments when the researchers carried out activities for the first time. These took much more time, trial and error, reflection, and sometimes consultation until the researchers were satisfied with the result. For example, on the same day of the etching process, the author observed the sound engineer working with the laser cutter.

> After lunch, at 2:30 p.m., I return to the basement and find SE working on a document for the laser cutter in the front part of the room. After starting a cutting process of small microphone holders, he edits the document again and starts another cutting process. He repeats this two or three times until the cut elements have the required radius. He explains to me that with a different laser cutter, he would have to test the material and radius again, "that's what I meant with 'finding the workflow.' The circuit board with the blue protective film works well. I use it all the time, because I know it works out. A different company might use a different composition." (Fieldnotes, line 910ff)

When sewing the strap models, the product designer (PD) consulted the sewing workshop director several times before and during the sewing process. She had worked on various versions with a sewing machine at home but was grateful for the workshop Director's advice on eyelets and tricks to correctly double, fold, and iron the cloth so that the final straps would not crinkle and would fasten the hand tightly to the upper instrument part (Fieldnotes, lines 418ff and 2292ff).

> During their conversation, both [workshop Director] and PD stop, look at the ceiling and think, trying to comprehend what the other just said without repeating it in words. PD has an aha-experience (11:25a.m.) and goes back to the iron. "I think, now I know how to do it," she says, rather to herself than to me. She explains the procedure to me again while ironing the cloth: three of the sides will be folded automatically, so that she only needs to pre-iron one. She briefly stops, hesitates, thinks and looks as if reconstructing the workshop Director's thought process once more. After finishing ironing, she goes back to the sewing machine. . . . At 11:35 a.m., she starts sewing the first double-layered piece, is focused, almost strained, and does not talk much. She only comments: "It's been a while since I've last used such an industrial machine. At home, I usually use a household device." (Fieldnotes, line 2299ff)
>
> . . . The following morning, we meet in the sewing workshop again, since further strap versions with different closing mechanisms need to be produced. My impression is that the product designer sews much faster and in a more directed manner with fewer hesitation or stopping-moments. As if reading my thoughts, she comments, "It's working much better today. Yesterday, I had to try things out a lot longer." (Fieldnotes, line 2551ff)

These examples demonstrate that, on the one hand, material knowledge influences various aspects relevant to artistic practices, such as finding forms and accurate solutions, the time one might spend on trial and error experiments, or on asking more experienced people for advice as opposed to just proceeding with an action. On the other hand, such knowledge that is based on experiences with certain tools or material can be readily explained. It only remains tacit as long as it does not need to be conveyed in the form of facts, instructions, or recommendations.

Further observations uncovered that working with familiar materials or tools can be an inhibiting factor regarding the development of new ideas. This was reflected in the sound engineer's comment: "With the laser cutter, we can cut Plexiglas or wood. That's all I know so that's the ideas I come up with" (Fieldnotes, line 3130f). At the same time, it also provided a practicable solution in a stressful situation, as can be seen in the final production phase when small bars were needed to stabilize and properly fix the upper hand part to the bellow. The bars were cut from Plexiglas, which was the cheapest, fastest, and thus the most convenient solution at that time.

3.2. Using Known Research Methods

In the examined project, new ideas did not result from known material or expert advice only. This section describes a specific method the product designer used to structure and develop new ideas. In order to further develop the upper instrument part including the strap, she created a*mood board*, a technique commonly used in design processes to visually organize inspirations (Figures 2 and 3). She first spent approximately 2 hours in one afternoon to look for pictures on the Internet. The author observed her during this time. The following morning, she printed, grouped, and pinned the pictures onto the board. The pinning process took approximately 3 hours, but could be observed for 1 and a half hours only.

Figure 2. The Mood board in the making. © Johanna Schindler.

Figure 3. Section of the finalized mood board. © Johanna Schindler.

While observing this process, the author (A) repeatedly asked the product designer (PD) for more details on the technique, which would otherwise have been carried out in a tacit manner:

> A: So you are looking for terms such as . . .?
>
> PD: Handle, grab, tether . . .
>
> A: Okay, and is this a technique you learned during your studies?
>
> PD: Yes, exactly.
>
> A: And you especially liked it or found it specifically useful?
>
> PD: Yes. It's a collection. Well, originally, the mood board stems from fashion. When you start to design a collection, you do this in order to get into a certain mood. It's not only blue, cold, winter [she says pointing to several images], but everything connected to it to create a mood. [The lecturer who gave a workshop on staging practices several days before this conversation] would say "to create a world." (Fieldnotes, line 1775ff)

The process of organizing pictures included several re-hangings. The author asked the product designer to explain why certain images were re-located. She mentioned several categories according to the pictures that were organized both in clustered fields (e.g., movie pictures, guitars) and in vertical lines (e.g., revolvers). Being interested in the reasons why these pictures were chosen and how they would be mirrored in the future instrument, the author asked the product designer for further explanation.

