

Maik-Jens Springmann

## **The Schlüsselfeld ship model from 1503, Nürnberg, is the focus of profound changes in shipping and seafaring on the eve of early modern times in northern Europe.<sup>1</sup>**

### **Prologue**

Several times in my professional career I have certainly been impressed by a person's deep knowledge; or colleagues have inspired me with their representational skills, impressed me through their management capabilities or their morality, their political attitude, their social competence, their understatement, their philanthropic and friendly charisma. But until now I had never met a person who combines all that in one. My friend Jerzy Litwin is such a person and because of that he has influenced me very much and has always been a sort of paragon for me. Despite the social disparity, he the important Director of a national museum, I the petty scientist, I have never felt that this was relevant in our long and continuous friendship. In all of these 25 years of cooperation, two people met each other on the basis of sympathy and enthusiasm, what job we did was never of importance.

I have had the chance to benefit from Jerzy Litwin's numerous talents. One which certainly not all people know of is that of a ship model builder. As we see in the article by Dieter Matysik in this volume, he was the person playing a significant role in the team of the international ship model association Naviga. In this group of enthusiasts he always tries to raise interest in the historical templates of boat and ship model building. He sees models as a tool to help answer open questions in historical shipbuilding. His "model interpretation" of the seal of Elbing from 1350 is a good example of this. The huge model of the PETER VON DANZIG, which is still exhibited in the museum hall, shows his expertise in that field too, especially with how much knowledge of historical ship construction he brought to the building of this model.<sup>2</sup> He is not a person to work in private. Jerzy always tried to share his fascination with other friends and colleagues. Therefore the Department of Ship Model Building at the NMM is probably one of the best official bodies in that field. Of course, with his intention to build a model to answer historical questions Jerzy is not alone. There are a variety of directions which model builders could follow to address open questions about the past. We can recognize a long tradition in that way. In his study of early 15<sup>th</sup> century carvels, Friedrich Jorberg built a research model to try to find out how much living space seamen had aboard ships in those times<sup>3</sup>. Harry Alopäus took a completely different route to building ship models after diving to shipwrecks to find a better understanding of the situation underwater, using models as a helpful tool while interpreting the construction of the remains of a wreck long before 3-D imaging tools made it easier. Because of his intensive studies in creating models, Dick Steffy, originally an electrician, became one of

---

<sup>1</sup> I am very grateful to Richard Barker who not only revised the English text, but also discussed with me details of shipbuilding and seafaring of this interesting period.

<sup>2</sup> See his publication J. Litwin, *Modelarstwo Okrętowe*, Gdańsk 1985, pp51-52.

<sup>3</sup> F. Jorberg, 'Ein Beitrag zum Studium des Hanseschiffes', in: *Zeitschrift des Vereins für Lübeckische Geschichte*, 1955, Vol.15, pp 57-71.

the leading specialists in historical shipbuilding. Ab Hoving builds models to show how sources like the book of Nicolaes Witsen from 1671 should be appreciated as reliable and authentic.<sup>4</sup> To a certain extent we will find the same idea if we look at historical ship models. If we study the very old ship models carefully, we find a reflection of an authentic situation; in other words the model could be considered to a certain extent to be a likeness of a real ship. The reality of such objects of representation sometimes leads to controversial discussions.<sup>5</sup> From the first models on, we see them in a liturgical religious context e.g. in Christianity as a metaphor for the House of God.<sup>6</sup> Very well known is that of an *ex voto* context.<sup>7</sup> The best-known models of this kind are certainly the Mataro model<sup>8</sup> and the Ebersdorf model<sup>9</sup>, both dated to the first decades of the 15<sup>th</sup> century. These models are made of wood, but the very old ones, going far back to the times of the Pharaohs, were created out of clay.<sup>10</sup> But in the same context metal ones were also already being built in the northern hemisphere at the beginning of the 12<sup>th</sup> century.<sup>11</sup> In general, this tradition is also much older than we have sometimes thought.<sup>12</sup>

Traditionally we see the 17<sup>th</sup> century as the beginning of the idea that shipbuilders used models not only to demonstrate the lines of a ship, but also to use them to demonstrate advantages of their design, rigging and specific details to their clients.<sup>13</sup> Barfod mentioned that during the time of the expansion of the Swedish fleet such models were already being presented to the Swedish King Erik XIV, to show him the lines of a new design.<sup>14</sup> In the 1570s the English writer William Bourne described the use of ship models to measure displacement<sup>15</sup>, and the English shipwright Anthony Deane (1638-1721) used models in the same way. Gerhard Timmermann states that the Grand Duke of Oldenburg used a model to measure the draught which he caused to have sealed from the inner side with pitch to make it waterproof.<sup>16</sup>

<sup>4</sup> Hoving A.J., *Nicolaes Witsen and Shipbuilding in the Dutch Golden Age*, Texas A&M University, College Station, 2012.

<sup>5</sup> The so-called Golden ship of Uelzen, made in 1598 in London of wrought copper gilt plate, was regarded as an object ("Gerät") and not as a ship model. Walter Müller Wulckow stated in 1962: "man müsse sich davon freimachen, als handle es sich in diesem Fall um ein Schiffmodell, wie bei zahlreichen Holzmodellen späterer Jahrhunderte" (one has to free oneself from the fact that in this case it is a ship model, as with numerous wooden models of later centuries). Detlev Ellmers recognised the Golden ship of Uelzen as a model of a Hulk. D. Ellmers 1995, p. 28, in: Hans-Jürgen Vogtherr, *Das Goldene Schiff von Uelzen*, Uelzen 1995.

<sup>6</sup> See. M.-J. Springmann, 'Schiff des Heils versus Narrenschiff als Dialektik von Gut und Böse. Eine Betrachtung zur Allegorie des Bildsujets der Wismarer Kalkmalerei und zur Metaphorik in der christlichen Schiffssymbolik im Allgemeinen'. in Eike Lehmann & Maik-Jens Springmann, *Das Wismarer Narrenschiff. Ein bedeutendes Zeugnis profaner Malerei des ausgehenden Mittelalters in Nordeuropa* forthcoming.

<sup>7</sup> H. Szymanski, *Schiffsmodelle in niedersächsischen Kirchen*, Göttingen 1966. W. Steusloff: *Votivschiffe. Schiffsmodelle in Kirchen zwischen Wismarbucht und Oderhaff*. Hinstorff, Rostock 1981.

<sup>8</sup> S. de Meer, "The Mataro-model: world's oldest ship model yields up its secrets", in *Maritime History*, 7, (2009), pp 28-49.

<sup>9</sup> A. E. Christensen & W. Steusloff, *The Ebersdorf Ship Model of 1400. An authentic example of Late Medieval Shipbuilding in Northern Europe*, Bremerhaven 2012.

M.-J., Springmann, Review of this book in: *Hansische Geschichtsblätter* 2016, pp347-351. The fact that on 2 February 1411 the guild of shipwrights dedicated a ship model to St. Nicolai in Wismar shows the close connection of such models with shipbuilding. K.-F. Olechnowitz, *Das Schiff der hansischen Spätzeit*, Weimar 1960, p189.

<sup>10</sup> See for example: S. Wachsmann, *Seagoing Ships & Seamanship in the Bronze Age Levant*, Texas, College Station, 1998, pp102-105.

<sup>11</sup> Shortly after 1132 a trader from Hildesheim dedicated a ship model made out of silver plates in the Cathedral of Hildesheim. Probably dated later in the 12<sup>th</sup> century, see H. Szymanski, *Schiffsmodelle in niedersächsischen Kirchen*, Göttingen 1966, p3.

<sup>12</sup> E.g. the Bronze ship model from Chios (Keos, Late Minoan IB, Late Helladic II), A. Göttlicher, *Materialien für ein Korpus der Schiffsmodelle des Altertums*, Mainz 1978, Taf. 25, p35.

<sup>13</sup> G. Timmermann, 'Die Suche nach der günstigsten Schiffsform', in *Schriften des Deutschen Schifffahrtsmuseums Bremerhaven*, Vol.11, Oldenburg 1979, pp16-19.

<sup>14</sup> *bådsmandene eller skibbyggerne på kongens skibe, der forstod at lave de små skibe. Hvis der er nogle, skal han straks lade bygge et skib 2 alen langt efter samme facon som FORTUNA med mers og alt andet tilbehør, hvorefter kongen siden vil lade det male og udruste*, (The boatmen or the ship builders on the king's ships, that understood (how) to make the small ships. If there are some, he should immediately have a ship (model) built, 2 alen long (1.143 m) in the same way as FORTUNA with a topcastle and all the other additions, thereafter the king will have it painted and equipped).

Kanc. Brevboger d. 15/6/ 1560 cited after J.H.Barfod, *Christian III's flåde: Den Danske Flådes Historie, 1533-1588*, Copenhagen 1995, p152.

<sup>15</sup> D.W. Waters, *The Art of Navigation in England in Elizabethan and Early Stuart Times*, London 1958, p147. William Bourne, *The treasure for travellers*, 1578, Book 4, Chs, 2,3, see also: <http://home.clara.net/rabarker/bibliog8.htm>

<sup>16</sup> G. Timmermann, *Die Suche nach der günstigsten Schiffsform*. Deutsches Schifffahrtsarchiv Band 11, Oldenburg 1979, p16.

