

Woodworking Revisited – Employing State-of-the-Art Video Technologies in Educational Contexts

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ABSTRACT

This paper presents the outcome of the research project WOODWORKING REVISITED. Within the framework of the two-year project, the two university teams collaborated with the Austrian Open-Air Museum Stübing and the Waldorf Vienna West School to document selected woodworking techniques on video. Formats and dissemination strategies were developed in a collaborative process including pupils and experts at all project stages. The formats were based on established content such as the “Nifty” style found on BuzzFeed (ref.) and further developed for the new immersive possibilities of 360° video. In order to compare the formats and test their efficiency, content produced in both formats was evaluated together with pupils of a technical school for woodworking. The team conducted a study that showed the suitability of both formats for the purpose.

INTRODUCTION

Wood remains one of the most important raw materials today. However, the processing of wood has changed considerably – away from agricultural or manual processing to ultra-modern industrial production (Wegener, 2007). As early as in 1917, folklorist Josef Blau (1917) described the loss of woodcrafts: "The old economy and way of working, the skills, knowledge, experience and conditions long inherited and with them much of the necessary language and cultural heritage are moving ever higher up the forests and mountains". Since then, the use of different wood species has been limited to between ten and 20 indigenous species in Austria. The unfavorable properties of some wood species are being reduced or compensated for by treatments (e.g. steaming, thermal treatment, etc.).

Wood is a material that can be used sustainably. Therefore, it will presumably play an even greater role in times of increasing resource scarcity and discussions about CO₂ emissions than it does now. The application of historical knowledge regarding species selection, processing and appropriate utilization may, under certain circumstances, help to increase the sustainable use of our forests.

The knowledge of wood selection, storage and processing, etc. was traditionally passed on from generation to generation. Written records exist only in exceptional cases. Whenever wood was used in earlier times – be it for farmhouses, castles, palaces or churches, furniture, tools, weapons, kitchen utensils, fences, etc. – it was usually done by various people (like famers), in many cases by “not specially trained” craftsmen. It was not until the 14th century that specialized crafts developed (Radkau, 2007), and even then the oral transmission of knowledge prevailed. As a result, existing publications often do not describe the details necessary to understand the work steps or to understand why a special type of wood was used for a certain purpose (Grabner et al., 2013). It therefore became apparent that in addition to the study of old literature, the analysis of historical objects is also necessary in order to comprehend the processes used in former times – and therefore the knowledge of craft techniques.

Certain handicraft techniques have been preserved or rediscovered in Austrian museums, especially in the Austrian Open-Air Museum Stübing. With the support of several projects (FWF TRP 21-B16, Sparkling Science SPA 04/188, Volkskultur Niederösterreich), it was possible to sample and analyze the collections of several museums in Austria in the past. In these projects, a lot of “material knowledge” was gained or rediscovered. Klein (2015 and 2016) gives a good overview of the wood species previously used in Austria. Why were ash and cornel cherry wood used for tool handles? This is mainly due to their strength, toughness and the ability to dampen vibrations. However, there are also tool handles made of wood species that are not particularly well suited, e.g. alder. There are oral traditions describing alder as a material for tool handles: “it is comfortable in the hand” and “you don’t get blisters from it”. Such important parameters can hardly be measured or verified with modern methods. We must therefore rely on traditional knowledge that may be thousands of years old and try to understand and reconstruct the reasons for specific techniques and utilizations.

In the analysis of inventory (furniture, appliances, tools, vats, barrels, etc.), it was possible to make statements about the processing technique with the help of dendrochronology. It was found that both in furniture and in vats, the outermost layer of wood (with the best wood quality) was processed as little as possible. In the example of a box, only seven years lie between the dating based on the outermost annual ring and the dating on the basis of the painting. The difference of seven years is due to drying (two to three years) and the loss of tree rings due to planing (i.e. a few millimeters) (Klein et al., 2014). This is one of the few examples where it was possible to rediscover immaterial knowledge, that is, the craft knowledge of wood drying and woodworking, on the basis of material analysis.

Museums are important sites for the preservation of ancient knowledge – at least in the form of material goods. This is also supported and accompanied by the International Council of Museums (ICOM). The great importance of preserving cultural assets is recognized – and this applies not only to so-called “high culture” but also to everyday culture as it is presented, for example, in the Austrian Open-Air Museum in Stübing. Without the existing objects and corresponding descriptions (also in the sense of oral history), it would be almost impossible to comprehend the historical use of wood and to rediscover its beginnings. Thus, it is not enough to preserve material cultural history; knowledge, skills and experience must be safeguarded and passed on as cultural assets as well (Anonymous, 2009).