> PD: This is a collection and then we choose and decide.
>
> A: How do you make that decision? Is it based on individual preference?
>
> PD: Well, it is not about individual preference. Of course, you are never independent from your personality, but first and foremost, it is about the material or the possibilities.
>
> A: That is, with regard to the instrument you first looked for forms or were there specific functions, too, you wanted the instrument to have?
>
> PD: First, it was about finding a form, but the functions were added as well. This is also a part of the conversation with [the product design professor advising the team]. Starting with weapons, masculinity, strength, going to animalistic, sadomasochism, something sexual, too. And then we constructed the bellow. The search for and collection of terms and pictures serves to find a code that is integrated into the work. . . .
>
> A: And why do you particularly look at guitars in such detail?

> PD: Guitars exist in the most diverse forms and combinations of material. It is also a matter of using various sorts of wood. (Fieldnotes, lines 1785ff and 1876ff)

This conversation on the reasons why she chose a specific field for her inspiration and why she pinned only a selection of the pictures previously printed led the product designer to the following statement:

> PD: It is difficult for me to put this in words and to always talk about intuition. But in the end, I think I choose images intuitively and pin them onto the mood board. There were functions we wanted to have, which resulted in a certain material and the other way round. Right now, my aim is to link the upper hand part and the strap with the already existing material of the bellow and the lower box, both from material and formal points of view. (Fieldnotes, line 1879ff)

With regard to the theoretical considerations in the first section of this article, two conclusions can be drawn here. First, the ethnographic fieldnotes quoted in this section illustrate that tacit knowledge was reflected in the routinized practice of searching and choosing pictures and material for a mood board, yet it did not need to be articulated. Rather, Schön's concept of the*reflective practitioner* (1983) became visible in the tacit processes of rearranging the images. Secondly, the product designer was able to give clear answers and reasons for using the method. The knowledge about the method itself, the instruments, and other fields of research could be conveyed to the author in an articulate manner. Even though this was considered to be difficult, it was possible to create an understanding of the research practice and its implications for the redesigning of the instrument. Put more precisely, while the pictures on the mood board visually underlined the product designer's line of reasoning, her knowledge was transferred on a linguistic level in the end.

3.3. Role of the Body

Contrary to the previous examples, there were also situations in which articulating knowledge linguistically proved more difficult. Among others, this was linked to experiences with the previous instrument prototype, which were used as an argument to introduce changes in the second version:

> 12:20 p.m. CS connects the round CapSense surface for the thumb to the computer and holds it into the air to demonstrate it.
>
> PD: Speaking of which: joystick or . . .
>
> CS explains that it was difficult to do circling hand movements on a CapSense.
>
> CS: They are more sensible, however. And the joystick was hard to play, too.
>
> CS gets a pen and paper and draws a potential thumb surface on the paper.
>
> CS: It would be interesting to look at it as a four-slider surface. The solder points are good as well: You sense the middle of the surface like via braille.

> SE walks around the table to look at the drawing and says: It's virtual to agree on something you haven't played yet.
>
> SE takes the paper model and draws the potential surface in an ergonomic shape with two axes. Then he puts the joystick into the former upper hand part and says that if he used the stick, it was with the second hand.
>
> PD: Intuitively, I feel better with the joystick, since you can push against it and because it hooks. I have never used CapSenses before. I need to try them, which is why now I quickly say "It's not very well playable."
>
> CS: Using the joystick is different, but it works very well, because you feel resistance.
>
> PD: YES!
>
> CS: There is a trend in design to remove every physical resistance, which I am not a fan of.
>
> CS then shows where the surface would need to be located in order to be "sensibly playable."
>
> CS: I don't think that it's like gamepads, that I'll be good at it just by rehearsing.
>
> He mentions other possibilities like having a smaller size or just removing it entirely and not doing anything with the thumb.
>
> SE: But the thumb can be moved the most freely.
>
> PD tries out the distance from the strapped hand to the potential surface in order to test the movability of her thumb. SE imitates her to demonstrate that moving his shorter thumb in that position is difficult. . . . The three continue discussing physical differences and the necessity of adapting the prototype and individual needs with regard to playability. (Fieldnotes, line 2878ff)