There is also another motivation connected with the building of ship models. From the 15<sup>th</sup> century onwards an elite of traders was established in Europe. By creating special networks – the best known are those of the German Hanse – they accumulated a lot of profit. By using this network traders created a special society or rather, a high society of their own. Special social circles of traders were established. A lot of effort was taken to nurture and widen this network. In this context we see models also in connection with prestige and as a tool to transmit communication within these circles. This kind of conversation culture reached its peak in the Baroque,<sup>17</sup> but some of the very attractive ship models of this kind give us a hint that this was already in practice from the beginning of the 14<sup>th</sup> century onwards, maybe first on the tables of noblemen and even kings, as illustrated in Figure 1<sup>18</sup>. Stefan Bursche suggests that at that time such models were reserved for kings, especially in France.<sup>19</sup> Sometimes these table pieces turned into showcase works.<sup>20</sup>

Within these circles, ships symbolised prosperity and, in a way, rising international connections. A ship model was a perfect tool to bring this feeling and attitude into the circles of societies which were growing up far away from the coast. The participation in international trade showed especially that the owner worked “worldwide” in a specially created society of shipowners because ships were seldom owned by only one trading family.<sup>21</sup> The big trading families from the end of the 15<sup>th</sup>, and the beginning of the 16<sup>th</sup> century in Nürnberg (Nuremberg) and



Fig. 1. Illustration of a prince dining at a banquet, dated 1326/27. Feast of King Charles V of France with the German Emperor Karl IV from 1378.

<sup>17</sup> S. Bursche, *Das Tafelzier des Barock*, München 1974.

<sup>18</sup> Bursche pointed out that herbs were stored inside such models to prevent attacks of poisoning during the banquet. Bursche p56. S.Bursche. *Das Goldene Schiff von Uelzen – ein Zeuge mittelalterlicher Lebenswelt*, in Hans-Jürgen Vogtherr, *Das Goldene Schiff von Uelzen*, Uelzen 1995. For the English context see R. Morton Nance, *Sailing ship models. A selection from European and American collections*. Revised edition, London 1949, p13. He mentioned that in the 15<sup>th</sup> century the Chapel of St. Anne in Bristol already had 27 wooden but also 5 silver ship models in its possession.

<sup>19</sup> Charles V of France owned five golden and 20 silver models. His brother Jean de Berry owned one golden model which weighed 20 kg, and 16 silver ones. The third brother Louis I of Anjou owned one golden and 30 silver ones. One weighed 56 kg, another 81 kg. Bursche 1995, p56.

<sup>20</sup> During a banquet of Philip the Good in Lille in 1453, a ship was sailing on an artificial lake erected on the table. The lake was surrounded with scale models of towns and castles of the king. Bursche 1995, p57.

<sup>21</sup> A so called Partnership (*Partenreederei*) was a society of traders founded to finance, administer and operate trade. We are speaking here about a time when traders no longer accompanied their goods on a vessel. A “Parte” as a share transformed from a special freight rate for a specific space in cubic metres in the hold into a financial investment in the vessel, the so called bottomry (*Bodmerei*). E. Baasch, ‘Zur Statistik des Schiffspartenwesens’, in *Vierteljahresschrift für Sozial- und Wirtschaftsgeschichte*, Vol.15, 1919/20, pp268-71.



Fig. 2. The Schlüsselfeld model is a rather complex source not only in questions of design, but also for socio-cultural analyses. a) soldiers and their weapons and gunnery at the two levels of the Schlüsselfeld forecastle, b) topcastle and top swivel gun, c) part of the foremast, rig and rigging ladder, d) middle part of the ship with a door, e) banquet scene with musicians, a soldier, travellers around tables and the captain wearing an amazing hat.

Augsburg, like the Fuggers and Welsers, owned several shares in several different vessels on different routes.<sup>22</sup> Even the ship itself became an important trading product on the eve of the 16<sup>th</sup> century. To attract other traders to invest in a ship, a reception held by one of the traders was a perfect opportunity. This becomes clearer when we look at the models in detail. A model specially made for this purpose, a so-called centrepiece, will be the focus of my presentation here.

These table centrepieces were mostly made out of metal, certainly created by very well-known goldsmiths, generally using silver and gold. Precious metals should certainly have helped to impress people as they always have done throughout human existence. Even if a centrepiece did not often symbolise a specific actual ship, some of them would have impressed the audience not only with their “fantastic” decor, but by quite authentic, sometimes highly authentic details of seamanship. In other words, a sort of socialisation related to the view of the object should lead to a discussion

<sup>22</sup> Both were not only very closely involved in North Sea and Baltic trade, but they were also dealing with the *Casa de Contratacion* in Seville and *Casa da India* in Lisbon. H. Kellenbenz, ‘Schiffahrt und Kaufmannschaft zwischen den Häfen der deutschen Nord- und Ostseeküste und dem Mittelmeer in der Zeit der Fugger und der Medici’, in *Schiff und Zeit*, 24, 1979, pp58-62; H. Kellenbenz, ‘Oberdeutsche Kaufleute in Sevilla und Cadiz. Eine Edition von Notariatsakten aus den dortigen Archiven’, in *Deutsche Handelsakten des Mittelalters und der Neuzeit*. Vol. XXI, Stuttgart 2001. H. Kellenbenz, *Die Fugger in Spanien und Portugal bis 1560. Ein Großunternehmen des 16. Jahrhunderts*, Munich 1990.

between the traders during the banquet about the real life of seamen. Even if I found no records about this impression and reflection, it seemed that authentic details should stimulate “shop talk” about transactions determined by maritime matters, especially at a time in the 16<sup>th</sup> century when new ideas in society, techniques and trade were being discussed everywhere in Europe. This essay, dedicated to Jerzy and his work, deals with an important centrepiece, maybe the most important one, as Stefan Bursche already mentioned in 2005<sup>23</sup>, the so-called Schlüsselfeld Model (Fig. 2), and what we can learn from it through intensive inspection.

By the way, I should also mention that Jerzy was the person who indirectly led me to the study of this interesting object category. He was working with one important centrepiece long before other ship-historians recognised them as worthy objects for study – even now he is still one of the very few. Jerzy was one of the first scientists to recognize the importance of the so-called Gdańsk Gold model. I was a young researcher when I recognised the Golden ship in the National Historical Museum in Gdańsk and asked at the reception for more information. They gave me a catalogue and of course Jerzy had already written an interesting chapter in it about this centrepiece.<sup>24</sup> Since then he and I have shared an interest concerning this part of historical modelling, seldom considered, and thus I present here the Schlüsselfeld ship model from 1503, in his honour.

### **History, dating and purpose of the model**

Friedrich Moll, the well-known collector of historical ship images dedicated a special chapter to this category of table centrepiece.

Twenty-one pieces were already listed and this list was rather incomplete (Fig. 3).<sup>25</sup> Charles Oman<sup>26</sup> as well as Maurizio Fusi<sup>27</sup> published a good compilation of such models. I myself found one in St. Petersburg used as a font.<sup>28</sup> Other researchers like Wolfram zu Mondfeld located one in Dubrovnik.<sup>29</sup> Historians dedicated a whole book to the Golden Ship of Uelzen.<sup>30</sup> Most of the centrepieces were lost during World War II. In the age of the internet some turn up in private collections, generally when the owners try to sell them in auctions. Only a few of them are as old as the Schlüsselfeld model from the beginning of the 16<sup>th</sup> century. Besides the Burghley model made in 1512/13 in Paris and now in the possession of the Victoria and Albert Museum<sup>31</sup> (Fig. 4), the Schlüsselfeld ship is certainly also the most worthy goldsmith's work of such a kind worldwide, especially in the sense of the richness of its details.

Therefore it is also a reference for the high standard of this art already achieved in Nürnberg at the end of the 15<sup>th</sup> century. According to the markings on the transport box, the model was made in 1503 or shortly before for one of the members of the Schlüsselfeld family: this must have been Wilhelm Schlüsselfeld, as his emblem is on the masthead flag on the foremast of the model (Fig. 2). In those times he ran one of the biggest iron enterprises in Europe. It is still in the possession of the Schlüsselfeld foundation, a society created by the Schlüsselfeld trading family, which has not existed since 1709.<sup>32</sup> In 1857 the Schlüsselfeld foundation gave this table centrepiece to the Germanisches Nationalmuseum in Nürnberg to exhibit and since then it has been on permanent exhibition. In 2013 I took the opportunity offered me by the Nationalmuseum to investigate

---

<sup>23</sup> Bursche 1995, p84.

<sup>24</sup> Already mentioned in A. Hinz, *Die Schatzkammer der Marienkirche in Danzig*, Danzig 1870, p37 and illustration Taf. XVI, No. 5 and in W. Drost, *Die Marienkirche in Danzig und ihre Kunstschatze*, Stuttgart 1963, p117, Fig. 29.

<sup>25</sup> F. Moll, *Das Schiff in der bildenden Kunst*, Bonn 1929, pp.

<sup>26</sup> C. Oman, *Medieval Silver Nefs* (Victoria & Albert Museum, Monograph No. 15), London 1963.

<sup>27</sup> M. Fusi, *Navi d'argento, nefi, silver ships*, Milano 1977.

<sup>28</sup> M.-J. Springmann, 'Neue spätmittelalterliche und frühneuzeitliche Schiffsdarstellungen. Ein Beitrag zur ergologischen Merkmalsanalyse in der Schiffstypologie', in *Deutsches Schifffahrtsarchiv*, 26, pp157-185.

<sup>29</sup> W. zu Mondfeld, *Die Schiffe des Christoforo Colombo*, Herford 1991, p72

<sup>30</sup> H.-J. Vogtherr, *Das Goldene Schiff von Uelzen*, Uelzen 1995.

<sup>31</sup> C. Oman, *Medieval Silver Nefs* (Victoria & Albert Museum, Monograph No. 15), London 1963.

<sup>32</sup> See all this information in the Research Database of the National Museum Nürnberg: <http://objektkatalog.gnm.de/objekt/HG2146>.



