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*Transmission of useful knowledge in texts written by craftsmen.
Two case studies from the Holy Roman Empire*

1. Intro

For mastering a craft successfully, not only talent and suitability of skills were required but also a solid education.¹ The knowledge required for the practice of a craft was passed on in workshops (Reith 2005, 356-58). According to Mokyr, the practical and technical knowledge conveyed in workshops can be defined as useful knowledge in the meaning of «prescriptive knowledge» (Mokyr 2011, 4). Prescriptive knowledge of craftsmanship has to be transmitted from one individual to another and is mostly embodied and tacit knowledge,² which is difficult, forbidden, or even impossible to write down.³ Craftsmen were forced to learn, depending on the degree of difficulty, through countless repetitions of the concrete activity. Instructed and, if necessary, corrected by a master of the profession directly in the workshop. Complex crafts such as gemstone cutting or the plating of harnesses entailed comparatively many years of apprenticeship but also a later field of activity that could be very lucrative.⁴

Nevertheless, craftsmen usually went through the city schools and learned to read and write in the vernacular and to do calculus. Some also learned Latin (Bernoulli 1890). It can be seen that guilds used written documents for legal and organizational regulations. In guild books kept by masters since the 15th century we can find rules, statutes, lists of members, accounts, and so on. The written form was therefore directly related to the guild's organization and administration; concrete craft knowledge about how the respective products were manufactured was not

¹ I would like to thank the members of the Datini Conference 2022 for the discussion, Andreas Lehnertz for the fruitful exchange of ideas, and Johanna Ecker and Carolin Schmitz for their help with the English language.

² «In this kind of model the social nature of knowledge is central: learning or diffusion would be defined as the transmission of existing knowledge from one individual or device to another» (Mokyr 2011, 5); cf. Mokyr 2011, 9-12 on transmission of prescriptive knowledge.

³ On the connection between embodied knowledge and writing cf. Smith 2010, who also offers a definition. She uses the term «practical knowledge» (Smith 2022).

⁴ Apprenticeship years could vary, usually lasting two to three years (Heusinger 2009, 62); complex crafts could significantly exceed this time (Brugger-Koch 1985, 7-8). In the cities of the late middle ages and Early Modern Period, the training periods for professions were regulated by guilds and outlined in guild statutes (Heusinger 2009, 61-64, 115 f.).

recorded. Merely in the margins, in the guilds' pragmatic literature, and in the legal writing of the city council, knowledge about the craft activity was at times revealed. For example, if a certain type of craftsmanship was to be used or not used, a certain product was to be made or not made. For instance, the Venetian gem cutters were not allowed to produce glass, the textile producers were required to use a certain number of threads, and the Augsburg harness makers had to produce in Augsburg (Brugger-Koch 1985, 4-6; Gamber-Becher 1980, 44 f.). Nevertheless, the focus was not on the transmission of craft knowledge but on the product's quality assurance.

However, it is evident that writing was widely used in the workshops as well (Rösler 2010). Chronical writings display that craftsmen were able to acquire a complex written form in order to compose intricate writings beyond pragmatic administrative action and bookkeeping. Last but not least, the late medieval and early modern Meistersingers show that literary writing was even encouraged among craftsmen (Bruch 2019; Hölscher 1903; Dehnert 2017).

Thus, knowledge was transmitted orally and practically and it was argued that this oral transmission, flanked by legal regulations, led to a stagnation of innovation. Because useful knowledge was always passed on within a workshop, it was assumed that it proceeded very statically and that innovations only came about slowly through testing and reinventing evolutionarily in each individual workshop. The craftsmen only learned what their master knew. However, this was countered by the fact that the guilds had found their own way out of the dilemma. The problem was not solved through writing but through craftsmen who had completed their training. They would work for other masters in foreign workshops and thus travel through the area. This constant exchange between cities and regions helped to spread innovations and even encouraged new developments. Thus, useful knowledge and skills were transported via individuals⁵ and the exchange of knowledge took place beyond the individual workshops. Moreover, a lively social and professional exchange due to the great geographical mobility of the journeymen, who moved from town to town and worked in other people's workshops, can be proven (likewise through voluntary and involuntary long-term migration).⁶ However, there were also efforts to protect economic advantages that certain techniques brought with them from exchange. In Nuremberg, for instance, the exchange of staff with the outside world was prohibited (Stahlschmidt 1971, 161-63).⁷ In the long run, this strategy proved to be less efficient as external impulses were less intense than in cities that promoted exchange (Reith 2008, 141).

⁵ Reith 2005; 2008. On mechanism of prohibition and dissemination of craft knowledge see also Belfanti 2004.

⁶ Travel routes of journeymen and, on the other hand, employment lists show very clearly how extensive this exchange could be (Schulz 1996).

⁷ In Solingen, the bladesmiths, hardeners, and grinders had to take an oath not to disclose the secret of producing blades. Schwertfeger, who were in charge of the final assembly and therefore involved in the production process, remained exempt from it (Beck 1884, 847-51).

In sum, the skills that craftsmen would have needed to record their knowledge were given since the late middle ages. Why didn't craftsmen write about it? The first answer is simple: it was not necessary as the knowledge was transmitted to the apprentice by the master. It was practical knowledge, which did not provide any benefits when put into writing. However, this narrative is contrasted by countless surviving craftsmen's manuals mainly for building, fireworks, war machines, painting, and barbering. These books convey knowledge about craftsmanship and were printed early, at the latest in the 16th century. Furthermore, these written and printed recipes and technical books became accessible beyond the own craft.⁸ If these books were apparently not needed for knowledge exchange within a craft, why were they written? And vice versa: did the knowledge conveyed play any role for the transfer of useful knowledge and spread of innovation within the craft community and beyond? These questions are related to actual debates about artisan writing and the transfer of craftsmanship knowledge.⁹ The sources have so far been rather neglected for economic-historical questions while interesting results have already been delivered by studies in art and architectural history, costume history, military history, history of technology, history of medicine, and history of knowledge (Leng 2002a; Smith 2010; Holzer 2021; Lindgren 2000; Oltrogge 2013; Schütte 2019, 131-3).¹⁰

I would like to apply this cultural-historical research on handicrafts and writing to questions of economic history. In this article, I would like to approach the answer to the raised questions with the help of two micro-studies on manuscripts written by craftsmen from the 16th century: a manuscript containing information about plate harnesses written by an etcher from Augsburg and a book about casting techniques written by a bell founder from Munich. For the analysis I will use the historical-critical method combined with the manuscripts' analysis. For a better understanding of the manuscripts' variability, I rely on two detailed studies. I have chosen two manuscripts which come directly from the workshops of the craftsmen who wrote them and can be directly linked to their products. This direct link between product and writing is not always verifiable. Moreover, both crafts belong to those metal crafts that specialized in the production of expensive luxury objects.

2. Type(s) of Sources

Writings that convey craftsmen's knowledge are divided into different source genres, whose classification criteria overlap. Most often, the sources are divided into model books (Musterbücher), master builder's books (Werkmeisterbücher), recipe books and books on pharmacy, as well as treatise on military engineering

⁸ According to Mokyr, technical manuals require knowledge to be decoded from users (Mokyr 2011, 11).

⁹ These questions were inspired by Pamela H. Smith' pioneering works (Smith 2010; Smith 2022).

¹⁰ These manuals appeared even among Jewish craftsmen. I thank Andreas Lehnertz for the reference to manuscript Munich, Bayerische Staatsbibliothek, *Cod. hebr. 235*.

(Büchsenmeisterbücher) and gunpowder (Feuerwerksbücher) (cf. Gabriel 1977; Keil 1980; Beate Braun-Niehr 1993; Keil 1995; Binding 1997).¹¹ All these sources have in common that they can be called «professional literature» or «technological treatises» and convey craft or professional knowledge (Lefèvre 2004).¹²

Since the high middle ages, manuscripts conveying knowledge about crafts have been known, first sporadically, then increasingly. The text *De diversis artibus* (On various arts) by Theophilus Presbyter,¹³ which was written around 1100-1125 and describes various techniques of medieval craftsmanship, can be named as a very early example. In this text the goldsmith's art, book and wall painting, glass technology, and bell founding are described.¹⁴ Another early example is Villard de Honnecourt's model – or sketchbook, made around 1220/1230 (Lindgren 2000, 9).¹⁵

The manuals convey craft knowledge especially through drawings, which are explained through text. The model – or sketchbooks of builders (Baumeister) not only contain information about ground plans, vaults, and longwall systems but also about building cranes and mechanical saws (Hagendorf 1978). Moreover, there are manuscripts on special topics, from the construction of clocks by Giovanni de Dondi († 1389) and Paulus Almanus (15th century) (Lindgren 2000, 9) to recipes for painting art (*Compendium artis picturae*, early 13th century) (Silvestre 1954) or mining (*Schwarzer Bergbuch*, ca. 1550) (Bartels and Bingener 2015).