The above observations from a team meeting underlines that, due to bodily constraints, the researchers encountered difficulties when they played the first instrument version. Consequently, they developed individual preferences and sought to integrate these preferences into the second instrument iteration. Even though the quoted discussion shows that they tried to attain a common denominator, the need for compromise was obvious. It was clear that sensations such as touching solder points, moving a finger freely, and the idea of CapSenses being "sensibly playable" were highly subjective. Such embodied knowledge was developed on the basis of bodily experiences and could partly be conveyed through gestures, while language was a less useful means of knowledge transfer in this specific case.

Below are two more indicative fieldnotes that emphasize the role of bodily knowledge.

> SE and I take the elevator and return to the wood workshop, where he takes a batten from the shelf and fixes it with a bench vice on the saw "in order to cut it straight at least to a certain degree." . . . "Would you like to do something?" he asks; I agree. "Go to the other room and look for the emery paper. Choose the finest and sand the edges," he says, handing me the freshly cut piece of the tube. I do as told and see three roles of yellow emery paper hanging on the wall. Feeling the surface of each of them I choose the one on the left, which is the finest. Returning to the sawing room, I see the sound engineer already cutting the second piece. Carefully, I sand the tube's edges and repeatedly touch them with my index finger to feel whether there are still rough parts. "Do you just want them to be smooth or rounded?" I asked. "No, no, just smooth," he replies. (Fieldnotes, line 1479ff)

> Several days later, I sand the lower Plexiglas box newly cut and glued together. On some of the edges, traces of the cutting and gluing processes are visible, my task is to remove them as good as possible. First, I use dry emery paper; then the product designer suggests sanding it with wet paper, which in her opinion works better. I do this for approximately an hour, during which I am alone in the office without actually realizing the time pass by. Rather, I feel the bodily efforts, I feel hot and even exhausted, even though my fingers stay cold. The sound engineer returns and I present the box to him. "Sanding is strenuous, isn't it? The other day, I spent a whole day sanding the first box," he says and I agree. (Fieldnotes, line 4150ff)

These short descriptions exemplify very clearly that once the quality of a feeling or activity needed to be explicated, individuality and subjectivity were more present than in other cases of knowledge transfer. What did "smooth" mean? What kind of sensual impression did "strenuous" imply? Symptoms such as "feeling hot" or "not feeling any sharp edges anymore" might be used as means to circumscribe such attributes, helping to gain a better understanding of the respective bodily experience. Nevertheless, they are no precise definitions and merely approach what the German term *nachempfinden* (English: re-feel or reconstruct a feeling, feel the same) most suitably describes. Kjørup (2006) coined the notion *sensuous knowledge* (p. 8) to designate knowledge derived from aesthetic experiences. If understood literally, it designates knowledge connected to human auditory, gustatory, olfactory, visual, and haptic senses. Such sensations need to be experienced individually in order to become a form of tacit knowledge. This specific quality of sense-related, embodied knowledge implies, however, that it cannot be fully explained by means of language like other forms of tacit knowledge.

4. Discussion

The presented ethnographic study was deliberately carried out in an artistic research context in order to examine the interplay of latent and manifest forms of knowledge, while at the same time questioning the ineffability of tacit knowledge. The previous assumption that researchers in an interdisciplinary team are conscious of and able to describe parts of their latent knowledge was confirmed. Even though the research practices were clearly marked by the conscious and unconscious use of knowledge,

technical, material, and methodical knowledge was transferred to the author on a very basic level. The researchers were able to explicate their knowledge in great detail, with varied levels of difficulty. In this manner, knowledge visible in routinized practices that would otherwise have remained tacit was transferred via language.

Against common conceptions of the ineffability of tacit knowledge (Borgdorff, 2010; Loenhoff, 2015; Rust, 2004; Zembylas, 2014), this article suggests that tacit knowledge can indeed be conveyed in an articulate manner. In addition to using models, gestures, drawings, and other visual examples, researchers need a certain degree of experience and expertise in talking about their specific knowledge and research processes. Then, parts of such tacit knowledge can be explicitly transferred to other researchers or lay people.