Fig. 3. In his well-known publication “Das Schiff in der bildenden Kunst”, Friedrich Moll dedicated a special chapter to centrepieces. Many pieces were lost in World War II.

the 79 cm high, 43 cm long and 24 cm broad model in Nürnberg.<sup>33</sup> I was also able to study the archive material and the restoration documentation from 1971, when the model was completely dismantled. A valuable black and white photographic documentation was made during this conservation, which I will be using for this contribution. This model shows a construction very similar, even in the details, to the *Kraeck* of the master with the sign WA (Fig. 5).<sup>34</sup> According to André Wegener Sleeswyk, the Flemish goldsmith Willem de Cruce could have been the author of this artwork. Thus we can even see the drawing of the *kraeck* as a pattern for the model, or vice versa, even though we know very little about the exchange of such paragons.<sup>35</sup>

Sea trade at the end of late medieval times was still a great risk. The transport of cargoes was as good and safe as the ship was modern and well built; modernity in those times also meant well-armed. Besides wind and storms and shallow harbour entrances, piracy had become one of the main hindering factors for sea trade. Models with authentic features could raise the truth between the invited trading partner and the owner of the table centrepiece. While sea trade played a great role, for the big trading families the great risk of such trade was very obvious.

<sup>33</sup> I thank the museum and the curator for offering me this opportunity.

<sup>34</sup> André Wegener Sleeswyk believed WA to be Willem de Cruce. See A. Wegener Sleeswyk, ‘The engraver Willem a Cruce and the development of the chain-wale’, in *Mariner’s Mirror*, 76, Issue 4, 1990, pp345-366.

<sup>35</sup> Morton Nance meant that the Master with the signature WA “made his engraving not from an actual vessel, but from a drawing of a church ship model”, R.M.Nance, ‘A fifteenth century trader’, in *Mariner’s Mirror* 43, 1955, pp65-67. See in general for the exchange art market: J. Richter, *Lübeck 1500 - Kunstmetropole im Ostseeraum*. Petersberg 2015.



Fig. 4. The Burghley model, made by a goldsmith from Paris in 1527-28, nowadays in the possession of the Victoria & Albert Museum, London, shows another step in the development of a multi-masted ship, especially when we focus on the so-called *Blide*, a spritsail on a bowsprit used as a sort of *artemon*.

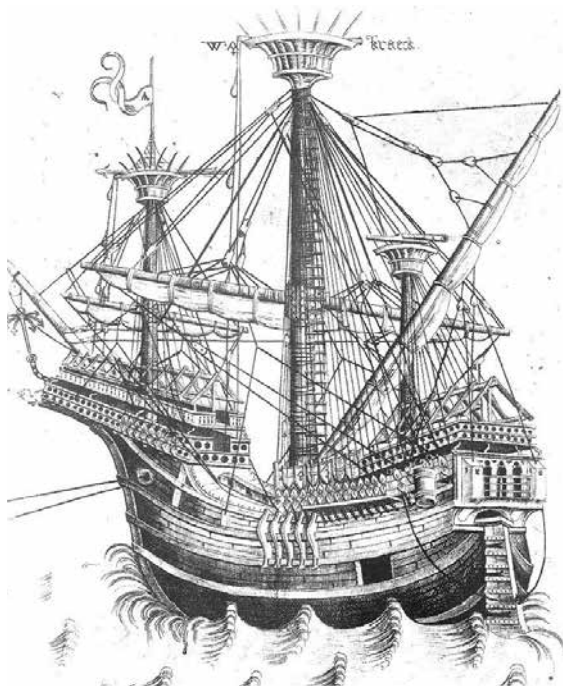


Fig. 5. The well-known *Kraeck* depiction, probably made by the Flemish goldsmith Willem de Cruce around 1480, was treated as a sort of paragon for the unknown goldsmith in Nürnberg, who made the Schlüsselfeld model in 1503.

but also military and socio-cultural aspects of seafaring. But how can such a model have aroused interest to start a talk between trading partners? Only by taking a microcosmic view can we see why. The hull does not look like a real ship. But apart from this, it is really astonishing how much effort the model builder invested to exhibit very special technical details e.g. the rigging, life and work aboard.

### The hull

Even if it is noticeable that the shape of the hull is not very realistic, it is worth discussing some details. Obviously the Schlüsselfeld model shows a carvel construction with flush laid planks and strong wales (*Berg- or Barkhölzer*). Iberian shipbuilding was already influencing the design of the vessels at this time, and through this the technology of building ships in northern Europe.<sup>39</sup> In the 15<sup>th</sup> century the first carvel ships were built in the north. Through the dynastic relationship of Burgundy with Portugal in 1439 the Portuguese shipbuilder Jehan Perhouse<sup>40</sup> constructed

To display knowledge about the logistics could be one further argument to make a good deal between trading partners. Another aspect is that because of the internationalism in transport, more and more traders invested in ships of foreign countries or took part in fleets going overseas even to America, as the Fuggers did quite often in the 16<sup>th</sup> century.<sup>36</sup> It is therefore not very astonishing to find one of the most fascinating centrepieces in Nürnberg, a town where not only the Fuggers had their headquarters.

It seemed that especially within the circles of big trading families, models of this kind as table centrepieces were very common. Around two litres (“zwo Maß getrancks”) was stored in the hollow hull of the model as it is mentioned in the description of the museum.<sup>37</sup> Even if we do not know how the spirit was served out of the model, it should have additionally attracted people in another way, to get them drunk. Table centrepieces were very expensive. Already in 1444 a trader paid 148 fl., 3 1/2 Schillinge for such a ship model<sup>38</sup>.

Certainly these models should demonstrate that the model's owner was well versed in all matters of seafaring. They present technological

<sup>36</sup> Hümmerich, F., *Die erste deutsche Handelsfahrt nach Indien 1505/06. Ein Unternehmen der Welser, Fugger und anderer Augsburgsburger sowie Nürnberger Häuser*. Munich/Berlin, 1922.

<sup>37</sup> <http://objektkatalog.gnm.de/objekt/HG2146>, see also R. Schürer, *Faszination Meisterwerk*, Nürnberg 2004. See also: A. Scherner, ‘„Gestern bin ich voll gewest“’. Alkohol und Trinkspiele in der frühen Neuzeit’, in Monika Bachtler, Dirk Syndram, Ulrike Weinhold: *Die Faszination des Sammelns. Meisterwerke der Goldschmiedekunst aus der Sammlung Rudolf-August Oetker*. Bielefeld-Dresden-München 2011, p97.

<sup>38</sup> see S. Schuler, *Saalbuch der Frauenkirche in Nürnberg*, Bamberg 1869, p16.

<sup>39</sup> Michel Mollat & Paul Adam., *Les aspects internationaux de la découverte océanique aux XVe et XVIe siècles: Actes du 5e Colloque international d'histoire maritime (Lisbonne, 14 - 16 septembre 1960) / Colloque International d' Histoire Maritime; 5*, Lissabon 1960, Corporation. Paris 1966. (Bibliothèque générale de l'école pratique des hautes études: Sect. 6; R.A.Barker, ‘Curiosities in Iberian Shipbuilding, and the confused cog’, in R. V. Gomes & K. T. Monchet (Eds), *Arvores, Barcos e Homens na Peninsula Iberica (Seculos XVI-XVIII)*, 2017, pp165-18.

<sup>40</sup> A. Wegener Sleeswyk mentioned this name which does not sound like a Portuguese name. Following Jacques Paviot, *La politique navale des ducs de Bourgogne : 1384-1482*, Broche 2017, p301 his name is Phonse as a short form of Alphonse. According to R.A. Barker his name was Joao Affonso, pers. com.

the first two carvels in Brussels in 1439.<sup>41</sup> In 1459 one of the first carvel ships was built in the Zuiderzee by a Breton shipwright.<sup>42</sup>

Several signs like the painting of the Artushof [Dwór Artusa, Arthur's Court] in Gdańsk, which was also investigated and published by Jerzy Litwin<sup>43</sup>, but also manuscripts like those of Michael of Rhodes<sup>44</sup> show that traders took quite careful notice of the general developments in shipbuilding. The time of the cog as a primitive northern sailing ship was coming to an end. One of the last cogs was built by Gustav Wasa in 1524 for private use, mainly fishing in the Stockholm archipelago.<sup>45</sup>

We do not know for sure whether the first carvel ships built in the early years of north European flush laid adoptions were built frame-first and how long northern shipbuilders followed the so-called "Ibero-Atlantic shipbuilding tradition", which is presented to us nowadays as a purely skeleton construction.<sup>46</sup> There is a long tradition of mixing the investigation of shipbuilding techniques with those of the technology of ships in the sense of the shaping and metrology of ships.<sup>47</sup> Flush laid planks were not an innovation in the North Sea and in the Baltic, as we see in the archaeology of inland river barges<sup>48</sup> as well as in the investigations of so-called bottom-based shipwrecks like those of the Bremen type.<sup>49</sup> What we can assume is that the shell-first tradition of the original clinker build was certainly not forgotten as the shipbuilders of the North Sea and the Baltic "discovered" the carvel technique for themselves. Therefore I cannot see that the appearance of the PIERRE DE LA ROCHELLE in Gdańsk in 1462 and the restoration in 1470 so much revolutionised the establishment of the carvel construction technique in the Baltic as some researchers still believe.<sup>50</sup> Especially the Dutch in Zeeland built the whole hull in shell-first technique on the basis of carvel planking and from there this technology was imported into Baltic shipbuilding quite fast, as the example of Lübeck makes evident.<sup>51</sup> This new technology brought problems. The overlapping of the planks in the clinker building tradition, which already limited the size of the vessels, gave the hull strength through the edge-fastening and the heavy beams. This strength was lost during the first decades of the transition process from clinker to carvel technique using the old shell-first tradition with smaller beams and smaller and widely spaced frames, a technique which was now combined with new shipbuilding techniques. After one or two sailing seasons the ships were soon "sailed soft", as the ships' structures and caulking worked loose.

---

<sup>41</sup> A. Wegener Sleseswyk, 'Carvel-Planking and Carvel Ships in the North of Europe', in *Archaeonautica*, Vol.14, 1998, pp223-228, p226.

<sup>42</sup> *ibid*

<sup>43</sup> J. Litwin, 'The warship in the painting from Arthurs Court in Gdansk – an attempt at a reconstruction', in C.O. Cederlund (ed.), *Postmedieval Boat and Ship Archaeology, Proceedings of the Third ISBSA*, Stockholm 1985, pp137-153.