In addition, there have been writings with a focus on war craft and tactics since the beginning of the 15th century (cf. Leng 2002b).¹⁶ Among the most influential ones in the German-speaking world are Konrad Kyeser's *Bellifortis* (1402-1405)

¹¹ Cf. the growing database: *Illustrated German-language manuscripts of the middle ages* (only the treatises on military engineering and gunpowder as well as on swordplay and fighting are included yet: <https://kdih.badw.de/datenbank/start>, Accessed: 29.3.2022).

¹² In the repertory *Historical Sources of the German middle ages* these manuscripts are identified as instructional writings (Lehrschrift), which also include the *Ars dictandi*, musical tracts, mirrors of princes, and treatises on offices (<https://geschichtsquellen.badw.de/das-projekt.html>, Accessed: 29.3.2022). The historian of technology Lindgren proposes the term «technical encyclopaedia» to account for the peculiarities of the manuscripts among which she includes a conglomerate of topics tending towards technical universality (Lindgren 2000, 9 f.). The term «technical», however, excludes recipe collections from medical, metallurgical and chemical knowledge, which must be counted as craft knowledge. The term «encyclopaedia» then excludes those writings that are not designed for universality.

¹³ Also known as *Schedula diversarum artium* (List of various arts).

¹⁴ The identification of the author, who calls himself Theophilus Presbyter, as the monk Roger of Helmarshausen, who was a priest and goldsmith (Freise 1981, 193-200), has been doubted in recent research (Oltrogge 2017; cf. the project of the text's digital edition: <https://schedula.uni-koeln.de/index.shtml>, Accessed: 29.3.2022).

¹⁵ In addition to these writings, which focus on conveying knowledge about craftsmanship, there are also those that contain technical figures. These drawings (with a focus on building trades) are collected in Nussbaum 1978.

¹⁶ Leng collected more than 170 examples of manuscripts on war handicraft and tactics from 21 libraries (Leng 2002a, 389 f.).

(Leng 2002a, 109-149),¹⁷ the *Feuerwerkbuch von 1420* (Leng 2010a), as well as the writing of the *Anonymous of the Hussite wars* (last third of the 15th century) (Hall 1979). The craft writings of the late middle ages, to which these war craft writings can be counted, usually offer a mixture of quite different fields of craft knowledge.¹⁸ In Italy, writings of this kind were established earlier than in the German-speaking area. The Italian examples show a superior mastery of perspective in their drawings.¹⁹

3. The Book on Plate Harnesses ('Harnisch-Musterbuch') from Stuttgart

My first case study is based on the so-called Stuttgart *Harnisch-Musterbuch*, which was handed down as part of a collective manuscript together with a partial copy of the Augsburg gunsmith Samuel Zimmermann's († after 1576) *Dialogus*,²⁰ a well-known and widely distributed literary discussion between a military engineer (Büchsenmeister) and a master of gunpowder (Feuerwerker).²¹ The manuscript is incomplete²² and the stitched layers are not clear.²³ The handwritten entries are subordinate to the drawings.²⁴ The foliations correspond paleographically to the texts but are continuous. Gamber suggests that 29 leaves have been omitted, the foliation, which has no gaps, must be subordinate and the leaves have been intentionally taken by the scribe, whose motive remains unclear (Gamber 1980, 13).

Technical knowledge is conveyed in the manuscript through 85 drawings and texts supplementing the drawings. The manuscript was written by the etcher Jörg T. Sorg († 1603), who did not directly indicate himself as the scribe. The attribution to

¹⁷ About the same time Munich, Bayerische Staatsbibliothek, *Cgm 600*; cf. Leng 2002b, 205 f. In addition, there are writings that are best known to scholars but less or not at all received by contemporaries: the *Hausbuch* of the Princes of Waldburg Wolfegg (Lindgren 2000, 10).

¹⁸ In this context, researchers are discussing whether war craft should be regarded as secret knowledge and therefore not be disseminated as a matter of principle. In view of the great number of manuscripts with war-related content, this point must be put into perspective (cf. Leng 2002a, 396-98 and Jütte 2015, 65-79).

¹⁹ Among the best-known craftsmen were Taccola († 1453/58), Lorenzo Ghiberti († 1455), Francesco di Giorgio Martini († 1502), Giovanni Fontana († ca. 1455), Leon Battista Alberti († 1472), and Leonardo da Vinci († 1519) (Lindgren 2000, 10).

²⁰ Stuttgart, Württembergische Landesbibliothek, *Cod. milit. 2° 24*. It is uncertain when the collective manuscript was bound together as its binding is not contemporary. *The Book on Plate Harnesses* (f. 1r-45v; ca. 230 x 345 mm) has a distinctly different format than the *Dialogus* (f. 46-79r; ca. 205 x 330 mm), which is provisionally dated after 1600 due to watermarks on the paper (Irtenkauf 1980, 9).

²¹ Another text about fire and its benefits is assigned to Samuel Zimmermann: *Pyromachia*; cf. Leng 2002a, 353-58 and Leng 2010b.

²² Irtenkauf 1980, 9. The entry f. 42r is fragmentary; in addition, entries for the years 1555, 1560-1562 are probably missing. Irtenkauf calculates that 29 leaves must have been omitted (Gamber 1980, 13).

²³ For detailed information cf. Gamber 1980, 11-13.

²⁴ Cf. footnote 29; the coats of arms also adapt to the templates (*Harnisch-Musterbuch*, f. 14v, 19r, 21v, 30r, 33v, 38r, or 41r).

an etcher, however, results from the illustrations' captions.²⁵ Some of the harnesses drawn in the codex have survived as objects and some bear not only the signature of the plater assigned in the manuscript but also the signature of the etcher Sorg.²⁶ In a letter to the King Gustav I of Sweden († 1560) from 1559, Jörg T. Sorg is described as a painter and etcher of harnesses («maller vnd etzer auffß harnissch») and can be found between other craftsmen involved in the production of harnesses (platers and polishers). The letter bears Jörg (= Georg) Sorg's seal: A parchment knife in a shield above the initials GTS. It contains information about negotiations between the craftsmen and the court. The Swedish king wanted to employ Sorg and the other masters at his court (Gamber-Becher 1980, 26).²⁷ Sorg was thus firmly connected with the other professions. Furthermore, the letter is written on paper with a pressed-through border pattern. This border pattern is identical to the pattern on the harness for Vratislav von Pernstein († 1582), which was produced by the Augsburg plater Wolf Neumair († 1563) and whose pattern had been made by the manuscript's scribe (Harnisch-Musterbuch, f. 33r-34r). The letter again depicts a collaboration between the plater Wolf Neumair and the etcher Jörg Sorg (Gamber-Becher 1980, 26).

Jörg T. Sorg's father, named Jörg Sorg, was a city painter of Augsburg and his mother Catharina († 1553) a daughter of Kolman Helmschmid († 1532). In 1548, Jörg T. Sorg was granted the right to paint in Augsburg by the guild (Gamber 1980, 17). His drawings have been dated from 1548 to 1563 (Gamber 1980, 11). Gamber proposes to narrow the time further based on the following entry: «Item, this armour made for battle I have etched for Wolf Neumair, belongs to the Lord Vratislav of Pernstein on Pardubice, councillor and chamberlain of the Roman emperor. 1556».²⁸ Vratislav of Pernstein († 1582) was a councillor (Geheimer Rat) of King Maximilian II, who had been elected king in 1562 and crowned emperor in 1564. The entry about Vratislav von Pernstein must have therefore been made between 1562 and 1564 (Gamber 1980, 13 f.). Thus, it must be noted that the plate harness was made at least six years before the inscription was written down. The illustration that preceded the inscription must therefore have been written down after 1556 and before 1564.²⁹

²⁵ E.g. «Item disen fuß kyris hab ich dem Matheus Frawen breyß gheetz gehertt dem donn Kaspar de Quinarach 1549» (Item, I have etched this armour for the fight on foot to Matthäus Frauenpreiss, belongs to Don Kaspar de Quiñones 1549) (Harnisch-Musterbuch, f. 3r).

²⁶ Boheim first suggests the attribution to the etcher Sorg in 1891 (Boheim 1893, 207); in addition, the Sorgs' family coat of arms is depicted several times in the codex (Harnisch-Musterbuch, f. 9v and 10r). A cross (†) on f. 27r correlates with the year of his mother's death (Gamber-Becher 1980, 27; Harnisch-Musterbuch, f. 27v).