In light of the present study, it can be concluded that merely sensuous knowledge (i.e., knowledge related to the auditory, visual, haptic, olfactory, and gustatory senses) cannot be entirely put into words. Experiences with playing the first instrument prototype in particular were related to highly individual, subjective impressions. Arguments brought forward were connected to sensations such as "hard to play," "sensibly playable," and "strenuous." These qualities of embodied knowledge were described with the help of language, but they could not be entirely captured in words. On the one hand, this is due to the subjectively perceived dimension of a sensual experience, which is difficult to convey. On the other hand, one may assume that people trained in knowledge transfer—such as teachers or researchers giving seminars—are able to describe sensuous qualities with categories they and their target audience are acquainted with. This underlines that sensuous knowledge can be transferred to a certain degree only.

4.1. Limitations and Outlook

Even though literature on ethnographic research reflects upon the central role of the researcher in data collection and analysis, it is often suggested that ethnographers leave aside their disciplinary theories, assumptions, and individual predispositions before entering the field (Geertz, 2001; Van Maanen, 1988). However, as mentioned in the methodological section, information gathered during field research depends on the ethnographer's disciplinary background and the understanding about the field he or she has prior to entering it (see also Knorr Cetina, 1981; Latour & Woolgar, 1979). Consequently, the results presented are subjective and depend on the phases and situations experienced at a certain point in time; another researcher carrying out this research might thus draw different conclusions (Strauss & Corbin, 2008, p. 10).

Against this background, the results of this study only provide indicative insights into the role of tacit knowledge and expertise in artistic practices and design processes. By actually feeling the surface of a specific material through one's own senses or by actually engaging in the bodily efforts certain practices imply, field researchers will be able to approach an understanding of incorporated, sensuous knowledge. However, this form of knowledge is traceable in actions and presentations carried out by artists and designers to a certain degree only. It will not be fully graspable and explainable.

Acknowledgements

I would like to thank the entire team of 3DMIN for their ongoing openness towards and support of my research.

References

Adloff, F., Gerund, K., & Kaldewey, D. (2015). Locations, translations, and presentifications of tacit knowledge: An introduction. In F. Adloff, K. Gerund, & D. Kaldewey (Eds.),*Revealing tacit knowledge: Embodiment and explication* (pp. 7-17). Bielefeld, Germany: Transcript.

Bergen National Academy of the Arts. (Ed.). (2006 onwards). *Sensuous knowledge: Focus on artistic research and development* (Vol. 1). Bergen, Norway: Bergen National Academy of the Arts.

Biggs, M. (2004). Learning from experience: Approaches to the experiential component of practice-based research. In H. Karlsson (Ed.), *Forskning, reflektion, utveckling* (pp. 6-21). Stockholm, Sweden: Vetenskapsradet.

Biggs, M. (2007). *Modelling experiential knowledge for research.* Retrieved May 10, 2015 from http://uhra.herts.ac.uk/bitstream/handle/2299/7434/904198.pdf?sequence=1

Biggs, M., & Karlsson, H. (Eds.). (2010). *The Routledge companion to research in the arts.*Abingdon, UK; New York, NY: Routledge.

Borgdorff, H. (2006). The debate on research in the arts. In Bergen National Academy of the Arts (Ed.), *Sensuous knowledge: Focus on artistic research and development* (Vol. 2.). Bergen, Norway: Bergen National Academy of the Arts.

Borgdorff, H. (2009). Artistic research as boundary work. In C. Caduff, F. Siedenthaler, & T. Wälchli (Eds.), *Art and artistic research: Zurich yearbook of the arts 2009* (Vol. 6, pp. 72-79). Zürich, Switzerland: Heidegger & Spiess.

Borgdorff, H. (2010). The production of knowledge in artistic research. In M. Biggs & H. Karlsson (Eds.), *The Routledge companion to research in the arts* (pp. 44-63). Abingdon, UK; New York, NY: Routledge.

Buck, C., Hofhues, S., & Schindler, J. (2015). Künstlerische Forschung unter Bildungsperspektive: Individualisierte Studienprogramme? [Artistic research as exemplary, individualized study programme? An analysis from an educational perspective]. *Zeitschrift für Hochschulentwicklung*, *10*(1), 53-77.

Busch, K. (2009). Artistic research and the poetics of knowledge. *Art & Research*, *2*(2). Retrieved April 27, 2015, from http://www.artandresearch.org.uk/v2n2/busch.html

Caduff, C., Siegenthaler, F., & Wälchli, T. (Eds.). (2009). *Art and artistic research: Zurich yearbook of the arts 2009* (Vol. 6). Zürich, Switzerland: Heidegger & Spiess.