The paper at hand presents an approach to preserving and passing on immaterial knowledge, skills and experiences in the form of detailed documentary films about specific woodcraft techniques. A corresponding project was set up in 2017 and is still ongoing. The main focus in these films is on the technical process and necessary background information required to produce wooden goods out of the raw material. As an additional requirement, the documentaries adopt a modern approach using state-of-the-art techniques of film and media creation to increase their attractiveness for young people. The films are designed to awaken interest in the craft and to serve as guidance and assistance for those interested in reproducing specific wooden goods. School pupils (Freie Waldorf Schule Wien West) were involved in the conception and production of the documentaries and contributed their personal experiences and ideas together with the scientific team consisting of wood scientists (University of Natural Resources and Life Sciences, Vienna), film and media creation researchers (St. Pölten University of Applied Sciences), museum and ethnology experts and craftspeople (Austrian Open-Air Museum Stübing). The interdisciplinary team developed a form of presentation which, in addition to the contemporary presentation to inspire people for the craft, is appealing to young people and can also be used for mobile purposes. The documentaries will be accessible to the general public via online video platforms such as

YouTube. Furthermore, both the presentation on monitors and the interactive applications are ways of showing the documentaries in the Austrian Open-Air Museum Stübing.

HISTORICAL WOOD UTILIZATION AND REQUIREMENTS FOR VIDEO PRODUCTION

The possibilities of acquiring knowledge about handicraft techniques of the past have become rare. Since the Austrian Open Air-Museum Stübing still uses several old techniques to preserve and maintain its exhibition, it is a precious source of knowledge. Certain handicraft techniques were preserved or rediscovered in the museum. One example is the technique used to produce or at least professionally restore a waterwheel matching the historical original in the museum exhibition. In addition to the experienced museum staff, the museum has established a network of craftspeople who are still active today. Only a few years from now, practitioners of certain craft techniques will no longer exist and their knowledge will be lost.

Apart from the approved craft trades such as carpentry and joinery, however, plenty of objects were made by farmers and the rural population for themselves, or as an additional source of income. These activities were hardly documented in the past. As a sideline, farmers or woodcutters would make important home, farm and work equipment. In the so-called “Machelkammer”, they carried out various repairs and proved their skills as carpenters, wainwrights, wood turners or instrument makers. They made ladders, rakes, shovels, forks, baskets, vessels, clips, spoons and bowls, troughs and much more. When their own need was covered, these craftpersons produced goods for exchange or sale which were sold by peddlers or on markets. The domestic industry developed from this as a sideline to agriculture. Gradually the goods, which were no longer produced for immediate use, were handed over to traders and merchants. The result was an entrepreneurial culture which intensified the dependence of domestic industrialists (farmers). The increasing industrialization replaced the peasants’ domestic industry and with it the accompanying immaterial cultural heritage (Liesenfeld, 2013).

Previous works found historical literature dealing with craftsmanship (see for example Amman and Lemmer, 1568, Monceau, 1767, Stübling, 1896, Krauth and Meyer, 1899, Graef, 1905, Jankuhn, 1983, Haid, 1991, Palla, 2010, Hasitschka, 2010). It turned out, however, that it is hardly possible to rebuild work pieces, let alone reproduce the work steps in detail, solely with the help of written sources. Subsequently, an overview of available video sources was created. During this review process, the requirements for the newly produced videos were kept in mind. In addition to the precise depiction of every work step including the tools used, their handling and the use of consumables, the condition of the raw materials and corresponding background information such as the desired wood quality, the harvesting season and the drying time have to be taken into account.

In short, the main focus was on creating end-to-end technical documentaries which are produced with the aid of up-to-date media technologies in a modern format. Only in this way will potential viewers be attracted and able to completely understand and reproduce all criteria necessary to successfully process the raw material into the desired item.