²⁷ Seal image: Gamber-Becher 1980, 27. Letter edited by Meyerson 1939, 215 f. quotation on page 216.

²⁸ «Jttem dissen kempff kyris hab ich dem Wolff Neymer geezt gehert dem hern Vrattislauß von Bernston auff Parduwitz. Ro ky mt ratt vnd camerer. 1556» (Harnisch-Musterbuch, f. 33r).

²⁹ The inscription considers the helmet's shape; likewise: Harnisch-Musterbuch, f. 3r, 6v, 21v, 25r or 26v; differently with the lances, which were drawn over the writing (f. 2r-v, 4v. 6r. 7r, 8r, 13r, 18r,

The manuscript's direct addressee is unknown. It is also unknown how the manuscript came into the Duchy of Württemberg's possession. However, the manuscript was certainly addressed to potential buyers of harnesses. In the court accounts of emperor Maximilian II it is written on May 28, 1564: «Georg Sorg, painter at Augsburg, receives for several drawings of harnesses made for Emperor Maximilian (II), 4 gulden by his own hand» (Gamber-Becher 1980, 27). Although it is highly unlikely that the Stuttgart codex contained these drawings of harnesses, this entry in the court accounts nevertheless shows that drawings by Sorg circulated even at the imperial court.

The watermark analysis of the manuscript, which was executed by the well-known watermark researcher Gerhard Piccard in the course of the edition, gives the following picture: F. 1-41 are of the same watermark which, according to Piccard, can be retraced to Augsburg between 1544 and 1551 (Gamber 1980, 11).³⁰ F. 44 has a different watermark which, following Piccard, is attested in Urach in 1561 (Irtenkauf 1980, 10; Briquet 1923).³¹ This watermark can still be found in other manuscripts about military engineering. On the one hand, the large Tetschen manuscript (†) with armour drawings probably contained this watermark.³² On the other hand, there is a parallel to a manuscript of Samuel Zimmermann's *Dialogus*, which also bears the same watermark (Leng 2010b). Zimmermann's *Dialogus* appears here for the second time. A coincidence that can only be explained by the thematic proximity. The codicological examination, however, appoints the manuscript not only into the context of military engineering writings but also to Augsburg (Irtenkauf 1980, 10). Both classifications agree with the content. Furthermore, it is no coincidence that such a handwriting was created in Augsburg as the city was considered a leading hub for this product in the 16th century. For further analysis it is necessary to look at the product, the manufacturing profession, and the buyers.

Plate armour with movable arms and legs was developed in Italy in the second half of the 14th century with the city of Milan being the technological leader (DeVries and Smith 2007, 172-83). Since the middle of the 15th century, plate armour lost its initially great protective function in the face of new weapon technologies and war tactics. Even though it was almost useless in active warfare by the middle of the 16th century, the plate armour retained its function as an object of

20r, 21r, 23r, 27v, 28r or 29r). This finding indicates a multi-part work process: Possibly the people were first prepared as a template, then the inscription was added and only afterwards the design of the armour, the coats of arms and the lances or swords.

³⁰ In the watermark database, which is based on Piccard's collection, the watermark has not been included. However, it can be found in Briquet (Briquet 1923), where it refers to Vienna 1563 and 1565-1573, Hustopeče 1563, Augsburg 1566, Ljubljana 1568-1570, and Bratislava 1576 (<http://briquet-online.at/2117>, Accessed: 28.03.2022; Briquet 1923).

³¹ The assignment to Urach cannot be traced. Briquet mentioned Praha 1537-1554, Augsburg 1545-1565, Stuttgart 1555, and Landsberg am Lech 1561-1632 (<http://briquet-online.at/1243>, Accessed: 28.03.2022).

³² Former library Thun-Hohenstein at Tetschen, Bohemia, Codex a/2. As far as it is at all possible to make statements about this manuscript, which was lost during the Second World War, there are also parallels in content here.

representation. Hence, the development of its practical use in combat and its representative function can be regarded as contrary. The design of the plate harness showed the social position and the social rank. Furthermore, plate armour was an essential part of knightly tournament fights (Gamber 1980, 14). The plate armour had evolved «from the first warlike utilitarian piece of the nobility to the exclusive status costume and multi-piece luxurious sports equipment» (Gamber 1980, 14).

Plating is a highly specialized craft based on experience and extensive knowledge of materials. The harness had to fit, which meant adapting to the wearer's physique, the joints had to be movable and, depending on their function, withstand physical manipulation. In addition, the appearance of the plate armour should correspond to the current fashion. Four to six masters were involved in the manufacturing process of a single product: Platers worked on the forging, polishers were responsible for smoothing and straightening, girdlers for strapping, upholsterers for the silk lining. Optionally, etchers and gilders were involved to decorate the harnesses (Gamber 1980, 15 f.).

In the empire, the platers of the cities of Augsburg, Innsbruck, and Nuremberg emerged as the technological leaders, with Italian craftsmen being superior in the production of embossed ceremonial armour. Augsburg specialized in luxurious work, whereas Nuremberg focalized mass production. After 1620, the demand for luxury armour ceased. During the period of the emperors Frederick III, Maximilian I, and Charles V, it was seemly for the German and Spanish courts to have their products manufactured in Augsburg, where the emperors bought as well. After 1560, Augsburg lost this supremacy as King Philip II of Spain turned to Landshut's plater workshops and Maximilian II followed. In addition, Milan regained importance (Gamber 1980, 15-17). In this time of Augsburg's loss of supremacy, *The Book on Plate Harnesses* was created in Augsburg, which recorded the heyday of the formerly exclusive court supplier of magnificent plate armour.

This thesis is supported by an analysis of the content. The manuscript lists all the important Augsburg masters with whom the etcher Sorg worked as well as the important patrons, with the harnesses standing in the centre. The drawings of the armour are uniform in their layout, which indicates the utilization of a template. Moreover, a preliminary drawing is not visible and the drawings were supplemented by colourful watercolour painting. Metal parts were painted in blue wash or black, gilded parts of the graphic (etched) decoration in yellow, ground stripes in brown-green. The coats of arms, lances, costume parts, and patterns of the command staffs are colourful; stronger paintings with opaque colours were probably applied later (Gamber 1980, 13).

The armour demonstrates the wealth of variations that the Augsburg platers were able to produce in combination with the other crafts. Not only the craftsmanship and artistic design become apparent in the manuscript but also the knowledge of how extensive an armour was and which parts belonged to it. Written numbers on the bottom of the pages refer to the number of armour parts; they can be un-

derstood as the scope of supply (Gamber 1980, 14).³³ The number of pieces of armour can be six, if the armour consists only of helmet, bevor / gorget, two pauldrons, cuirass, and backplate, or twelve: helmet, bevor / gorget, cuirass, backplate, two pauldrons, two armllets, two gauntlets, and two saddle-plates. Several figurines often represent one delivery, which is why the numbers of the delivery scope are correspondingly large. For example, the order for Ludwig Ungnad of Weißenwolff, Freiherr of Sonnegg († 1584) consists of 80 pieces (Gamber 1980, 14; Hengerer 2012, 1533-5). All in all, the figures give, according to Gamber, precise information on how many parts a harness consisted of, which was important knowledge for producers and buyers (Gamber 1980, 24).

This shows that around the middle of the 16th century, the harness was already subject to a standardization of its technical composition, which had developed in the courtly circles and was equally binding for the nobleman as well as the plater (Gamber 1980, 24).

Gamber assumes that the specified scope of supply was important to the etcher, as it would have served as proof of his activity (Gamber 1980, 25). In my view, the chosen recording method, namely written word and numbers in combination with images, is too elaborate for an order book. The knowledge conveyed there does not refer solely to clients owing payment to the etcher. For that knowledge you need no images and an order book's most important point is missing: The costs for the objects and the work. In addition, the platers with whom Sorg worked are named. They were all Augsburg master craftsmen whose fame was known far beyond the city and some of whose work had been handed down to us to this day (Gamber-Becher 1980, 28-45).

Gamber agrees that Maximilian II is a key figure among the clients (Gamber 1980). Although he himself is listed merely once as a client (Fig. 2), his closest circle also appears as well as the Spanish buyers (and the Italian ones), who were connected to him through his wife (belonging to her or Philip II's court). Clients from the European nobility can be found as well as citizens from Augsburg, the latter with a different helmet shape (Fig. 1-2).