<sup>44</sup> P. O. Long, D. Mc Gee, A. M. Stahl, *The Book of Michael of Rhodes: A Fifteenth-Century Maritime Manuscript*, 3 Vols. Massachusetts 2009.

<sup>45</sup> C. Ekman, 'Skeppstyperna under Gustav Vasas son Erik XIV's tid', in *Sjöhistorika årsbok 1945-46*. p??

If we look at the important Vicke Schorler Rolle 1586, of 135 ships depicted 128 are single-masted ships, with cogs still used for coastal trade, M.-J. Springmann, *Schiffahrt und Schiffbau im Übergang zur Frühen Neuzeit im Ostseeraum, Tradition versus Innovation*, unpublished Dissertation, 2014, p. 712.

<sup>46</sup> B. Loewen, 'The structures of Atlantic shipbuilding in the 16th century. An archaeological perspective', in *Proceedings of the International Symposium on Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition. Hull remains, manuscripts and ethnographic sources: a comparative approach*, Ed. F. Alves, Lisbon 2001, pp241-258.

<sup>47</sup> M.-J. Springmann, *Schiffahrt und Schiffbau im Übergang zur Frühen Neuzeit im Ostseeraum, Tradition versus Innovation*, unpublished Dissertation, 2014, pp233-280.

<sup>48</sup> Ossowski W., *Przemiany w szkutnictwie rzeczonym w Polsce*, Gdańsk 2010.

<sup>49</sup> F. Hocker, F., *Bottom based shipbuilding technology*. Texas A&M. 1991.

<sup>50</sup> W. Vogel, *Geschichte der deutschen Seeschiffahrt. Von der Urzeit bis zum Ende des XV. Jahrhunderts*, Berlin 1915, p 475; B. Hagedorn, *Die Entwicklung der wichtigsten Schiffstypen bis ins 19. Jahrhundert*, Berlin 1914, pp59, 63 and 68; K.-F. Olechnowitz *Der Schiffbau der hansischen Spätzeit: eine Untersuchung zur Sozial- und Wirtschaftsgeschichte der Hanse*. Weimar 1960, p. 10, Lienau 1943, G. Krause, *Handelsschiffahrt der Hanse*, Rostock 2010, pp. 108-109., P. Dollinger, *Die Hanse*, new edited by Volker Henn & Nils Jörn, Stuttgart 1989, p183, J. Bill, 'Schiffe als Transportmittel im nordeuropäischen Raum', in *Mitteilungen der Deutschen Gesellschaft für Archäologie des Mittelalters und der Neuzeit*, 2003, pp9-19, p16.

<sup>51</sup> Already in 1540 ships built by such technology were being exported to England. R. Reinhardt, 'Die Karacke Jesus von Lübeck?', in *Zeitschrift des Vereins für lübeckische Geschichte und Altertumskunde* 31 (1949), pp79-110.



Fig. 6. The seals of Amsterdam (left) and Danzig (right) from the beginning of the 15<sup>th</sup> century already show the design of the hull, mirrored in the Schlüsselfeld design. Both seals expose the closely spaced transverse beams, strengthening the clinker-built hull.

The integration of several huge and heavy masts in the hull in conjunction with windward courses increased the leakiness of such ships, as I pointed out in connection with the first long sailing trip of ships of the Duke of Mecklenburg sailing to Portugal in 1567.<sup>52</sup> Poor wood quality and bad resource management in forestry and storage for shipbuilding accelerated these developments. Service on the pumps become one of the important jobs in these first multi-masted vessels built in this “new technology”.<sup>53</sup> This became very problematic because more and more ships were being used purely for military purposes. In those days this was still fighting by going deck-to-deck. Impacts were severe as ships crashed into one another, and the hulls of the early big carvel-built ships were maybe not as strong as those of the smaller clinker vessels, which were getting more and more transverse beams, already on two deck levels in the second half of the 15<sup>th</sup> century, as a closer look at the seals of those times makes clear.<sup>54</sup>

If we see the change from clinker to carvel hulls not only details in ergology and technique but rather a change in technology which influenced the design, in other words the shape of the ship, then a tendency to more U-shaped carvel hulls is recognisable, which further burdened the ship construction. At the end of the 15<sup>th</sup> century the castles were made bigger and especially higher. Ships were being turned more and more into “floating castles”, a trend which could already be recognised in the so-called Skampstrup ship from 1325 (Fig. 6).<sup>55</sup>

<sup>52</sup> M.-J., Springmann, ‘Der Schiffbau und die Handelstransaktionen Johann Albrechts I. von Mecklenburg nach Portugal im Lichte der tiefgreifenden Veränderungen im Schiffbau und der Schifffahrt zu Beginn der Frühen Neuzeit’, in *Deutsches Schifffahrtsarchiv*, 38, pp97-180, p162.

<sup>53</sup> Information about pumps arises immediately upon the advent of carvel ship building. On 12<sup>th</sup> March 1472 the already mentioned PETER VON DANZIG had to come back to the harbour (*die See in großer Not räumen muß*) because of leakage, Lienau 1943, pp24-25..... Humboldt in his studies concerning the literature of the discoveries mentioned that the ships were taking so much water, that it was enough to start a watermill (...*als hinreichend gewesen wäre, eine Mühle in Bewegung zu setzen*) A.v. Humboldt, *Kosmos. Der Entwurf einer physischen Weltbeschreibung*, Paris 1845, edited by M. Enzensberger u Frankfurt a. M. 2004, p232.

<sup>54</sup> The first example could be already seen in the Seal of Elbing from 1350, see also M.-J. Springmann, ‘The building and metrology of ships in the transition from medieval to early modern times – free creativeness or constructional and standardised building?’, in J. Litwin, Ed., *Baltic and beyond...*, *Proceedings of the ISBSA*, 2017, pp75-86.

<sup>55</sup> B. Landström, *Skippet*, 1961, p76 Early examples are the English REGENT (rebuilt from clinker to carvel) and the SOVEREIGN of 1480, the Scottish GREAT MICHAEL from 1506, the HENRY GRACE A DIEU built in 1514, the Danish ENGELEN, came into service in 1511, the MARIA, Christian II’s flagship from 1514, the Swedish STORA KRAFWELEN of 1532 and the JESUS VON LÜBECK built 1540, lost 1568 off the Mexican coast. For the early periods see Bill J, ‘Castles at Sea, The warship of the high middle ages’, in *Maritime warfare in northern Europe*, Copenhagen 2002, pp47-56. As regards height, Alfred the Great increased the height of the side of his ships for advantage in battle, and indeed Caesar had noted the great height of the Veneti ships too.

Therefore, more weight rested on the hull, which left the crossbeams to provide more of the hull strength, as we recognize from their large numbers in medieval clinker ships. Here, too, centrepieces, especially such as the Schlüsselfeld model, give us an impression of these developments (Fig. 2).

The positions of heavy guns high on the deck and upper decks aggravated the problems of leakiness. In those days they were mostly wrought iron chamber guns.<sup>56</sup> Aboard the Schlüsselfeld model we can count 13 guns placed on the second deck of the fore- and sterncastles; this should also include around four chambers for every gun.<sup>57</sup> But the Schlüsselfeld model only marks the development towards so-called fighting castles with sometimes 100 and more guns, within two or three decades from 1500 onwards. The inventory known as the Anthony Roll from 1546 made this clear.<sup>58</sup> With this addition of guns weighing around 100 kg and more, the recoil and the so-called jumping (*Buken*), a movement in a vertical direction, should not be forgotten.<sup>59</sup> Shipbuilders and gunmakers reflected on these military developments in a marine environment.

Therefore the inventions concerning the construction of the hull in those times are worth mentioning. At the beginning of the 15<sup>th</sup> century we see the integration of the fore- and sterncastles into the ship.<sup>60</sup> The Ebersdorf and the Mataro models from the first half of the 15<sup>th</sup> century reveal the first constructional solutions.<sup>61</sup> The Schlüsselfeld model from 1503 shows the same features (Fig. 2). Even this integration was an invention in comparison with the construction seen in the Bremen cog type vessels, but still resulted in high and markedly cantilevered sterncastles on a V-formed aft hull section, which not only influenced the steering in a negative way from its windage, but also the construction itself was still top-heavy. The first sterncastles of the 15<sup>th</sup> century already reached far out aft.

The sides of the ships in a free shell construction could not be constructed identically, as a close look at the *Vasa* demonstrates. Especially with very high castles, it must have been a nightmare for the master shipwrights to calculate or better estimate the weight of the ballast and the load of both castles in such a way that the ship did not list too much to one side.<sup>62</sup> Apart from this, the great windage of the high castle could easily turn the ship to one side or give it more top or loading aft. The Schlüsselfeld model is an example of the early implementation of such a construction embedded in the hull. Huge rudders with several boards one after another were necessary and invented, specially secured with ropes, as the view of the Schlüsselfeld model also made evident (Fig. 2). But the development of the square panel stern construction, already seen in the Anthony Roll of 1546, was still some decades away.<sup>63</sup> This construction was convenient for the integration

---

<sup>56</sup> M.-J. Springmann, 'Das bronzene Kammergeschütz von 1551 aus einem Wrackfund vor Mukran. Der Nachweis einer frühen Form von Treibladungsbeschleunigung?' in *Waffen- und Kostümkunde*, Heft 1, 2018, pp1-38.

<sup>57</sup> Springmann 2018, p6.