Cross, N. (2006). *Designerly ways of knowing*. London, UK: Springer.

Dewey, J. (1934). *Art as experience*. London, UK: Penguin.

Dombois, F., Bauer, U. M., Mareis, C., & Schwab, M. (Eds.). (2012). *Intellectual birdhouse: Artistic practice as research*. London, UK: Koenig.

Emerson, R. M, Fretz, R. I., & Shaw, L. L. (2011). *Writing ethnographic fieldnotes* (2nd ed.). Chicago, IL: University of Chicago Press.

Frayling, C. (1993). Research in art and design. *Royal College of Art Research Papers, 1*(1), 1-5.

Feyerabend, P. (1984). *Wissenschaft als Kunst* [Science as art]. Frankfurt a.M., Germany: Suhrkamp.

Geertz, C. (2001). *The interpretations of cultures: Selected essays*. New York, NY: Basic.

Hannula, M., Suoranta, J., & Vadén, T. (2005). *Artistic research: Theories, methods and practices*. Helsinki, Finland: Academy of Fine Arts.

Hannula, M., Suoranta, J., & Vadén T. (2014). *Artistic research methodology: Narrative, power and the public*. New York, NY: Peter Lang.

Holert, T. (2011). Artistic research: Anatomy of an ascent. *Texte zur Kunst*, *82*, 38-63.

Ignatow, G. (2007). Theories of embodied knowledge: New directions for cultural and cognitive sociology? *Journal for the Theory of Social Behaviour*, *37*(2), 115-135.

Kjørup, S. (2006). Another way of knowing. In Bergen National Academy of the Arts (Ed.),*Sensuous knowledge: Focus on artistic research and development* (Vol. 1). Bergen, Norway: Bergen National Academy of the Arts.

Klein, G. (2007): Dance in a knowledge society. In S. Gehm, P. Husemann, & K. von Wilcke (Eds.), *Knowledge in motion: Perspectives of artistic and scientific research in dance*(pp. 25-36). Bielefeld, Germany: Transcript.

Knorr Cetina, K. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford, UK; New York, NY: Pergamon.

Latour, B., & Woolgar, S. (1979). *Laboratory life: The construction on scientific facts*. Princeton, NJ: Princeton University Press.

Loenhoff, J. (2015). Tacit knowledge: Shared and embodied. In F. Adloff, K. Gerund, & D. Kaldewey (Eds.), *Revealing tacit knowledge: Embodiment and explication* (pp. 21-40). Bielefeld, Germany: Transcript.

Mäkelä, M., Nimkulrat, N., Dash, D. P., & Nsenga, F. (2011). On reflecting and making in artistic research. *Journal of Research Practice*, *7*(1), Article E1. Retrieved from http://jrp.icaap.org/index.php/jrp/article/view/280/241

Mareis, C. (2012). The epistemology of the unspoken: On the concept of tacit knowledge in contemporary design research. *Design Issues*, *28*(2), 61-71.

Mareis, C. (2014). *Theorien des Designs zur Einführung* [An introduction to theories of design]. Hamburg, Germany: Junius.

Martínez, C. (2012). How a tadpole becomes a frog: Belated aesthetics, politics, and animated matter: Toward a theory of artistic research. In C. Christov-Bakargiev (Ed.),*dOCUMENTA (13): The book of books* (pp. 46-57). Ostfildern, Germany: Hatje Cantz.

Niedderer, K. (2007). Mapping the meaning of knowledge in design research. *Design Research Quarterly*, *2*(2), 1-13.

Niedderer, K., & Imani, Y. (2008). Developing a framework for managing tacit knowledge in research using knowledge management models. In D. Durling, C. Rust, L.-L. Chen, P. Ashton, & K. Friedman (Eds.), *Undisciplined! Proceedings of the Design Research Society conference 2008*. Retrieved April 27, 2015, from http://shura.shu.ac.uk/507/

O'Riley, T. (2011). A discrete continuity: On the relation between research and art practice.*Journal of Research Practice*, *7*(1), Article P1. Retrieved from http://jrp.icaap.org/index.php/jrp/article/view/257/238

Polanyi, M. (1983). *The tacit dimension.* Gloucester, MA: Peter Smith.

Rust, C. (2004). Design enquiry: Tacit knowledge and invention in science. *Design Issues*,*20*(4), 76-85.