The clients are mentioned in the inscriptions and their coats of arms are placed prominently on the side of each figurine (Fig. 1-2); the coat of arms attached to Maximilian II's plate armour for foot combat (Fig. 2) was revised. The one originally placed there was pasted over with a piece of paper on which the large archducal coat of arms, including Bohemia-Hungary's royal coat of arms, had been painted. When and by whom the updating was done is unclear. Gamber sees this as evidence that the harness was still in production at the time of Maximilian's elevation to King of Bohemia (1562) and that the coat of arms therefore had to be changed

³³ The word «rechnung» on Harnisch-Musterbuch, f. 5v marks the numbers and signs as representation for piece numbers.

(Gamber 1980, 17). The inscription indicates 1549 as the year of production. In my opinion, the coat of arms' correction should be seen independently of the armour's production. The drawings in the manuscript were made after the armour was produced anyway. The coat of arms' correction only shows that the manuscript was started before 1562. Since its last dating is from 1563, the corrector can be identical with the scribe. Sorg updated the manuscript and added the more prestigious coat of arms of the King of Bohemia.

Fig. 1. **Harness of a bourgeois**



Fig. 2. Harness of Maximilian II



In this codex, knowledge is transported in different ways. The artistry of the Augsburg harnesses is conveyed and at the same time Sorg demonstrates what he can create through the drawings.³⁴ The illustrated manuscript offers the possibility

³⁴ In retrospect, the fashions and their change in the years 1548 to 1563 can be seen (Gamber 1980, 25).

for anyone who had access to get an overview of what the Augsburg harness makers were able to produce, what forms and finishes were possible and current, and who decided on which form. The manuscript thus not only conveys knowledge about the product and the craftsmen's skills but also which craftsman was able to produce which products or with whom an etcher worked together. Furthermore, it becomes apparent for whom harnesses were produced and for whom a special harness form and decoration was created. Thus, the manuscript could assist in the decision after which model the own palate armour could be made and hence, in who's shadow one wanted to place oneself. This indicates that the products were not only shown and advertised in a certain way, but also that social knowledge was transported. Therefore, the inclusion in a social group, in which the potential buyer could also place himself by purchasing the plate armour in the latest pattern, was communicated. But why was this knowledge recorded at all? Is it «only» social information or can economic interests be suspected behind it? *The Book on Plate Harnesses* can be read as a kind of catalogue that advertised the Augsburg harness makers and etchers. The manuscript's time of writing offers information about the Causa Scribendi, which wrote and drew a representative of the former market leaders of a luxury product. The knowledge conveyed through the manuscript should recruit other clients. Last but not least, Jörg T. Sorg also records knowledge for himself. In this way, the book can also be read as a reminder, a memorial, for what he (and the Augsburg harness makers) could produce.

4. Christoph Sesselschreiber's Book of Casting

My second case study is based on a manuscript by the bell founder Christoph Sesselschreiber, entitled *Of bell and artillery foundry, military engineering, gunpowder processing, fireworks, hoisting and crushing equipment, water and well works*.³⁵ Using the example of bell casting, which is a highly complex craft, the problem of solely orally transmitted knowledge will be briefly explained. In the 15th and 16th centuries, bell-casting centres developed in a number of cities, among them Salzburg (Kral 2020, 443). Some of the Salzburg bell founders were so renowned that they received orders from beyond their region, e.g., the Salzburg founder Jörg Gloppitscher († 1480). Among other objects, he cast the large bell for Wasserburg am Inn.³⁶ Jörg Gloppitscher had no direct successor, his foundry was sold several times, and none of the owners could reach to his level. Apparently, Gloppitscher's templates were sold separately. In addition, the bells from his successors' foundry (esp. Josef Erhart, a founder who obtained the Salzburg citizenship as a goldsmith) were less elaborately decorated and showed less variance in their inscriptions, which were, however, inspired by Gloppitscher's (Kral speaks of imitation). The construction of

³⁵ Von Glocken- und Stuckgiesserei, Büchsenmeisterei, Pulverbereitung, Feuerwerk, Heb- und Brechzeug, Wasser- und Brunnenwerken (Munich, Bayerische Staatsbibliothek, *Cgm 973*).

³⁶ Called «the Salzburgerin», weight 4500 kg (Kral 2020, 443 f. and 454, annot. 2-3).

the bell also did not reach its predecessor, which affected its musical quality. In addition, casting defects are often found in the bells such as rough surfaces and gas inclusions (Kral 2020, 444-46). Hence, if a workshop was not continued, the knowledge was lost with the master. Conversely, this was different with knowledge conveyed through written manuscripts.

Christoph Sesselschreiber, the writer of the manual about bell founding, was the son of the Munich painter Gilg (Ägidius) Sesselschreiber, who had been a painter at the court of Maximilian I († 1519) since 1502. In 1508 Gilg Sesselschreiber was commissioned to lead the casting work for Maximilian's tomb in Innsbruck.³⁷ He was put in charge of the princely foundry in Mühlau near Innsbruck with staff and employees, including the bell founder Peter Löffler. The foundryman's expertise was certainly extremely important for Gilg, who as a painter had no experience with casting. Another painter, two carvers, two founders, a brazier, and a blacksmith worked under his direction (Hartig 1927, 279; Egg 1961, 54; 62).

It is likely that Gilg prepared drawings that served as the basis for the cast figures.³⁸ The idea that knowledge of craftsmanship, in this case of bronze casting, was written down and drawn on paper was therefore not new to Christoph Sesselschreiber. He had apparently acquired sufficient knowledge of bronze casting in the foundry run by his father to produce his own castings. Thus, in 1519 he cast the bell of the Salzburg City Hall and in 1521 the bell for Arnsdorf (Salzburg). Sesselschreiber was presumably active in Salzburg between 1518 and 1521 (Egg 1961, 62; Kral 2020, 451). Afterwards, Christoph possibly went to Munich. It is uncertain whether he had a permanent employment relationship with Duke Wilhelm IV of Bavaria († 1550) as the court accounts have survived only sporadically and the tax books list a painter Christoph in 1525 and 1526 but without a surname (Hartig 1927, 280; Leng 2002a, 369).³⁹ Moreover, journeys to Bavaria, Austria, Salzburg, and Innsbruck are documented. It is unknown whether Christoph had a fixed location where he executed the commissioned work or whether he should be assessed as a traveling bell and gun founder (Leithe-Jasper and Gürtler 1996, 88; Leng 2002a, 369).⁴⁰

³⁷ For details on Gilg and the events surrounding the production of the figures that led to his temporary imprisonment cf. Hartig 1927, 278-82; Leng 2002a, 369; Egg 1961, 62; still fundamental Schönherr 1890.

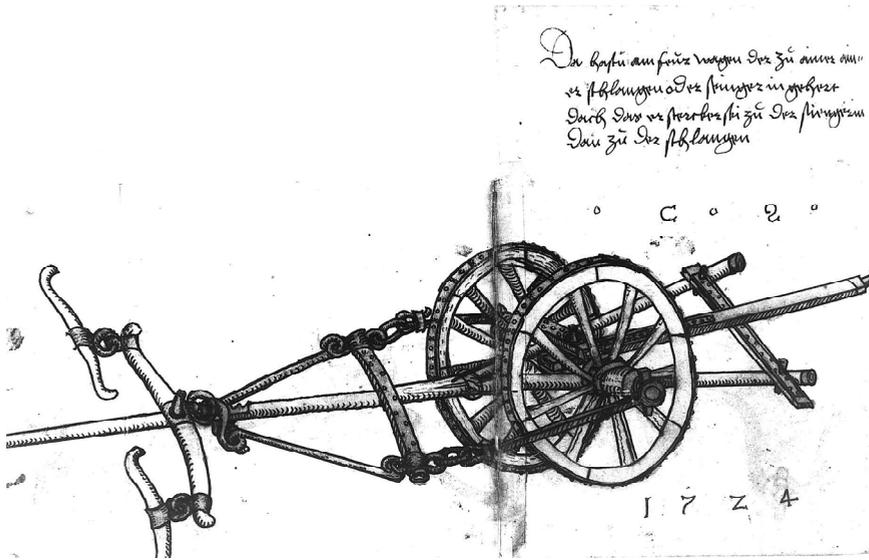
³⁸ Schönherr 1890, 170-6 assumes that Vienna, Österreichische Nationalbibliothek, *Cod. 8329* was made by Gilg Sesselschreiber. According to the library, the drawings were made by the court painter Jörg Kölderer and were based on Gilg Sesselschreiber's drawings and the bronze casts.

³⁹ Following Boenheim 1897, 59 Sesselschreiber stood in the duke's service, but again Boenheim gives no clues as to where he obtained this information.

⁴⁰ According to Egg, the described gun types indicate travel (Egg 1961, 63). The coats of arms painted in the manuscript show us the buyers of Christoph's objects: Coats of arms of Bavaria, Austria, Salzburg (including the coat of arms of Archbishop Leonhard von Keutschach, who died in 1519), Innsbruck, Nuremberg, Württemberg, Augsburg, and Hungary.