<sup>58</sup> [https://en.wikisource.org/wiki/Anthony\\_Roll/First\\_roll#The\\_Jhesus\\_of\\_Lubeke](https://en.wikisource.org/wiki/Anthony_Roll/First_roll#The_Jhesus_of_Lubeke)

<sup>59</sup> While the guns were fixed with a rope (Hemmtau in German) the recoil was transformed into a vertical movement, called *Buken* (jumping) which sometimes led to an enormous vertical movement during the firing so that early gunports were built bigger. This led to the development that decoration on the mouth of the guns was reduced so that they wouldn't destroy the gunports, which resulted in smaller gunports, as can be seen in the Archaeology of the MARY ROSE. see Hans Aufheimer, *Schiffsbewaffnung von den Anfängen bis zur Mitte des 19. Jahrhunderts*, Rostock 1983, p25.

<sup>60</sup> Already in 1527 Gustav Vasa ordered in his "riva av förtyningen" that the higher aft part of the ships should be reduced. The king already considered high aft parts as having great windage ("stord vindfång"). A. Zettersten, *Svenska Flottans Historia*, Stockholm 1890, p. 68.

<sup>61</sup> S. De Meer, 'The Mataro-model: world's oldest ship model yields up its secrets', in *Maritime History* 7 (2009), pp28-49. M.-J., Springmann & S. Schreier, 'The Ebersdorf Cog Model as a basis for a reconstruction of a late medieval sailing vessel', in *Historical boat and ship replicas, Proceedings of the scientific perspectives and the limits of boat and ship replicas*, Torgelow 2008, pp105-116.

<sup>62</sup> Tests were made in the harbours and not out at sea. Mostly people running from one side to the other. Experiences in the open sea lead to the reduction of the castles on many of such "floating castles". See for this special question: Jürgen Hausen, Ursachen für den Kenterunfall des schwedischen Regalschiffes WASA im Jahre 1628, in: *Skyllis, Zeitschrift für Unterwasserarchäologie* 2, 1998, pp38-53.

<sup>63</sup> One of the first examples on the way to the square panel stern construction is the square-tuck stern (Gillung) could be seen in the transom aft part of the Mataro Model dated 1403-1429, Sjoerd De Meer, 'The Mataro-model: world's oldest ship model yields up its secrets', in *Maritime History* 7, 2009, pp.28-49, p. 30; M.-J. Springmann, Archaeological and archival indicators of socio-cultural change on board ship in the 16th century', in *From the River, Down to the Sea*, Proceedings of the VIII.

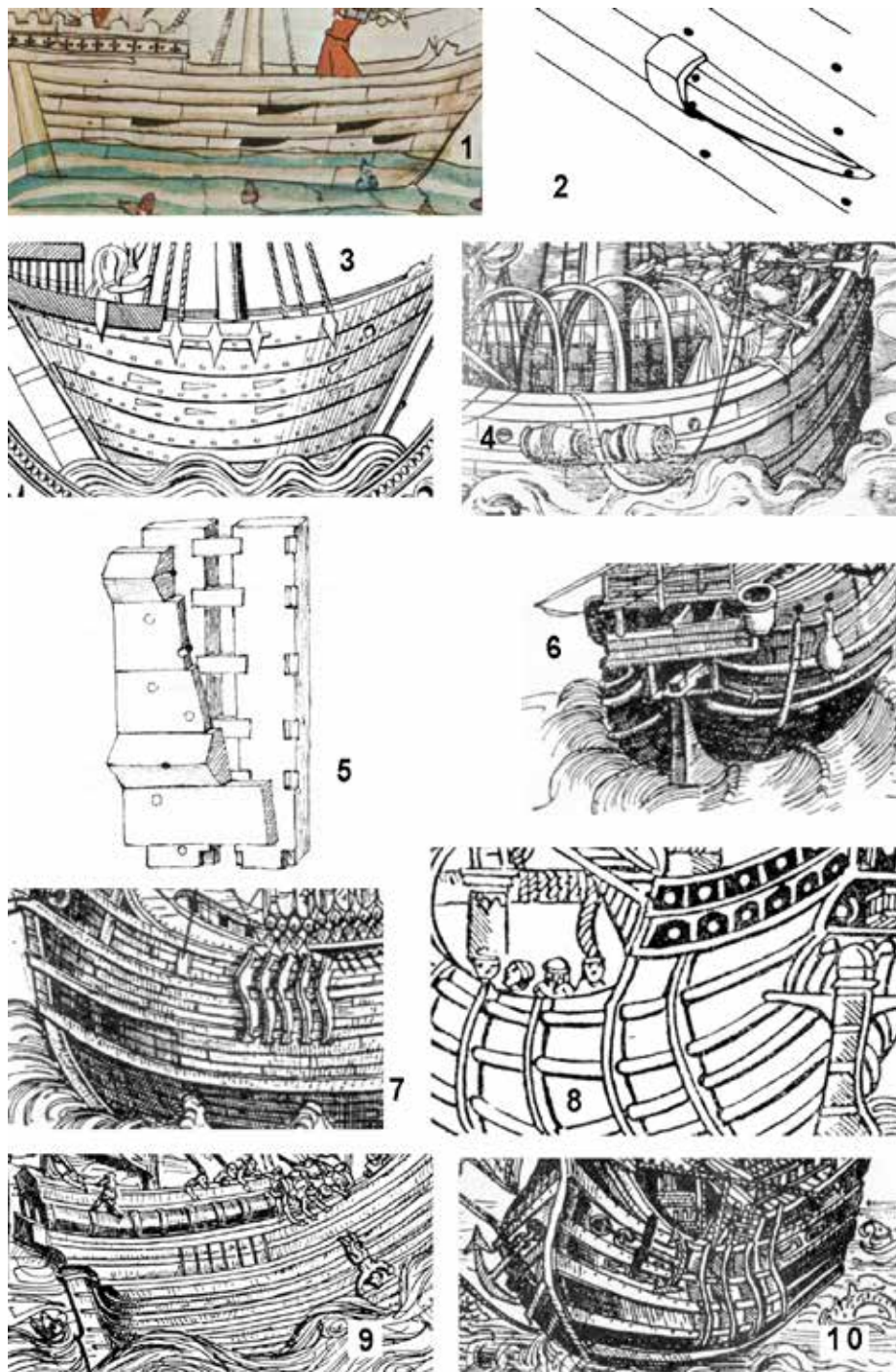


Fig. 7. Steps in the development of wales to protect the hull: 1.) A sort of fender on a medieval cog-shaped hull, 2.) The same at the Vedby Hage wreck (after Myrholm 2000), 3.) First sign of chain wales and double transverse beam construction in the Seal of Elbing from 1350 (after Ewe 1972), 4. Sand-filled wooden barrel in the Weißkunig woodcut made between 1512-16, 5.) Cross section of a shaped wale from the Swedish warship ELEFANTEN, built in Stockholm in 1554 (Ekman 1934, p. 351), 6.) Smaller vessels were fitted with a smaller number of wales as one engraving of Willem de Cruce indicates, 7.) The development from the gunwale to the chainwale is already evident in the copper plate of the so-called *Kraeck* from 1497, 8.) In the Mediterranean skids were being used as vertical protection supplemented with horizontal wales to protect the hull as seen in *Libre de consolats dels fets maritims*, Barcelona 1502, 9.) Chainwales in the bronze relief “Opferung des Jonas” 1484 protect the middle section of the ship and as well the aft part, 10.) Wales could also be seen on Turkish carracks (Grünenberg Pilgrimage, 1486).

of gundecks in the hull, allowing straighter lines of the ships in which the guns were positioned on one level nearer the waterline, as can be seen in the clock machine made in Augsburg between 1580 and 1590 (Fig. 8). This promoted broadside firing. Some early examples in the Baltic can be seen in the ELEFANTEN.<sup>64</sup>

Even increasing the plank thickness from the 1–2 cm of Viking ships<sup>65</sup> up to the 9 cm of the tangentially sawn planks of the Bremen wreck<sup>66</sup> and up to more than a brick (*tegelsten*) thickness of carvel built ships did not strengthen the hull enough.<sup>67</sup> The implementation of very strong wales, the so-called *Berg-* or *Barkholz*<sup>68</sup>, was one solution to make the hull stronger.<sup>69</sup> It is first visible in the archaeological remains of the Utrecht ship. This last aspect might be reflecting the shrinking resources of shipbuilding timber.<sup>70</sup> The Schlüsselfeld model also symbolised this (Fig. 7 a). Such constructions were fabricated in thicknesses of around 15 cm and more and were half the width of an ordinary plank. Therefore this thick stuff was narrower and regarded more as beams than planks. Sometimes they were fabricated in a special cross-section, as we see in Carl Ekman's investigation of the ELEFANTEN in 1933, (Fig. 7 a+b).

This ship already carried guns on a strengthened deck *overloopsdeck*<sup>71</sup> connected with so-called *cravels hakebultar* (hock-bolts).<sup>72</sup> Strong beams (*lastebalkar*) allowed heavy guns to be put on aboard within the hull, as we see in the clock-ship from Augsburg, now in Paris (Fig. 8)

At the end of the 15<sup>th</sup> and the beginning of the 16<sup>th</sup> century, we see a change in fleet management. Because fleets were more and more often being administered by local noblemen and bigger trading enterprises like the Fuggers and Welsers, big Hanseatic fleet manoeuvres of 20-40 ships in one fleet were falling out of fashion. Now, just two or three ships sailed together and tried

---

ISBSA, Gdansk 1998, pp75-85. M.-J. Springmann, 'The ships of the crusaders. The exchange of nautical expertise between the Mediterranean and the Baltic in medieval times', in *ISBSA Conference proceedings*, Mainz, pp257-274. 2009, pp264-65. For the development of square panel stern constructions in case of the ELEFANTEN see: C. Ekman, *Sjöhistorika undersökningar vid Björkenäs*, in: *Sancte Christophers Gilles Chroenica VIII*, Stockholm 1933/34, pp1-15, especially pp9-11.

<sup>64</sup> *ibid*

<sup>65</sup> E.g. O. Crumlin-Pedersen, *The Viking Age Ships and Shipbuilding in Hedeby/Haithabu and Schleswig*, Schleswig & Roskilde 1997, pp113-16.