EXISTING DOCUMENTARIES ON WOODCRAFT TECHNIQUES

As previously mentioned, research was carried out on films which represent traditional (wood) handicraft techniques in order to generate an overview of the existing material. In total, more than 240 relevant films were identified. The availability and the storage medium used proved to be problematic, and it was not possible to view every film as some of the videos are stored as 16 mm film rolls in archives and are therefore technically difficult to access. A systematic digitalization of this material would be of great importance but exceeds the resources of this project by far. Also, some of these films were shot with a different focus – e.g. with a folkloristic background. The Waldbauernmuseum in Gutenstein (Lower Austria) began filming the trades of “forest farmers” very early on (Pawelak-Ast, 2013). Some crafts were documented in good quality – e.g. the rake maker. However, a folkloristic approach is often in the foreground – focusing on the craftsmen and not the technical production process. Another example is films from the series “Der Letzte seines Standes?” (“The last of their trade?”) produced by the public-service radio and television broadcaster Bavarian Broadcasting (BR) which shows several crafts, e.g. the wainwright's workshop. Made for television, these films also lack an exact documentation of every work step necessary for a reproduction of the techniques. In other words, these works do not correspond to the requirements of the project at hand. Furthermore, the field of folkloristic film collections was searched and analyzed in order to determine which crafts are to be found and what the quality is like (e.g. Maissen and Maissen, 2004).

It was found that existing films, depending on the target audience and medium (ethnological background, TV audience, do-it-yourself community, etc.), did not meet or only inadequately met the project objectives in various respects. In particular, the frequent focus on the craftspeople and their lives pushes the technical process of manufacturing a work piece into the background or, for dramaturgical reasons (TV series), demonstrates this

process only insufficiently. The project goal of making a technique completely comprehensible for the viewer cannot be realized in these films. An additional problem is the fluctuating quality of content conveyed on online platforms regarding the fundamentals of wood science and the associated validity of the background knowledge and sources presented in those videos.

The decision for a visual and acoustic form of representation for the production of the new videos was based on the literature and film research phase. Pupils were motivated to collect documentaries from television or the Internet and to analyze them with regard to criteria such as target group, technical implementation and content conveyed. On the basis of these results, the students, with advice from the scientists, evaluated which documentation techniques are best suited for the presentation of the individual work steps in wood processing.

SELECTION OF TOPICS FOR DOCUMENTATION

The handicraft techniques existing in the Austrian Open Air-Museum Stübing or practised by craftsmen associated with the network of the museum were recorded. A list of priorities was drawn up from these techniques. The craft films to be realized in the project were selected according to the threat of extinction (e.g. existence of still active craftspeople, or copious documentation), the availability of qualified craftspeople, the production duration and thus the feasibility within the timeframe of the project.

Several additional interesting topics were identified but it was not possible to find any craftspeople capable of carrying out the works during research. One criterion which led to the elimination of a theme was the duration of the production process. Due to the limited number of shooting days in the project, particularly long-term processes could not be realized within this framework. Processes such as charcoal burning or the construction of a water wheel, which take several weeks to complete, were therefore no feasible craft techniques in the study at hand. During the selection of techniques to be filmed, additional consideration had to be given to external conditions: If the production of a wooden object is dependent on e.g. a timely correct harvest of the raw material (dormancy of vegetation, etc.), this had to be considered in the entire project planning. On the basis of the above-mentioned requirements, of the literature research and research in film archives, the handicraft activities were selected in consultation with the Austrian Open-Air Museum Stübing and the associated craftspeople. Since an important goal of the project is to document the selected handicraft techniques as completely as possible, these techniques and the according work steps were carefully defined. Among other things, the hand posture, angle of the tools, working direction and tool speed are part of a catalogue created which lists the critical points of the manual work. The decision for a visual and acoustic form of representation is also based on the research phase.

The following production processes were realized as documentary films: “the production of a wooden nail”, “the manufacture of a fence ring”, “the hewing of logs with a broad axe” and the “production of a birch besom”, furthermore the process of “building a hazel basket” and “carving of a house blessing”.

WOODEN NAILS

Made of larch wood, the carpenter’s nail was used in various applications such as roof construction. The wooden nails came in various sizes and shapes and were also used for fences, furniture or as pegs in log construction. The tiniest nails were used by cobblers. The processing, however, is always similar: Work pieces are split out of trunk segments and then carved further into their final shape with a knife or draw knife on a shaving horse.

HEWING OF LOGS

The transformation of round wood into a squared profile was an elementary step in Austrian timber construction. This was done manually by hewing all four sides of a log with an axe. In a first step, markings are provided with a chalk line as a guide for the worker. Segments are hewn off the log with a mortising axe before the final surface is produced with a broad axe.