The book examined here was written by Sesselschreiber in 1524 and was in the possession of Duke William IV, as evidenced by a handwritten note by his brother Duke Louis X († 1545).⁴¹ The manuscript's attribution to Sesselschreiber as its writer is quite simple; he constantly refers to himself in the manuscript (e.g., Sesselschreiber, f. 1r, 6v, 7v, and 8r). The manuscript consists of 158 leaves bound in parchment.⁴² Sesselschreiber utilizes both texts and drawings to convey his knowledge. It is striking that in his writing he alternates between the usual cursive and a font consisting of capital letters enriched with smaller figures, acorns, stars, bells, and so on. The letters D, S, and N are mirror-inverted throughout.⁴³ The illustrations are made with watercolour technique. According to Boenheim, the manuscript is «awkward and incorrect, but sometimes vivid and mostly understandable» (Boenheim 1897, 60).

Fig. 3. Chariot for a cannon



Because the manuscript has not been edited, the content's analysis must be more detailed. The book can be divided into several parts as already the title preserved in the library shows. The first part covers the foundry of bells (casting plac-

⁴¹ On the back cover of the codex is written: Return to brother William, acted on 14.01.1542 («Brueder hertzog Wilhelm wider zuzu stellen, actu(m) den 14 tag Jenner Anno 1542»).

⁴² In quarto format (160 mm x 215 mm); 145 of these leaves are foliated.

⁴³ Boenheim sees in it a youthful and unskilled writer (Boenheim 1897, 60). By using the cursive Sesselschreiber never had such problems.

es, casting tools, cross-section of a bell, table with wall thicknesses); knowledge is conveyed both in pictures and as text (Fig. 3).⁴⁴

The foundry section also covers gun foundry, which includes the crafting of guns, pipes, and bullets (on gun-powder artillery cf. DeVries and Smith 2007, 195-202).⁴⁵ The next part describes the operation of the guns using tools (such as setting scales). Furthermore, this part is interspersed with coats of arms (Sesselschreiber, f. 23r-42r). «Here he stands on the ground of the very own study and experience, and resolutely advances his colleagues» (Boeheim 1897, 61).⁴⁶ According to Boeheim, «everything proves the capable expert and serious thinker. In individual cases, he becomes an ingenious inventor again» (Boeheim 1897, 62). Sesselschreiber was particularly significant as a designer of gun mounts (frames for cannons) (Boeheim 1897, 62). Thus, the illustrations of guns on racks also occupy a significant place (Fig. 3).⁴⁷ You can read there: «There you have a fire chariot, which belongs to a culverin or a long kartouwe (Singerin), but it (fits) better with the long kartouwe than with the culverin. C(hristoph) S(esselschreiber). 1524».⁴⁸ Next, techniques for calculating flight altitude and range and necessary instruments are treated (Boeheim 1897, 62).

The following topics are lifting and crane devices, some of them very complex, which a bell and gun founder urgently needed for his work to transport bells and guns or to install bells in towers.⁴⁹ Bell casting in the 15th century had reached the point where musically excellent bells could be cast, which could also be very large (several thousand kilograms) and still be placed in the towers (Kral 2020, 443). In this part of the codex, knowledge is conveyed not only on a textual and pictorial level but also on a haptic level. Sesselschreiber depicts complex hoisting devices consisting of multiple pulleys and ropes with the aid of threads. Instead of drawing

⁴⁴ Sesselschreiber, f. 1r-2r: on furnaces, shape, and casting of bells and their sound; f. 3r-11r: on hanging of bells, on weights and measures (in addition, repeatedly page-long instructions) (Boeheim 1897, 60 assumes that it is a copy of an older text).

⁴⁵ Sesselschreiber, f. 15r: culverin Nuremberg type; f. 15v: Bavarian style; f. 16r-v: falconet; f. 17r-v: falcon; f. 18r: long kartouwe (Singerin); f. 18v: medium size cannon (Scharfmetze); f. 19r-21r: several versions of cannon balls.

⁴⁶ In contrast Egg 1961, 63: «The book itself is a late descendant of the fireworks books rather than a manual of the new artillery created by Emperor Maximilian and, in contrast to Strasbourg, for example, suggests that gunnery in Bavaria before 1525 was more conservative than progressive»; cf. Leng 2002a, 369 f.

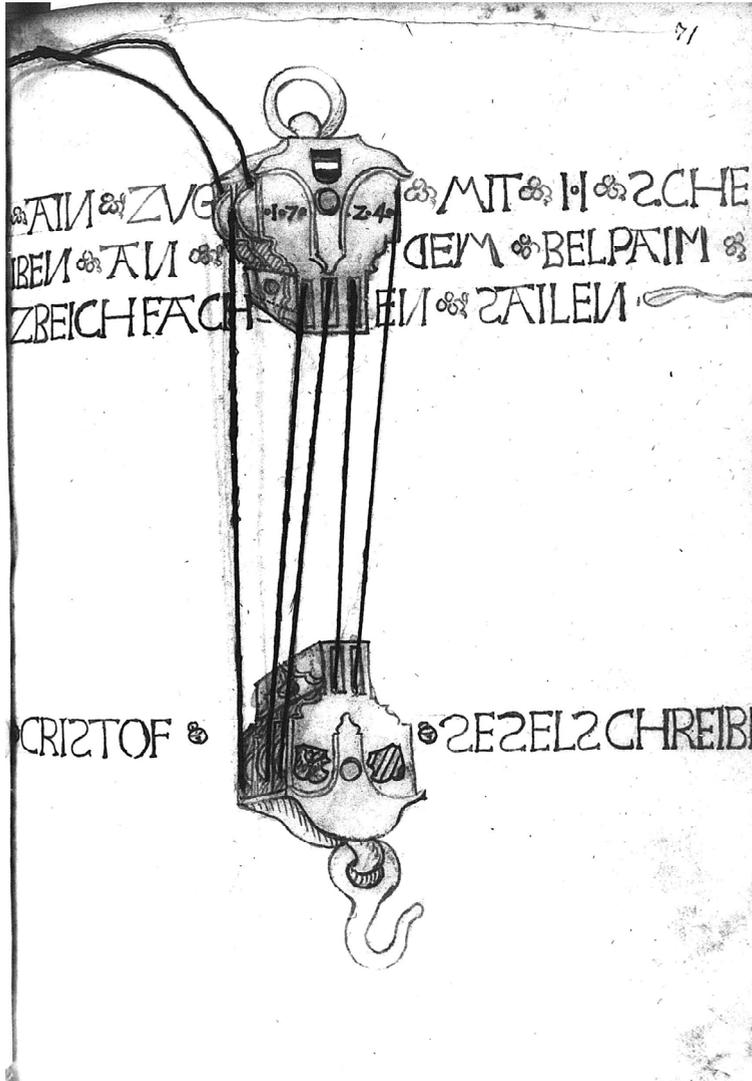
⁴⁷ Sesselschreiber, f. 42v-43r: gun on a stand; f. 43v-44r: artillery on mount (for the size of the figure a larger sheet was added; cf. Fig. 3: Sesselschreiber, f. 44v); f. 44r: limber; f. 45r: wheeled cart for use in a wagon castle; f. 45v: Bavarian field artillery (all on extended sheets).

⁴⁸ «Da hastu ain feur wagen der zu ainer schlangen oder seingerin gehert dach das er stercker sei zu der siengerin dan zu der schlangen. C.S. 1524». (Sesselschreiber, f. 44v).

⁴⁹ Sesselschreiber, f. 60r-72v: hoisting device; the ropes were partly not drawn but threads were punched through the manuscript (69r-72v) in between coats of arms; on hoisting devices drawn in manuscripts cf. Scaglia 1966.

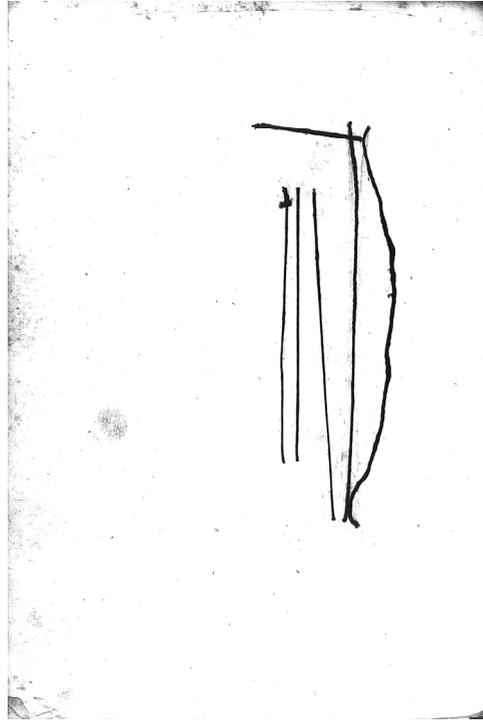
ropes, he punched threads through the codex (Fig. 4-5). The text says: «a hoisting device with eleven pulleys on which hang two ropes. Cristof Seselschreiber».⁵⁰

Fig. 4. Hoisting device



⁵⁰ «Ain zug mit 11 schein an dem belpain zbeichfachen sailen. Cristof Seselschreiber» (Sesselschreiber, f. 71r).