<sup>66</sup> W. Lahn, *Die Kogge von Bremen*, vol.1: 'Bauteile und Bauablauf', in *Schriften des Deutschen Schiffahrtsmuseums*, 30, Hamburg 1992, pp34-37.

<sup>67</sup> In comparison with the Bremen wreck from 1380 the planks of the ELEFANTEN built in 1554-59 in Stockholm were rather thin (6 cm) and this was not enough to strengthen the hull C. Ekman, 'Sjöhistorika undersökningar vid Björkenäs', in *Sancte Christophers Gilles Chroenica VIII*, Stockholm 1942, pp1-15, p10. That in the Mukran wreck sunk in 1565 was also only 3 cm. M.-J. Springmann, 'The Mukran wreck, sunk off the Isle of Rügen, Germany in 1565: a preliminary report', in: *International Journal of Nautical Archaeology*, 1998, Vol.2, pp113-125, p. 116. In a quotation made by Hermann Sternberg of a 300 Last ship to be built for the Duke of Mecklenburg Johann Albrecht in 1561 250 *Kraffels-Delen 4 Finger dicke* (8 cm). Olechnowitz, 1960, Appendix XLI, p199. Following Arne Emil Christensen's researches, a plank thicker than 5 cm could not be easily bent, which resulted in the processing of smaller planks and straighter lines in ship design, Christensen, A. E., 'Der Übergang von der Klinker zur Kraweeltechnik im skandinavischen Kleinschiffbau', in *Auf See und an Land, Schriften des Schiffahrtsmuseums*, Rostock 1997, pp101-117, p106.

<sup>68</sup> There is still some discussion about the etymological roots of the word *Bergholz*. Witsen pointed out that this term came from trees growing on hillsides and sandy soil, which form very strong wood. N. Witsen, *Aeloude en Hedendaegsche Scheepsbouw en Bestier*, Amsterdam 1671, reprint 1972, p179. *Bergholz* could also come from the German word *bergen*, which means to be safe. K. Schiller & A. Lübben, *Mittelniederdeutsches Wörterbuch*, 1875-1881, Vol. 1, p. 244.

<sup>69</sup> This prevents longer ships from hogging and sagging, which resulted from different buoyancy and loads along the hull, the so-called „*Katzenbuckel*“. The planks lying on top of such wales called *black and thick strakes* should reduce the movement of the wales in a swell at sea (Fig. ??). The first wales were bolted on top of the ordinary planks. According to Ekman, this feature is first seen in Mediterranean *naos*. C. Ekman, 'Skeppstyperna under Gustav Vasas son Erik XIVs tid', in *Sjöhistorika årsbok* 1945-46, p213. Another question was the water pressure which increases with greater draft. Thicker planks below the waterline allow more room for caulking. Plank thicknesses are reduced in the upper part to reduce weight and therefore draft and to spare timber, because more planks can be got out of a trunk of the same age.

<sup>70</sup> In a specification for a 150 Last ship made by the shipbuilder Hermann Sternberg from Wismar for a ship planned by the Duke of Mecklenburg, five so-called *Berghenhult*, in Lübeck six *Bercklotz* each side, should have made the hull stronger, 5 *Stucke Berchholtzer von 30 Fussen* (9 m long), Olechnowitz 1960, Appendix No. XLI, p 199. *Unde up jeder Seidt 6 Bercklotz*, Olechnowitz 1960, Appendix XL, p197. Unfortunately Olechnowitz mixed sources from the Archives in Lübeck and Schwerin in this case. See Springmann 2014, pp41-42 and Springmann 2015, pp107-08.

<sup>71</sup> Not to be confused with the English term gundeck or *orlogsdeck* in German and sources from the Netherlands). See Barker in this Volume, p. ???

<sup>72</sup> *Skibbyggeren hal lagt alle bjælkerne, både lastbjælker og overlopsbjælker*. J.H. Barfod, *Christian 3s flåde: Den Danske Flådes Historie, 1533-1588*, Copenhagen 1995, pp70-71. Elefantens already carried 50-80 guns aboard. Ekman 1934.



Fig. 8. The clock machine made between 1580-90 in Augsburg, now in the possession of the Musée national de la Renaissance in Écouen, already shows a transom construction aft and the guns mounted on cannon decks in a ship more or less made for military purposes, as the heraldic symbols demonstrate. Here, a shroud ladder has replaced the solitary mast ladder, visible on the Schlüsselfeld model (Fig. 2).

to defend each other. Pirates had become a problem everywhere, which led to the development of ships with a sort of hybrid function, combining the capabilities of a military ship with those trading as merchantmen.<sup>73</sup> That the Schlüsselfeld model does not present a vessel used purely for military purposes can also be seen in the fact that it has no pavesses, shields with heraldic symbols fastened along the gunwale, as used in most purely military vessels. Every trader contracted mercenaries for the defence of their ships.<sup>74</sup> The numbers of soldiers grew. They needed a place to live aboard, to separate them from the rest of the crew, who slept inside the ships<sup>75</sup> and from travellers aboard. This was aimed to create social peace and also led to the increasing size of castles before the gundeck was invented.<sup>76</sup> Merchant ships became more and more important to host travellers.<sup>77</sup> These people also needed space. Here, too, the Schlüsselfeld model gives us hints of this development.

The hull also tells us something about the main purpose of the ship: carrying goods for the Schlüsselfeld family. We see two barrels on board (Fig. 10). We do not know what they were to contain. Such multi-purpose containers transported not only foodstuffs,<sup>78</sup> but also potash and even metals, in more and more standardised barrels.<sup>79</sup> The Schlüsselfeld family may have dealt as much with other kinds of raw material as with cereals.

Wreck investigations of ships from the 16<sup>th</sup> century, e.g. that of the Red Bay, show how specialised the storage of those barrels was.<sup>80</sup> Normally this was not done by the crew. Special stevedores in the harbours looked after their safe stowage inside the ship. The captain oversaw their work.<sup>81</sup>

<sup>73</sup> Springmann 2015, pp97-180.

<sup>74</sup> S. Ekdahl, 'Schiffskinder im Kriegsdienst des Deutschen Ordens. Ein Überblick über die Werbungen von Seeleuten durch den Deutschen Orden von der Schlacht bei Tannenberg bis zum Brester Frieden (1410-1435)', in *Acta Visbyensia IV*, Visby 1973, pp 239-274; Baltzer, Martin, *Zur Geschichte des Danziger Kriegswesens im 14. und 15. Jahrhundert, Programm des königlichen Gymnasiums 33*. Danzig 1893. See also Springmann 2014, pp655-733.

<sup>75</sup> *Je noch geben dem seleuten man da vor das folk mochte ein werkleder 3 in der stau liggenn denn ich noch in de schepe ser kalt wede so hedden nicht werk kleder, dar war geinem 3 daler*. Archiv Schwerin, Germany LHAS, 2.12-2/10, Nr. 21, Springmann 2015, p157. [translations notes 72, 73 ???]

<sup>76</sup> *...og en adelsmand Ulrik Pentz frøs endog ihjel inde i kojene*, leads to the assumption that rooms for senior soldiers already existed in 1536. *Danske Magister 1536 III rk.*, Bd. 3, pp87-88 cited after Barfod, 1995, p45.

<sup>77</sup> R. Ward, *The world of the medieval shipmaster. Law, business and the sea, c.1350 - c.1450*. Woodbridge 2009, p. 114.

<sup>78</sup> M.-J. Springmann, 'Normierung und Standardisierung im Schiffbau zur Zeit des Überganges zur Frühen Neuzeit. Ein vornehmlich auf den Frachtraum gerichtete Untersuchung und Beitrag zum Verständnis der tiefgreifenden Umwälzungen der Schifffahrtsverhältnisse im Ostseeraum', *Hansische Geschichtsblätter*, 2017, pp219-286, p242.

<sup>79</sup> O. Held, 'Hansische Einheitsbestrebungen im Maß- und Gewichtswesen bis zum Jahre 1500', in *Hansische Geschichtsblätter*, Jg. 1918, p127-167. See also W. Ossowski, 'The Copper Ship's cargo', in *The Copper Ship, A Medieval Shipwreck and its Cargo*, Ed. Waldemar Ossowski, Gdansk 2014, pp241-301; F. Robben, 'Spätmittelalterliche Fässer als Transportverpackung im hansischen Handelssystem', in *Archäologische Informationen*, 31, 2008, pp77-86.

<sup>80</sup> In the SAN JUAN more than 1,000 barricas were loaded. B. Loewen, 'The tonnage of the Red Bay Vessel and Ship Tonnage in the 16<sup>th</sup> century Spain' in R. Grenier et al., Eds, *The underwater archaeology of Red Bay*, Vol.3, *The hull*, Ottawa 2007, pp299-314, p300.

<sup>81</sup> Springmann 2014, pp861-65; Springmann 2017, p242.