FENCE RING

A fence ring is made of a spruce twig which is twisted to a ring by heating over an open flame. These rings provide stability to pole fences and act as a connection between the vertical pillars and horizontal poles.

BIRCH BESOM

Made of birch twigs, these besoms were a common sight in Austrian farmhouses. They come in different shapes (plane or round forms) with either a hazel handle connected to the broom or, more simple, only with the bundled birch twigs as the handle piece.

HAZEL BASKET

Used for carrying fire wood, straw or livestock feed, these baskets of different sizes can either be carried in one’s hand or as a carrying frame on one’s back. The wickerwork is made of split hazel rods and partly of ash. As an eco-friendly carriage device, baskets were an omnipresent sight in the Austrian cultural landscape some decades ago.

HOUSE BLESSING

In some regions of Styria, religious ornaments known as house blessings were placed in farmhouse parlors as protection for the house and its inhabitants. They are made of various small carved decorative elements combined to form a three-dimensional cross. Made of poplar and mainly carved and split with different knives, there are only few people still actively producing these pieces of folk art.

DEVELOPING THE VISUAL FORMATS

Preserving the woodworking techniques also required a suitable environment for the finished videos. It was clear from the outset that all videos would be used in the Open-Air Muesum Stübing and on the project’s website. Yet the challenge of reaching a broader audience asked for a broader evaluation of the available video platforms and formats. Several workshops were held to introduce the Waldorf school pupils to the basics of the woodworking craft and media production. During the first workshop, the pupils were encouraged to reproduce a wooden nail solely on a textual basis. Based on that experience, they were then asked to research videos that appropriately convey craft skills. A collective process of screening and evaluating came up with a state-of-the-art list of more than 240 documentary productions, most of which were created in the 20th century for a very different media environment. The evaluation of the pupils provided ideas about the media forms which a contemporary young audience interested in woodcraft skills would find suitable.

In a second workshop, the team focused on format development and discussed the examples. In small groups, first steps towards a format for four of the chosen topics – hewing of logs, wooden nails, birch besom and fence ring – were taken. (figure 1)



Figure 1: Pupils at the workshop

Due to the rise of VR formats in educational contexts, 360° degree video was also considered a possible approach. While a rich tradition and vast knowledge on educational video exists, 360° video has only recently entered educational contexts, so no extensive literature on its employment is available. Some case studies indicated general directions and benefits of using the 360° video technology (Kavanagh et al 2016) or provided some important insights into the possibilities of editing the footage (Kjaer et al 2017). The workshop led to two formats. The BuzzFeed format Nifty was deemed suitable for the more delicate steps needed to produce the wood nail and the birch besom. For the hewing of logs and the fence ring, the less precise, yet more immersive approach of 360° video was chosen. The 360° films were designed for watching either using in VR headsets or a desktop based player. The emphasis was on the VR headset as it provides an immersive environment.

CHOOSING A PLATFORM AND FORMAT DEVELOPMENT

In addition to the technical aspects of being able to store the intended formats for presumably a long time and in good technical quality, aspects of community impact were also considered, and making the video accessible and present beyond the initial scope of the project was also an important aspect. A video platform such as YouTube is a complex system which does not entail several cultural practises and techniques that reach well beyond its immediate material context (Weber 2011). The way knowledge is transferred from and into communities and the

corresponding formats had to be analysed in the collective process. An evaluation of communities conveying crafts in a broad sense indicated that YouTube is the dominant platform for those activities. An extensive elaboration on corresponding types of contemporary micro video content can be found in team member Corinna Stiefelbauer's bachelor thesis (Stiefelbauer 2018). Besides YouTube's ability to deal with the formats including 360° footage, the broader scope of YouTube as a collective archive was also taken into account. 70% of all visits to YouTube occur due to interest in instructional content (Stiefelbauer 2018). It also seemed suitable for a broad variety of viewing devices, which becomes increasingly important due to the massive shift of content consumption to mobile devices (Sahoo 2017).