Fig. 5. Threads punched through the codex



The following two parts, consisting of recipes for powder and military and civilian fireworks,⁵¹ siege weapons,⁵² and divers,⁵³ certainly go back to other written sources. Sesselschreiber's manuscript is strongly linked to other treaties on military engineering and it appears that a part of these manuscripts refers to conventions of presentation (Friedrich and Krusenbaum-Verheugen 2021).

Sesselschreiber describes the contemporary artillery but not the new developments recognizable since 1520. Boheim draws attention to the fact that Sesselschreiber refers to the old, known fireworks books. However, he does not hand down the old, incomprehensible recipes but rather cited «improvements

⁵¹ Sesselschreiber, f. 74r: list of materials; f. 74v-78v and f. 80r-84v: recipes for powder and (military) fireworks; f. 87r-90v: arrows and powder for arrows; f. 91v-105v: recipes; f. 107r-123r: dealing with sulphur and saltpetre.

⁵² Sesselschreiber, f. 123v-132v: siege weapons; Sesselschreiber, f. 126r has similarities with Munich, Bayerische Staatsbibliothek, *Clm 197, I*, f. 12v (cf. Hall 1979, 40 f).

⁵³ Sesselschreiber, f. 135v-140r. The illustrations show similarities with Munich, Bayerische Staatsbibliothek, *Clm 197, I*, f. 12v, 13r, and 14r and *Clm 30150*, fol. 78v-80r (cf. Hall 1979, 40 f.; Egg 1961, 63); they can probably be found in other manuscripts as well. Hartig assumes Robertus Valturius († 1475): *De re militari* or Vegetius (both printed) as models for the technical drawings (Hartig 1927, 283 f.). Leng added to this list books from the circle of Johannes Formschneider († after 1470) and the *Feuerwerkbuch von 1420* (Leng 2002a, 370).

based on his own invention and testing», which are, however, explained incomprehensibly (Boeheim 1897, 60). In addition, he highlights the fact that he was recording new technology several times in the manuscript (Sesselschreiber, f. 65v-66v and 68v-70r).

Independent is the last part of the manuscript, which contains knowledge about the construction of water heaters and bathhouses, waterworks for fountains, as well as decorative fountains.⁵⁴ The book is particularly interesting for the casting of fountains and bells, which Theophilus Presbyter wrote about before Sesselschreiber (12th century) (Kral 2020, 451). Especially the detailed calculations of the bell construction and the new lifting process with vertical axis are to be highlighted. This new lifting method made it easier to hoist products weighing several tons into the casting pit and is still in use today (Kral 2020, 452).

The constantly recurring coats of arms of the patrons, which also await a more detailed analysis, do not indicate the manuscript's patrons,⁵⁵ but provide information about the products made by Sesselschreiber. This puts the manuscript into a clear relationship with *The Book on Plate Harnesses* (Leng 2002a, 369). These parts, according to Leng, should be read as a «memorial book» about the things cast by him (Leng 2002a, 370). In my opinion, the interpretation as a «memorial book» does not go far enough; the proximity to *The Book on Plate Harnesses* rather shows that knowledge is also stored for potential future employers.⁵⁶ Sesselschreiber can thus show his repertoire and announce himself. He describes not only what he can theoretically produce but what he has already created.⁵⁷ No one could learn founding bells, fountains or guns, and constructing scaffolds, siege towers or grinders directly from the manuscript; however, if you were already able to found and build things, then you could imitate the techniques provided in the manuscript. The manuscript addresses master bell founders who could adapt technology and their buyers who could chose a gun, fountain or siege tower they liked.

⁵⁴ Sesselschreiber, f. 141r-142v: water heater and bathroom; f. 143r-153v: waterworks for wells; on fountains cf. Magnusson 2001, 103-9 and on hydraulic technology Magnusson 2001, 169.

⁵⁵ Egg 1961, 63 assumes that the book was dedicated to Wolfgang Hofer von Urfahrn, the son of the important Schwaz mining entrepreneur Virgil Hofer († 1496). Egg describes him as a patron who brought Sesselschreiber into the Lower Bavarian service. This conclusion is based on the erroneous assumption that the repeated drawings of Hofer's coat of arms indicated patronage.

⁵⁶ Leng also softens the attribution «memorial book» and draws attention to the fact that it «could have served as a presentation to his patron» (Leng 2002a, 371). In addition, Leng sees it as an effort «to rehabilitate himself as a gun and bell founder, perhaps to acquire new orders, and at the same time to prove his abilities [...]» (Leng 2002a, 370).

⁵⁷ For example, two fountain drawings are provided with locations. In the drawing of a fountain with a statue of the Lorelei it is written: «stet auf der Maczen» (Sesselschreiber, f. 149v. Burg Matzen im Unterinntal; Hartig 1927, 284) and in the drawing of a fountain with Freising coat of arms: «sett in Freising» (Sesselschreiber, f. 150r; Hartig 1927, 284).

5. Conclusions

The case studies show that craftsmen, masters of their trade, transmitted knowledge in manuscripts. Those manuscripts are multifunctional and, besides a whole range of functions, serve to transfer useful knowledge for economic purposes. They convey useful knowledge in written, pictorial, and partly haptic form. Moreover, they address the knowledge to the future and to the craftsmen of their own craft, who partly received the writings and compiled them into their own records. The countless manuscripts bearing this knowledge demonstrate the craftsmen's interest in the latest (military) technology. Current fashions and innovations are conveyed, but neither the writings nor the images do provide the know-how on how to manufacture the products. The transmission of this knowledge remained in the workshop and bound to the human being; it was not passed on in manuscripts. It remains practical and oral to this day. The construction drawings and concept collections show what is possible and conceivable, but they do not convey the knowledge of how the products could be made.

The fact that not all objects could be realized might be obvious with regard to the divers, but the writers mark the already realized objects with the buyers' coats of arms. This also explains the supposed lack of knowledge, which Reith describes as empty spaces that have to be filled with knowledge acquired in the workshops (Leng 2004, 97; Reith 2005, 352-3). A plater, however, can very well recognise how many parts an armour has, which parts are currently used for which armour, and how the armour is cut from *The Book on Plate Harnesses*; the etching painter recognises the patterns that are in fashion. A bell founder can read the measurements and utilize them or reconstruct the beam construction for his own lifting gear. For better illustration, the threads for the tackle are punched into the manuscript as examples. However, an unskilled person cannot do anything with them. Today, construction drawings are standardised and much more complex, but again, the amateur can do nothing with them. What is conveyed are new techniques and innovations within one's own craft; Sesselschreiber repeatedly draws attention to the fact that he reflects new techniques. In this way, complex technologies can be communicated. This aspect is more evident in Sesselschreiber's manuscript, which contains a mixture of conventional, old familiar knowledge and new knowledge. The innovation, however, did not take place in the manuscript but in the workshop. Sesselschreiber's new technologies are usually marked with coats of arms, i.e., they were actually built. Sesselschreiber thus ensures that he will be able to reproduce the complex constructions even years later. Therefore, the manuscript served as a memorial device. This article shows that writing is equally used to disseminate useful and valuable knowledge beyond the individual and thus contributes to the question of artisan writing.

At the same time, a potential client's attention can be drawn to the products, which are not display goods that were first made and then sold. Contrary, all these products were very expensive. The manuscripts advertise goods which cannot be

shown in a shop. Thus, these manuscripts served to increase the sales of the products as the knowledge about them and their appearance had to leave the narrow framework of the craft in order to sell them. These results can be applied to the question of the sale of luxury goods. In the case of *The Book on Plate Harnesses*, it should be added that the writer is writing against the crafts' decline in Augsburg. He demonstrates the art of plate harnesses in order to help the city's craftsmen back to the top. The book can therefore be seen as a fight against economic decline. This shows that writing was used as a way of regaining economic significance. This result is certainly interesting for the questions about methods to strengthen one's own business.

It is also interesting to examine who could access the military objects and the knowledge about them and whether new technologies were kept under secrecy in order to have a strategic advantage in wars. More research is needed here. In addition, the objects' production involved several craftsmen working together. This applies to the crafting of harnesses as well as bells, fountains, and war machines. The etcher also displays samples of his work by inserting his patterns into the drawings.