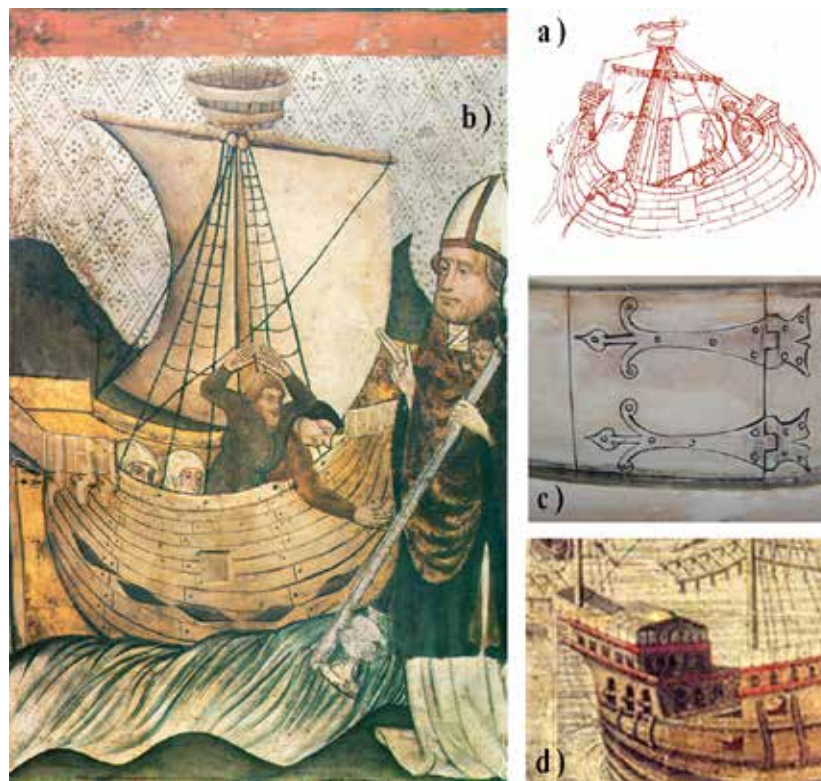


Fig. 9. A compilation of hatches

- a) Kirkehylling from 1378 shows an early example of a hatch in a probably clinker construction.
- b) Hatch door from the altar piece of St. Mary, Gdańsk from 1435.
- c) The hatch door in the port side of the Schlüsselfeld model from 1503.
- e) Ship illustration of the Stockholm town view (Blodbadstavlan 1520), showing a multi-masted ship with two hatches on different levels. There is also an opening from the upper deck.

If the ship encountered a big storm, barrels moving could easily cause distress at sea. But what can the Schlüsselfeld model tell us about it? Surprisingly, the Schlüsselfeld model has no hatchway in the deck, such as we find in the Mataro model (Fig. 9).

It is certainly a close-laid and not a loosely laid deck as we assume for medieval ships like the cog shape vessels of the Bremen type. More or less waterproof decks were a big invention of 15<sup>th</sup> century shipbuilding, increasing the reserve buoyancy of the ships. We recognize them from a closer look at the Mataro model but also at the ship from the miniature from the *Histoire des Guerres Judäiques* dated 1490.<sup>82</sup> The Schlüsselfeld model also makes this obvious. The pump discharged towards the side so that the water could flow out of the scuppers.

But where could such a ship be loaded without a cargo hatch? First I looked only at one side of the model. If I went to the other side I could see where the stevedores could carry the barrels aboard. For some reason the goldsmith implied such a cargo port only in the port side. This kind of port may have been an invention of 15<sup>th</sup> century carvel shipbuilding as the collage in Figure 9 shows us. It was certainly difficult to find a constructional solution for this big intervention in a clinker hull. But if the chalk painting was correctly dated by B. Landström to the 13<sup>th</sup> century, then the so-called Kirkehyllinge ship from Denmark already presents us with a cargo hatch in a clinker built vessel (Fig. 9 a).<sup>83</sup> This cargo port is also an indication of another deck.

<sup>82</sup> Springmann 2018, p. 56, Fig. 8.

<sup>83</sup> B. Landström, *Skippet*, 1961, pp78-79.

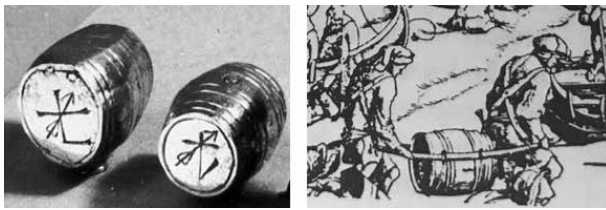


Fig. 10. Left: two barrels with trademarks, probably from the Schlüsselfeld family. Right: a section of an anonymous woodcut from the ship of St. Stonybroke showing one possible method of carrying barrels aboard.

In comparison with ship archaeology of the Mediterranean and the prospection of amphoras, we do not know very much about the stowage of goods in northern shipping. Most of the goods are gone before we can investigate a wreck or they became disordered during a wreck, so that scientists are not much interested in investigating ideas of stowage. But good stowage determines the efficiency of seagoing transport and is one of the important safety aspects of sailing. The maritime laws

reflect this very much.<sup>84</sup> The “Copper ship”, which was more deeply investigated for the first time by Jerzy, gives us an idea that stevedores carried out a responsible job with the stowage in the ship.<sup>85</sup>

As in today’s shipping, medieval seamen knew how important it was to correctly position different goods and different weights, with different shapes and dimensions: this was a clear and important aim of seamanship. Concerning the door hinges on the port side of our model, it shows that the door opened outwards and sideways. In contrast to the gunports, it could be sealed up, which was certainly important during stormy weather. Therefore the hinges are in the right direction. The port also shows that the development of gunports was not that big invention of Descharges in 1501, as Konijnenburg first pointed out in 1911.<sup>86</sup> Some ports already opened like later gunports, as Figure 9 illustrates.

The port easily allowed barrels and so-called *pipen* to be rolled on or carried aboard (Fig. 10)<sup>87</sup>, but the loading of wood was also possible. All the cargo hatches I noticed extended over no more than three strakes and therefore could not have been used for horses, just for timber, barrels and other goods.

### The military character

One of the main questions of late medieval seagoing trade is: how did traders defend themselves against the continuously growing danger from attack by pirates?

In general, the Schlüsselfeld model is probably one of the earliest examples to provide some answers about the use of guns in a marine environment. A comparison with the aforementioned seal of Maximilian from 1493 and the clock-ship from Augsburg made in 1580/90 (Fig. 8) gives us some hints of the rapid developments in the first decades of the 16<sup>th</sup> century, especially about the positioning and the effect of guns. The military activity reflected by the Schlüsselfeld model is very much connected with the erection of castles in the fore and after parts of the ship. Gunnery on the first deck is separated from thrusting and cutting weapons. The main deck is more or less reserved for the seamen and their main activities: sailing the ship. As I already mentioned, the model maker placed three guns on each side on the first decks of both castles<sup>88</sup>; in addition,

<sup>84</sup> Seerecht im Hanseraum des 15. Jahrhunderts. Edition und Kommentar zum Flandrischen Copiar Nr. 9, Eds. Carsten Jahnke & Antjekathrin Grasmann [Veröffentlichungen zur Geschichte der Hansestadt Lübeck herausgegeben vom Archiv der Hansestadt, Reihe B, Band 36, Lübeck 2003. Vonesse von Damme und Wisbyer Seerecht von 1537 § 22, p37.

<sup>85</sup> Litwin, J., ‘The Copper Wreck. The Wreck of a Medieval Ship Raised by the Central Maritime Museum in Gdansk, Poland’, in *IJNA* 9.3, 1980, pp217-25.

<sup>86</sup> Following him Français Descharges implemented such gunports in the year 1500 in the sailing vessel CHARENTE on a larger scale. E. van Konijnenburg, *Der Schiffbau seit seiner Entstehung*, 3 vols, Brussels 1911-14, Vol. 3, p51. Gunports could be seen already on the seal of the Emperor Maximilian from 1493. (H. Ewe, *Schiffe auf Siegeln*, Rostock 1972, p218, No.233; according to R.A. Barker, the seal is much younger, from the beginning of the 16<sup>th</sup> century, pers. comm.). Jochen Brennecke had even proved them already in the year 1430 (J. Brennecke, *Geschichte der Seefahrt*, 1999, p133). Due to the fact that gun carriages were not developed in parallel with gunports, the first gunports must have been bigger so that the gun, which just lay on the deck, did not destroy the hull by its jumping on recoil. Springmann 2018, p14.

<sup>87</sup> In the comparison of the size of the barrels on the Schlüsseldorf model and the hatch door, the barrels are only a bit bigger than the hatch door.

<sup>88</sup> Following the same shape so looking quite like the breech-loading cast bronze gun from Mukran. Springmann 2018, pp1-38.

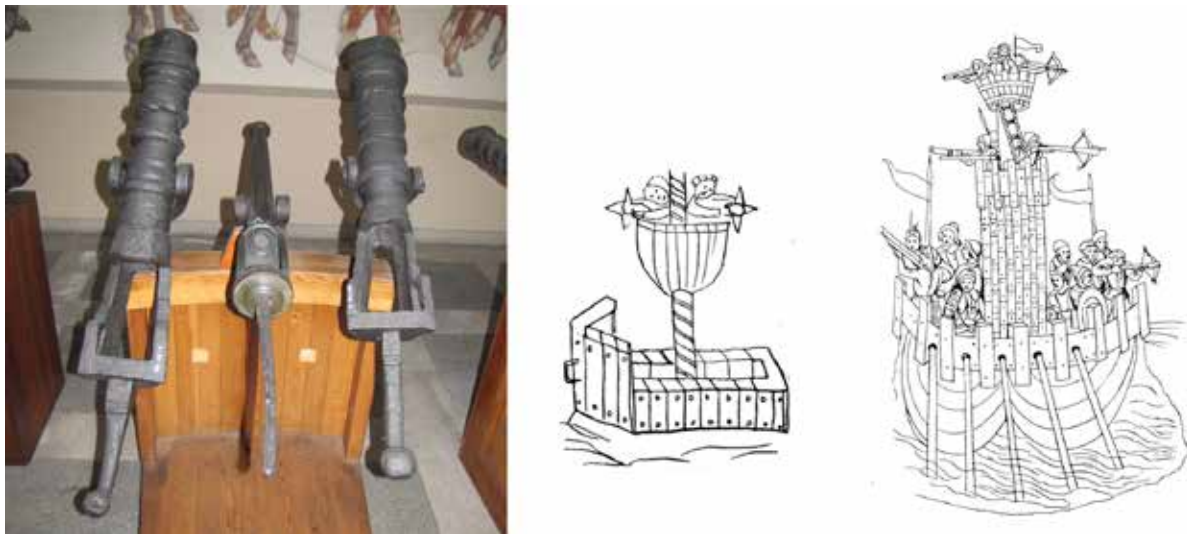


Fig. 11. Left: Different types of swivel gun, used as a *topbusse* and also termed *Drehbasse*, from the collection of the Historical Museum Vienna (Photo: M.-J. Springmann). Right: Movable siege towers are probably the exemplars for the development of top castles in a marine environment.

one gun is positioned firing forward from the forecastle. There is no trace that any gun was originally positioned firing astern from the sterncastle as we see in the clock-machine (Fig. 8). The restoration and dismantling of the model in the 1970s give us an impression of the types of gun used aboard.