THE FORMAT

Buzzfeed's Nifty format provided the foundation for developing the basic format framework and a graphical layout for a multicam format. Although the videos feature people preserving nearly forgotten handcrafting skills, the ethnographical aspect was not relevant for the project. The video was to solely focus on the artisanship and the key elements of producing the pieces. All details such as the choice of material, the exact time of harvest and the quality standards of the wood had to be explained. The schematic narrative structure entailed the following main elements:



Figure 2: Format development workshop

EMOTIONAL PULL / AGREEMENT: To draw attention; an off-text with a trigger and the presentation of the finished piece

PRIMING / CONTEXT: Background information; description of required tools and materials

CONTENT / STORY: Content guiding through the work steps

REFLECTION / DESCRIPTION: Presentation of the work and possible variants; emphasis on key tasks and elements

EMOTIONAL PULL / CONCLUSION – Emotional moment; off-text indicating next steps and graphical call-to-action

These additional Nifty elements were also adopted:

- The protagonist mainly uses her/his hands to indicate key elements of the process, thus supporting the off-text.
- The narrative is dominant, while the protagonist rarely speaks.
- The required materials and tools are presented.
- The movement of materials and tools needs to be carefully planned to allow for a fluid narrative and the use of graphical elements.
- In post-production, text and graphical elements are applied in order to support the narrative, but also as a stylistic element.
- stop motion and time lapse are used.
- The video employs a point-of-view narrative.
- There is a large number of close-ups.
- The environment consists largely of a white room without any unnecessary ornaments.
- The protagonist is in the frame only when necessary, yet the process is the main element of the narrative.
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Graphical Elements:

The use of colors, fonts and a logo was defined in a style guide. The only font used was Lato in bold and bold italics. The highlight colors yellow and turquoise provide visual emphasis of graphical and textual elements. (figure 3.)



Figure 3: Style Guide Stiefelbauer, p 41.

A corner logo consisting of the textual element of the main logo was created and provides coherence and a visual brand for all videos of the series. It serves as a common element in the upper left corner of the frame. To structure the sequences, a separating element was developed based on the logo and using a text in italics. (figure 4)



Figure 4

Text inserts were used to emphasize spoken information (figure. 5.), tools were labeled (figure 6.), -measures and dimensions (figure 7) and specific areas of interest indicated (figure 8.).

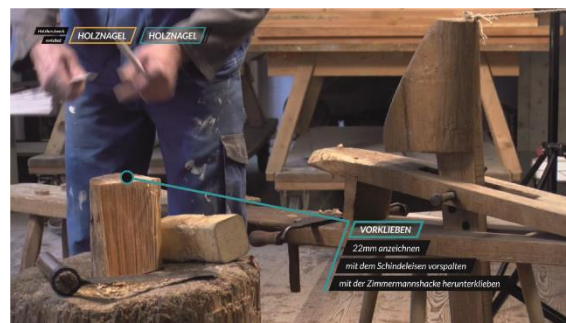


Figure 5



Figure 6



Figure 7



Figure 8

360° video

For the 360° video production that covered the fence ring and the hewing of logs, the format had to be adapted. To focus the viewer's attention on the proceedings, a different approach was developed, with two educational videos providing ideas for the 360° format. The 6-minute BBC1 documentary Ambulance VR 360 demonstrated how the use of masks and animation could help with transitions, especially as far as spatial and temporal shifts are concerned. (figure 9.). Animated stripes announce the transitions early on (figure 10.).



Figure 9



Figure 10

The extensive transition time allows the audience to adjust to the new scene. Sound and acting direct the viewer's attention, and occasionally parts of the 360° sphere are unused to further focus the attention. A similar concept of viewing windows was used to focus the attention in both videos. A grey fog effect was employed to exclude areas that are not necessary. (figures 11. & 12.)



Figure 11



Figure 12

A number of graphical elements were also employed in the 360° video. Yet the majority of elements was much harder to use as there was no established workflow in the software used at the time (Adobe Creative Suite 2018), although important functions for the editing of 360° video were available in the 2018 version of Adobe CC. A comprehensive description of the workflow that was developed for the project can be found in team member Clemens Baumann's bachelor thesis (Baumann 2018). Essentially, a rough cut was carried out in Adobe Premiere and then imported in Adobe After Effects where the edit was turned into a VR comp. A VR comp allows the insertion of 2D graphics into a 3D scene (figures 13 and 14). A transition was animated similar to the transitions in the Ambulance VR video. To do this, a mask was used that resembles stripes, so that the image of the next scene of the video is seen through these stripes and viewers get a glimpse of the next scene. The end products are six craft films in two formats: conventional filming from several camera angles, the “multicam” format, and the concept using 360° camera technology have been finished. One topic, the production of a fence ring, has been realized in both formats – multicam and 360° video – to be able to get a profound comparison of both formats.