The coats of arms and names in the manuscripts indicate that individual products have already been made and tested. Moreover, the client can place himself in a line of prestigious former customers by buying the products. This is how advertising still works today (e.g. the British court suppliers).⁵⁸ The knowledge that is imparted is multi-layered; in addition to craft knowledge, there is social and cultural knowledge that craftsmen preserved via manuscripts. But it is the everyday skills that cannot be conveyed through books.

BIBLIOGRAPHY

Unedited Sources

Munich, Bayerische Staatsbibliothek, *Clm 197, I* (urn:nbn:de:bvb:12-bsb00113810-6; accessed: 29.03.2022).

Munich, Bayerische Staatsbibliothek, *Clm 30150* (urn:nbn:de:bvb:12-bsb00090291-5; accessed: 29.03.2022).

Munich, Bayerische Staatsbibliothek, *Cgm 973* (urn:nbn:de:bvb:12-bsb00110920-7; accessed: 29.03.2022).

Stuttgart, Württembergische Landesbibliothek, *Cod. milit. 2° 24*, (https://digital.wlb-stuttgart.de/index.php?id=6&tx_dlf%5Bid%5D=1385&tx_dlf%5Bpage%5D=1; accessed: 29.03.2022).

Vienna, Österreichische Nationalbibliothek, *Cod. 8329* (<http://data.onb.ac.at/rec/AC13954012>; accessed: 29.3.2022).

⁵⁸ Court supplier to the Queen: Twingings for tea; current list at Wikipedia (https://en.wikipedia.org/wiki/List_of_Royal_Warrant_holders_of_the_British_royal_family, Accessed: 29.3.2022).

- Bartels, Christoph und Andreas Bingener. 2015. "Das Schwazer Bergbuch in seinem historischen und technologischen Kontext." In *Bergauf Bergab. 10.000 Jahre Bergbau in den Ostalpen*, ed. Thomas Stöllner, and Klaus Oeggel, 519-26. Bochum: VML Verlag.
- Beck, Ludwig. 1884. *Die Geschichte des Eisens in technischer und kulturgeschichtlicher Beziehung, Erste Abteilung: Von der ältesten Zeit bis um das Jahr 1500 n. Chr.*, Braunschweig: Vieweg.
- Belfanti, Carlo. 2004. "Guilds, patents, and the circulation of technical knowledge: Northern Italy during the early modern age." *Technology and Culture* 45/3: 569-89. <https://doi.org/10.1353/tech.2004.0111> .
- Bernoulli, August. 1890. „Hans Brüglingers Chronik im Zunftbuche der Brod Becken 1444-1446.“ In *Basler Chroniken*, Bd. 4, ed. Bernoulli, August, 165-229. Leipzig: S. Hirzel.
- Binding, Günther. 1997. "Art.: Werkmeisterbuch." *Lexikon des Mittelalters* 8: 2206.
- Boeheim, Wendelin. 1893. "Augsburger Waffenschmiede, ihre Werke und ihre Beziehungen zum kaiserlichen und zu anderen Höfen." *Jahrbuch der Kunsthistorischen Sammlungen des Allerhöchsten Kaiserhauses* 14: 329-45.
- Boeheim, Wendelin. 1897. "Studie über die Entwicklung des Geschützwesens in Deutschland." *Zeitschrift für historische Waffen- und Kostümkunde* 1: 57-62.
- Braun-Niehr, Beate. 1993. "Art.: Musterbuch." *Lexikon des Mittelalters* 6: 974-75.
- Briquet, Charles Moïse. 1923. *Les filigranes. Dictionnaire historique des marques du papier dès leur apparition vers 1282 jusqu'en 1600*, Leipzig: Hiersemann.
- Bruch, Julia. 2019. "Aber es haben fil leÿtt drin glesen, das es sich schier will anfahen zerreyssen, dan es ist nitt einbunden gwesen. Zur Materialität städtischer Chroniken des 16. Jahrhunderts" In *Die Materielle Kultur der Stadt in Spätmittelalter und Früher Neuzeit*, ed. Heusinger, Sabine von und Susanne Wittekind, 137-60. Wien [u.a.]: Böhlau (Städteforschung, Reihe A 100). <https://doi.org/10.7788/9783412516147.137>
- Brugger-Koch, Susanne. 1985. "Venedig und Paris - die wichtigsten Zentren des hochmittelalterlichen Hartsteinschliffs im Spiegel der Quellen, Teil 1." *Zeitschrift des deutschen Vereins für Kunstwissenschaft* 39: 3-39.
- Dehnert, Uta. 2017. *Freiheit, Ordnung und Gemeinwohl: reformatorische Einflüsse im Meisterlied von Hans Sachs*. Tübingen: Mohr Siebeck (Spätmittelalter, humanismus, Reformation: studies in the late middle ages, humanism and the Reformation, 102).
- DeVries, Kelly, and Robert Douglas Smith. 2007. *Medieval weapons: an illustrated history of their impact*. Santa Barbara: ABC-CLIO.
- Egg, Erich. 1961. *Der Tiroler Geschützguß 1400-1600*, Innsbruck: Wagner (Tiroler Wirtschaftsstudien, 9).
- Freise, Eckhard. 1981. "Roger von Helmarshausen in seiner monastischen Umwelt." *Frühmittelalterliche Studien* 15: 180-293. <https://doi.org/10.1515/9783112322109-007>
- Friedrich, Udo, and Christiane Krusenbaum-Verheugen. 2021. "Konventionalität und die Literatur der Vormoderne. Zur Einführung." In *Kunst und Konventionalität: Dynamiken sozialen Wissens und Handelns in der Literatur des Mittelalters*, ed. Friedrich, Udo, Christiane Krusenbaum-Verheugen, and

- Monika Schausten, 7-61. Berlin: Erich Schmidt (*Zeitschrift für Deutsche Philologie*. Beiheft 20).
- Gabriel, Erich. 1977. "Art.: Feuerwerksbücher." *Lexikon des Mittelalters* Bd. 4: 423.
- Gamber, Ortwin. 1980. "Der Codex." In *Das Stuttgarter Harnisch-Musterbuch: 1548-1563*, ed. Gamber-Becher, Charlotte, Ortwin Gamber, and Walter Irtenkauf, 11-18. Wien: Schroll.
- Gamber-Becher, Charlotte. 1980. "Die Meister." In *Das Stuttgarter Harnisch-Musterbuch: 1548 - 1563*, ed. Gamber-Becher, Charlotte, Ortwin Gamber, and Walter Irtenkauf, 26-45. Wien: Schroll.
- Hagendorf, Lucie. 1978. "Bauhüttenbuch des Villard de Honnecourt." In *Der mittelalterliche Baubetrieb nördlich der Alpen in zeitgenössischen Darstellungen*, ed. Binding, Günther und Norbert Nussbaum, 1-21. Darmstadt: WBG.
- Hall, Bert S. 1979. *The technological illustrations of the so-called «Anonymous of the Hussite wars»: Codex Latinus Monacensis 197, Pt. 1*, Wiesbaden: Dr. Ludwig Reichert Verlag. <https://doi.org/10.2307/3104673>
- Hartig, Otto. 1927. "Christof Sesselschreiber und sein Buch über Büchensmeisterei und technische Erfindungen." *Kultur des Handwerks. Amtliche Zeitschrift der Ausstellung München 1927 "Das bayerische Handwerk"* 12: 278-84.
- Hengerer, Mark. 2012. "Ungnad von Weissenwolff." In *Grafen und Herren. Höfe und Residenzen im spätmittelalterlichen Reich. Band 2*, ed. Hirschbiegel, Jan, and Werner Paravicini, 1531-45. Ostfildern: Thorbecke.
- Heusinger, Sabine von. 2009. *Die Zunft im Mittelalter. Zur Verflechtung von Politik, Wirtschaft und Gesellschaft in Straßburg*. Stuttgart: Steiner (Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte: Beihefte 206).
- Hölscher, Lucian. 1903. "Handwerkerbriefe aus der Zeit der Reformation." *Zeitschrift der Gesellschaft für niedersächsische Kirchengeschichte* 7: 250-74.
- Holzer, Stefan M. 2021. *Gerüste und Hilfskonstruktionen im historischen Baubetrieb: Geheimnisse der Bautechnikgeschichte*, Berlin: Ernst & Sohn. <https://doi.org/10.1002/9783433607961>.
- Irtenkauf, Walter. 1980. "Vorwort." In *Das Stuttgarter Harnisch-Musterbuch: 1548-1563*, ed. Gamber-Becher, Charlotte, Ortwin Gamber, and Walter Irtenkauf, 9-10. Wien: Schroll.
- Jütte, Daniel. 2015. *The age of secrecy: Jews, Christians, and the economy of secrets, 1400-1800*, New Haven: Yale University Press. <https://doi.org/10.12987/9780300213423>
- Keil, Gundolf. 1980. "Art.: Arzneibücher." *Lexikon des Mittelalters*. 1: 1091-94.
- Keil, Gundolf. 1995. "Art.: Rezept, Rezeptliteratur." *Lexikon des Mittelalters* 7: 778-79.
- Kral, Josef. 2020. "Eben noch weltberühmt - heute verschwunden? Der Glockenguss in der Zeit der Erzbischöfe Leonard von Keutschach und Matthäus Lang von Wellenburg." In *Zeit des Umbruchs: Salzburg unter Leonhard von Keutschach und Matthäus Lang (1495-1540): Ergebnisse der internationalen Fachtagung von 11. bis 12. Juni 2019 in Salzburg*, ed. Peter Franz Kramml, and Thomas Mitterecker, 443-54. Salzburg 2020 (Schriftenreihe des Archivs der Stadt Salzburg 57).
- Lanzinner, Maximilian. 1994. "Geheime Räte und Berater Kaiser Maximilians II. (1564-1576)." *MIÖG* 102: 296-315.