Sennett, R. (2008). *The craftsman*. New Haven, CT; London, UK: Yale University Press.

Schön, D. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic.

SHARE. (2014). *SHARE handbook for artistic research education*. Step-Change for Higher Arts Research and Education, Amsterdam, Netherlands. Retrieved April 27, 2015, from http://www.elia-artschools.org/images/products/120/share-handbook-for-artistic-research-education-high-definition.pdf

Sheikh, S. (2006). Spaces for thinking. *Texte zur Kunst*, *62*. Retrieved April 27, 2015 from https://www.textezurkunst.de/62/spaces-for-thinking/

Sheikh, S. (2009). Objects of study or commodification of knowledge? Remarks on artistic research. *Art & Research, 2*(2). Retrieved April 27, 2015 from http://www.artandresearch.org.uk/v2n2/sheikh.html

Shotwell, A. (2015). Racial formation, implicit understanding, and problems with implicit association tests. In F. Adloff, K. Gerund, & D. Kaldewey (Eds.), *Revealing tacit knowledge: Embodiment and explication* (pp. 169-184). Bielefeld, Germany: Transcript.

Stehr, N. (2009). Knowledge societies. In N. Stehr & V. Meja (Eds.), *Society & knowledge: Contemporary perspectives in the sociology of knowledge & science* (2nd ed., pp. 299-322). New Brunswick, NJ: Transaction.

Stemmler, S. (Ed.). (2014). *Wahrnehmung, Erfahrung, Experiment, Wissen: Objektivität und Subjektivität in den Künsten und den Wissenschaften* [Perception, experience, experiment, knowledge: Objectivity and subjectivity in the arts and sciences]. Zürich, Switzerland; Berlin, Germany: diaphanes.

Steyerl, H. (2010). Aesthetics of resistance: Artistic research as discipline and conflict.*Mahkuzine, 8*, 31-37. Retrieved April 27, 2015, from http://www.mahku.nl/download/maHKUzine08_web.pdf

Strauss, J., & Corbin, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, CA: Sage.

Tröndle, M. (2012a). Methods of artistic research: Kunstforschung im Spiegel künstlerischer Arbeitsprozesse [Methods of artistic research: Art research in light of artistic work processes]. In M. Tröndle & J. Warmers (Eds.), *Kunstforschung als ästhetische Wissenschaft: Beiträge zur transdisziplinären Hybridisierung von Wissenschaft und Kunst* [Artistic research as aesthetic science: Contributions to a transdisciplinary hybridization of science and art] (pp. 169-198). Bielefeld, Germany: Transcript.

Tröndle, M. (2012b). Zum Unterfangen einer ästhetischen Wissenschaft: Eine Einleitung [On the venture of an aesthetic science: An introduction]. In M. Tröndle & J. Warmers (Eds.),*Kunstforschung als ästhetische Wissenschaft: Beiträge zur transdisziplinären Hybridisierung von Wissenschaft und Kunst* [Artistic research as aesthetic science: Contributions to a transdisciplinary hybridization of science and art] (pp. xv-xviii). Bielefeld, Germany: Transcript.

Tröndle, M., Greenwood, S., Ramakrishnan, C., Tschacher, W., Kirchberg, V., Wintzerith, S., . . . Wäspe, R. (2011). The entanglement of arts and sciences: On the transaction costs of transdisciplinary research settings. *Journal for Artistic Research, 1*. Retrieved 27 April, 2015, from http://www.jar-online.net/index.php/issues/view/483

Tröndle, M., & Warmers, J. (Eds.) (2012). *Kunstforschung als ästhetische Wissenschaft: Beiträge zur transdisziplinären Hybridisierung von Wissenschaft und*

Kunst [Artistic research as aesthetic science: Contributions to a transdisciplinary hybridization of science and art]. Bielefeld, Germany: Transcript.

Van Maanen, J. (1988). *Tales of the field: On writing ethnography*. Chicago, IL: University of Chicago Press.

Zembylas, T. (2012). Epistemologie der künstlerischen Praxis [Epistemology of artistic practice]. *Zeitschrift für Ästhetik und Allgemeine Kunstwissenschaft, 56*(2), 203-215.

Zembylas, T. (2014). *Artistic practices: Social interactions and cultural dynamics*. London, UK: Routledge.

Received 28 May 2015 | Accepted 3 December 2015 | Published 4 December 2015