Evaluation of the finished documentary films

Possible future users (young people) evaluated the concepts in their final state with usability tests. This will allow to further improve the target group-specific, content-related presentation of historical woodcraft techniques in possible follow-up projects. For the evaluation of the finished documentaries, a group of students from a technical school (HTL Mödling, Holztechnik), who were not involved in the project until then, tested the videos. With a basic education in carpentry, they have some knowledge of woodworking and tool handling. They had, however, not used old craft techniques until that point. On the one hand, the pupils watched selected videos (wooden nail and fence ring) from the project at hand and, at the same time, tried to recreate the depicted workpiece in a workshop. On the other hand, they compared both concepts of presentation for the fence ring: the multicam- and the 360° video format. The students thereby determined whether the production method of the video clips and the presentation via the web platform and its mobile application were appealing and informative. In total, 21 students between 17 and 19 years of age conducted the survey. Six of them watched the multicam documentary of the fence ring, while eight students rated the 360° version. Another seven pupils watched both versions and rated them afterwards. All 21 students watched the multicam documentary of the wooden nail and tried to reproduce the process with the according tools.



Figure 13



Figure 14

Before watching the videos and trying to reproduce the wooden nail, some questions were asked regarding the personal background of the students, their opinion on crafts and their Internet usage habits. 19 out of 21 persons agreed with both of the following general statements: that craftsmanship is highly appreciated nowadays, and that handcrafted products are of higher quality than industrial products. However, the students answered the question regarding product quality more clearly: 12 of them said that they strongly agreed on the higher quality of handcrafted products, while only seven strongly agreed on a high appreciation of craftsmanship in today's society. Interestingly, none of the students completely disagreed with these statements. In both cases, however, there were two persons who said that they rather disagreed. When it comes to Internet usage, most of the pupils (n=16) in the present survey stated that they sometimes (n=7) or even frequently (n=9) used YouTube as a tool for solving the practical problems of their everyday lives. Only three said they rarely or never (n=2) used YouTube as a source of tutorials. In contrast, only two students had actively posted and contributed their support on Internet forums, while three had produced a video tutorial themselves and uploaded it to YouTube or a similar platform. The vast majority had not been actively involved in sharing their knowledge online. When rating their personal craft skills, most of the students saw themselves as "skillful" (n=8) or at least "rather skillful" (n=6), in contrast to six persons considering themselves to be "rather not skillful" or even "not skillful at all" (n=1). Accordingly, 14 students are considering arts and crafts as one of their hobbies, while six said they would rather not or not at all (n=1) see crafts as a leisure activity.

For the review of the videos in the study at hand, the students were given enough time (several hours) to carefully watch the tutorials and try to recreate the wooden nail and to compare both versions (multicam and 360°) of the fence ring documentary. Although some students (n=7) considered themselves as “not skillful”, 17 stated they would now be able or at least rather able (n=4) to produce wooden nails after having watched the film and processed nails. None of the students considered themselves unable to do this. Therefore, 19 pupils also agreed that the video helped or rather helped (n=2) them to process a wooden nail. Nonetheless, when asked about the content shown, only eleven students thought that the information was sufficient, while ten rated the tutorial as rather sufficient. Nobody thought that the information shown was insufficient or rather insufficient. In order to obtain more information regarding the work steps which were hard to understand, the pupils tried to identify these. Most of them stated that “carving the nail head” (n=5) or “tapering and slanting” (n=4) were hard to understand, while another two found “carving on the shave horse” and “splitting into workpieces” (n=1) difficult to understand. Accordingly, most students wished for more information on “carving the nail head” (n=10) and “tapering and slanting” (n=6), but “splitting into workpieces” and “carving on the shave horse” (both n=3) were mentioned as well. When asked about the attempts needed to successfully recreate the wooden nail, ten students said it took them “2-5 attempts” to reproduce the nail, while five needed as few as “1-2 attempts”, four people needed “5-10”, and only two needed more than ten attempts. This leads to an overall agreement that the design of the video was “well-made” (20 students), while only one student found it to be “rather well-made”. Furthermore, 16 students said they would recommend the video to a friend interested in crafts, and four stated that they would rather recommend it (one did not answer the question). Yet only ten of the students said they would subscribe to a YouTube channel providing similar content, five would rather subscribe, four rather not, and two people would not subscribe to such a channel.