- <https://doi.org/10.7767/miog.1994.102.34.296>.
- Lefèvre, Wolfgang. 2004. "Introduction" In: *Picturing machines 1400-1700*, ed. Wolfgang Lefèvre, 1-10. Cambridge, Mass: Transformations.
<https://doi.org/10.7551/mitpress/5380.003.0001>
- Leithe-Jasper, Manfred, and Eleonore Gürtler, ed. 1996. *Ruhm und Sinnlichkeit: Innsbrucker Bronzerguss 1500-1650, von Kaiser Maximilian bis Erzherzog Ferdinand Karl; eine Ausstellung des Tiroler Landesmuseums Ferdinandeum*, Innsbruck: Tiroler Landesmuseum Ferdinandeum.
- Leng, Rainer. 2010a. "Feuerwerks- und Kriegsbücher. »Feuerwerkbuch von 1420« (Nr. 39.2)." In *Katalog der deutschsprachigen illustrierten Handschriften des Mittelalters (KdIH)*, Band 4/2, ed. Hella Frühmorgen-Voss, Norbert H. Ott, Ulrike Bodemann, Peter Schmidt, and Christine Stöllinger-Löser. München: Schwabe.
- Leng, Rainer. 2010b. "Feuerwerks- und Kriegsbücher. Samuel Zimmermann (Nr. 39.16)." In *Katalog der deutschsprachigen illustrierten Handschriften des Mittelalters (KdIH)*, Band 4/2, ed. Hella Frühmorgen-Voss, Norbert H. Ott, Ulrike Bodemann, Peter Schmidt, and Christine Stöllinger-Löser. München: Schwabe.
- Leng, Rainer. 2002a. *Ars belli: deutsche taktische und kriegstechnische Bilderhandschriften und Traktate im 15. und 16. Jahrhundert*, Bd. 1. Wiesbaden: Dr. Ludwig Reichert Verlag (Imagines Medii Aevi 12, 1).
- Leng, Rainer. 2002b. *Ars belli: Deutsche taktische und kriegstechnische Bilderhandschriften und Traktate im 15. und 16. Jahrhundert*, Bd. 2. Wiesbaden: Dr. Ludwig Reichert Verlag (Imagines Medii Aevi, Bd. 12, 2).
- Leng, Rainer. 2004. "Social character, pictorial style, and the grammar of technical illustration in craftsmen's manuscripts in the late middle ages." In *Picturing machines 1400-1700*, ed. Lefèvre, Wolfgang, 85-111. Cambridge, Mass: Transformations. <https://doi.org/10.7551/mitpress/5380.003.0008>
- Lindgren, Uta. 2000. "Technische Enzyklopädien des Spätmittelalters. Was ist daran technisch?" In *Konrad Kyeser. Bellifortis. Clm 30150*, 9-20. München: Bayerische Staatsbibliothek.
- Magnusson, Roberta J. 2001. *Water technology in the middle ages. Cities, monasteries, and waterworks after the Roman Empire*. Baltimore: Johns Hopkins University Press.
- Meyerson, Åke. 1939. *Vapenindustrierna i Arboga under äldre Vasatid*. Stockholm: Kungliga Livrustkammaren (Akte och utredningar 3).
- Mokyr, Joel. 2011. *The gifts of Athena: Historical origins of the knowledge economy*. Princeton: Princeton University Press.
<https://doi.org/10.1515/9781400829439>
- Nussbaum, Norbert. 1978. "Katalog" In *Der mittelalterliche Banbetrieb nördlich der Alpen in zeitgenössischen Darstellungen*, ed. Günther Binding, and Norbert Nussbaum, 86-273. Darmstadt: WBG.
- Oltrogge, Doris. 2013. "Recipe books for illuminators in 15th century Germany and Netherlands - workshop practice and encyclopedic ambition." In *Craft treatises and handbooks. The dissemination of technical knowledge in the middle ages*, ed. Córdoba de la Llave, Ricardo, 55-68. Turnhout: Brepols.
<https://doi.org/10.1484/m.dda-eb.5.102145>

- Oltrogge, Doris. 2017. "Art. Theophilus Presbyter." Lexikon des gesamten Buchwesens online. http://doi.org/10.1163/9789004337862_COM_200315
- Reith, Reinhold. 2005. "Know-How, Technologietransfer und die Arcana Artis im Mitteleuropa der Frühen Neuzeit." *Early Science and Medicine* 10, 3: 349-77. <https://doi.org/10.1163/1573382054615451>
- Reith, Reinhold. 2008. "Circulation of skilled labour in late medieval and early modern Central Europe." In *Guilds, innovation, and the European economy, 1400-1800*, ed. Stephan R. Epstein, and Maarten Roy Prak, 114-42. Cambridge: Cambridge University Press. <https://doi.org/10.1017/cbo9780511496738.005>
- Rösler, Irmtraud. 2010. "Mecklenburgische Handwerkerrechnungen und quittungen (16.-18. Jahrhundert)." In *Historische Soziolinguistik des Deutschen IV. Soziefunktionale Gruppe - kommunikative Anforderungen - Sprachgebrauch. Internationale Fachtagung, Rostock 13.-16.9.1998*, ed. Brandt, Gisela, 37-52. Stuttgart: Hans-Dieter Heinz Verlag.
- Scaglia, Gustina. 1966. "Drawings of Machines for Architecture from the early Quattrocento in Italy." *Journal of the Society of Architectural Historians* 25: 90-114. <https://doi.org/10.2307/988375>
- Schönherr, David von. 1890. "Geschichte des Grabmals Kaisers Maximilian I. und der Hofkirche zu Innsbruck." *Jahrbuch der Kunsthistorischen Sammlungen des Allerhöchsten Kaiserhauses* 11: 140-268.
- Schulz, Knut. 1996. "Handwerk im spätmittelalterlichen Europa: Zur Wanderung und Ausbildung von Lehrlingen in der Fremde." *Jahrbuch des historischen Kollegs*: 69-97.
- Schütte, Jana-Madlen. 2019. "Kollegen oder Konkurrenten? Universitär und handwerklich ausgebildete Heiler auf dem medizinischen Markt im späten Mittelalter." In *Universitäten und ihr Umfeld. Südwesten und Reich in Mittelalter und Früher Neuzeit*, ed. Müsegades, Benjamin und Ingo Runde, 123-38. Heidelberg: Universitätsverlag Winter (Heidelberger Schriften zur Universitätsgeschichte 7).
- Silvestre, Hubert. 1954. "Le Ms Bruxellensis 10147-58 (S. XII-XIII) et son Compendium artis picturae." *Bulletin de la Commission Royale* 119: 95-140. <https://doi.org/10.3406/bcrh.1954.1533>
- Smith, Pamela H. 2010. "Why write a book? From lived experience to the written word in early modern Europe." *Bulletin of the German Historical Institute* 47: 25-50.
- Smith, Pamela H. 2022. *From lived experience to the written word: Reconstructing practical knowledge in the early modern world*, Chicago: The University of Chicago Press.
- Stahlschmidt, Rainer. 1971. *Die Geschichte des eisenverarbeitenden Gewerbes in Nürnberg von den 1. Nachrichten im 13./14. Jahrhundert bis 1630*. Nürnberg: Stadtarchiv Nürnberg (Nürnberger Werkstücke zur Stadt- und Landesgeschichte 4).