When it comes to the fence ring video, three groups of students can be defined: those who watched the multicam version (n=6), those who watched the 360° video version (n=8), and those who watched both (n=7) before answering the questionnaire on the content. All in all, every respondent but one said they considered themselves to be able to reproduce the fence ring shown after watching either the multicam or 360° video, while the one student who saw himself as rather not able to reproduce watched both versions but preferred the multicam tutorial. The picture is similar for the question about the sufficiency of the information shown: 13 rated it as sufficient or rather sufficient (n=6), whereas two students rated it as rather not sufficient, one of them being the above-mentioned student (who watched both versions) and one out of the 360° group. When asked about the design of the videos, 16 pupils rated them as well-made or at least rather well-made (n=3), while two respondents said they were “rather not well-made” – one of them being the above-mentioned student once again, and one of the multicam group. Accordingly, when asked which version they liked better, the person from the 360° group who rated the information shown as being rather insufficient and the person from the multicam group who found the design rather not well-made both said they would prefer the respective other version (multicam/360°). After all students watched both versions, twelve said they preferred the multicam version, while six students preferred the 360° video (one did not answer the question as she watched only the 360° version). As the 360° video was presented with the aid of a virtual reality headset (Oculus go), the pupils were asked whether they found it easier to follow the action shown through that device. All in all, twelve people found the headset to be beneficiary (n=8) or rather beneficiary (n=4) for following the production of the fence ring, while eight found it to be rather not beneficiary (n=5) or not beneficiary (n=3), and one student did not answer the question. When asked which version they would watch if they had to reproduce a fence ring at home, 15 students chose the multicam version and four chose the 360° video, while two did not answer the question. Interestingly, all four students who owned a virtual reality headset said they would choose the multicam version at home. To further investigate the difference between both versions, one possibility could be to look at questions concerning the students’ comprehension of the individual work steps of processing the fence ring. Three steps seem to be difficult to understand (several mentions were possible): “heating the branch over an open fire” (n=9), “twisting the branch to a ring” (n=9) and “assembling the fence” (n=6). There was no major difference between the three groups (multicam, 360°, both), as all of them mentioned the same steps: in each group, “heating” and “assembling” were mentioned three times and two times, respectively. A small difference occurred with regard to the “twisting” step, as group multicam and those who had seen both videos mentioned it two times each. In the 360° group, on the other hand, “twisting” was mentioned five times as the probably most difficult work step. However, the overall sample size is rather small and the groups differ slightly in size, so care has to be taken to not overinterpret the difference of the three mentions. Still, it could be a hint for the project team to look further into specific steps and to revise those sequences. The difficulty in identifying the crucial steps is emphasized when cross-checking the mentioned example with the specific question on that work step: “Twisting and weaving the fence ring is well depicted”. The multicam group was in agreement (n=3) or rather in agreement (n=3), while the group who watched both versions was in agreement (n=6) or rather in disagreement (n=1), but surprisingly, the 360° group was in full agreement (n=8) – although they referred to this step as

difficult most often (n=5). Therefore, these mentions do not necessarily have to correlate with the chosen method of depiction.

All in all, the evaluation with school students produced valuable information for the project team to assess and further improve the design concept for the produced videos. In general, the videos were rated as predominantly well-made. For the wooden nail tutorial, all pupils were approving (n=20) or rather approving (n=1) of the concept. Furthermore, 18 found the camera angles used suitable and another three found them rather suitable. When looking at the fence ring video, a total of 16 people agreed or rather agreed (n=3) that it was well-made, while two students rather disagreed (one from the multicam group, one from the group which watched both versions). Here twelve students found the camera angles suitable or rather suitable (n=8), while one found them rather not suitable (also from the group who watched both versions). In general, the respondents preferred the multicam version over the 360° version (n=12 to n=6; three did not answer). To further refine the concepts, it could be helpful to consider the students' comments on the videos. For example, suggestions such as "how to exactly direct the tools" or "how to precisely use the tools", "show important steps slower", "show the exact measurements of the product when it is finished", "show other people trying to reproduce the product and comment on typical mistakes" could be taken into account.

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