Such guns were seldom strong enough to destroy the strong and thick timbers of an enemy's hull, even though Andreas Kammler found in a source from 1464 that a frame of a Hamburg ship had been destroyed by a shot from a gun<sup>89</sup>. As Guilmartin, in contrast to some other researchers<sup>90</sup>, pointed out, there is no differentiation in 15<sup>th</sup> century northern Europe of ship gunnery between "man killers" and "ship smashers"<sup>91</sup>, in contrast to the Mediterranean galleys which were already equipped with one big gun at the front to fire at the hull of an enemy ship.<sup>92</sup>

The gun chambers were loaded already in the harbours.<sup>93</sup> In the first decades, munitions were still made from granite stones. Through a rough manufacturing of the projectiles and the shortness of the gun the trajectory was rather uncontrolled. Guns were fired without elevation, which means that a knowledge of ballistics did not yet exist.<sup>94</sup>

Four chambers for every gun allowed quite frequent but uncoordinated fire. Most of them fired grape shot and smaller projectiles to injure many of the crew of the opposing vessel in one shot. Some of them were already made of lead.<sup>95</sup>

<sup>89</sup> Hansisches Urkundenbuch IX, Nr. 104, from 8 June 1464 cited from Kammler 2005, p147.

<sup>90</sup> P. Schmalenbach, 'Die Geschichte der deutschen Schiffsartillerie', Herford 1993, p29. In the discussion of that topic see also Richard Barker's review in *IJNA* of Guilmartin's papers from 1974 and 1982. R. Barker, 'Bronze cannon founders: comments upon Guilmartin 1974, 1982', in *IJNA* 12.1, 1983, pp67-74.

<sup>91</sup> J.F. Guilmartin, 'Ballistics in the Black Powder Era', in R. D.Smith (Ed.), *British Naval Armaments, Royal Armouries Conference Proceedings* 7, London 1989, pp76-93, p85.

<sup>92</sup> Springmann 2014, pp.631 Fig. 4.82 .

<sup>93</sup> Springmann 2018, pp27-28.

<sup>94</sup> Tartaglia and later Galileo tried to mathematically estimate the trajectory, but the aerodynamic determination was not completely investigated before the 20<sup>th</sup> century. Guilmartin 1994, p142. The practical usage of gunfire was described in so-called Firework books (Feuerwerksbüchern), like those of Biringuccio (first published 1540), Ruscelli (1573), Deventer (1585), Fronsberger (1573) and Arentsehe (1578). I would indicate that the so-called *Rollschuß*, in the romance languages also known as ricochet or rikochett, could have already been advantageous to ships at the beginning of the 16<sup>th</sup> century. R. Barker, 'A Glance at Ricochet', in *Journal of the Ordnance Society* 10, 1998, pp1-16. I am grateful to R. Barker for mentioning to me this interesting topic of early tactics, also in the marine context of ordnance.

<sup>95</sup> Some very early evidence of such guns in a marine environment could be found in the English AL HALLOWS from 1337. Somebody paid 3 Schillinge „...pro quod instrument ferro pro quarrel e pelottes plumbi inde sagittand cum pulv pro defens navis.“, L.G.C. Laughton, 'The Cog', in *Mariner's Mirror*, 46, 1960 , pp69-70, p70.

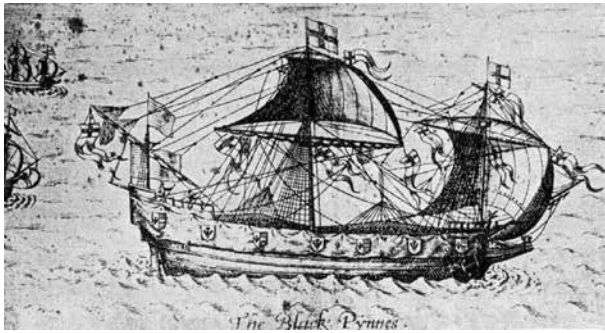


Fig. 12. Some old depictions show roof constructions not only as shelter from the sun, but also as a kind of net for defence against boarding by enemies.

Sometimes these guns were also generally placed on swivel bases (*Drehbasse*), enabling the gun to be turned through 360°. <sup>99</sup> Generally these were wrought iron weapons but also sometimes already made out of cast bronze. <sup>100</sup> In the Schlüsselfeld model it is fixed on a spike on top of the topmast in the crow's nest of the mizzen mast so it can be moved around and fired in different directions. The weight, immobility and the change of their target grew with their shot size. Bigger guns were impossible for one person to move. They were fixed on carriages, some of them already carried two little wheels. <sup>101</sup> The trunnion made the gun carriage without wheels redundant and reduced the impact of the recoil and the so-called *Buken*, the gun's vertical movement during firing. <sup>102</sup> Moving the gun was more and more a secondary effect of wheeled carriages. With the limited angle of elevation of weapons without wheeled carriages, more or less only the hull of the opposing ship could be reached, especially if the guns were positioned inside the hull on gundecks. On the main mast of the Schlüsselfeld model, a sort of Paternoster shows how the crow's nest was provided with material to reload the weapons (Fig. 2).

The beginning of the 16<sup>th</sup> century still marks the very early days in which guns were used on board in northern European waters. The quantity of guns aboard the Schlüsselfeld centrepiece is quite unique for a model reflecting the marine situation on the eve of the 16<sup>th</sup> century. <sup>103</sup> Therefore it should not surprise us that the model maker also introduces us to the main weapons of those times: spears, bows and swords. Spears are depicted in the other two crow's nests on the fore and main masts of the model and elsewhere aboard the ship. On the sterncastle a soldier appears to be equipped with an early kind of musket, but this could also be a musical instrument like a bagpipe (Fig. 12).

In 1986 Detlev Ellmers described the development from a square basket to a round topcastle on the basis of the seal of Danzig from around 1400 (Fig. 2). <sup>104</sup> Andreas Kammler noticed in his

<sup>96</sup> Springmann 2018, pp17-20.

<sup>97</sup> The first written evidence I have found is from 1354.

<sup>98</sup> W. Brehmer, 'Geschützausrüstungen lübeckischer Kriegsschiffe im Jahre 1526', in *Hansische Geschichtsblätter*, 1884, pp165-70, p167.

<sup>99</sup> It seems that two kinds of such guns (*store mersstyke*, *smaa mersstyke*) existed. See reference for 1569: RA Stockholm, SE/RA/51308,23.

<sup>100</sup> Springmann 2018, pp1-35.

<sup>101</sup> Springmann 2018, p28, Fig.19.

<sup>102</sup> The development of trunnions made the upper part of the old gun carriage, a wooden bed (*Lade*), redundant (allegedly invented in Carl VIII's bivouac at Pont d'Arche). The diameter of the trunnion matched the bore diameter of the gun itself. H. Aufheimer, *Schiffsbewaffnung von den Anfängen bis zur Mitte des 19. Jahrhundert*, Rostock 1983, p39.

<sup>103</sup> There were already a number of small swivels in the larger 14<sup>th</sup> century warships. Springmann 2014, pp558-560.

<sup>104</sup> Ellmers 2018, pp338-339. Several illustrations of a crow's nest show several different constructions. In the Mataro model the crow's nest is surrounded with a railing. Some other depictions indicate a close covering, some others show cloths around the crow's nest in which sometimes holes were cut through which the gunners shot at the enemies. Kloth proved four different constructions in the ship David operated by the town of Lübeck H. Kloth, 'Lübeck's Seekriegswesen in der Zeit des Nordischen Siebenjährigen Krieges 1563-1570', in *Zeitschrift des Vereines für Lübeckische Geschichte*, Nr. 21, 1923, p217.

source material from Hamburg special timbers to fit such a crow's nest of a so-called *Auslieger*<sup>105</sup> of the Hamburg town council for more military purposes. All this marked the development of the crow's nest from a simple lookout post to an important fighting castle.<sup>106</sup> So-called *mersemakere* became a special job for shipbuilders in the naval bases<sup>107</sup> of the 16<sup>th</sup> century, especially in 16<sup>th</sup> century Sweden.<sup>108</sup> From this position the gunner (*bossemester*) and crossbowman had a perfect overview. There is still not much reflection in the history of shipbuilding about how the constructional features of the crow's nest influenced the development of mast-caps to fit a topmast above the mainmast.<sup>109</sup> The opposing crew was the main target but gunnery certainly also tried to destroy the enemy's sails. How important these topcastles became could also be seen in the fact that in Hanseatic cities a ship that carried a topcastle had to dismantle it before entry to the harbour was allowed.<sup>110</sup>

The effect of damaging the enemy's sails and rigging was to reduce the speed of the pirates and to prevent them from boarding the ship, or as a pursuer to provide a good basis for entering the enemy ship. The fore and aft castles – this can also be seen in the model – could be turned into defensive strongpoints. This also had the advantage that even if the enemy already occupied the main deck, this did not affect the operation of the fore and mizzen masts. The pattern for these “ship castles” was certainly the medieval motte. All the ladders could be lifted up so that nobody could enter the castles. Even a sort of roof on both castles hindered people trying to enter from above.

The roof construction on top of the fore and sterncastles of the Schlüsselfeld model and in the depiction of the *Kraeck* of Willem de Cruce as well on the Augsburg clock-machine of 1580/90 show that this is not only a construction for awnings.<sup>111</sup> (see Figs. 5 and 8). It was also used as a visual screen and a special defence sail: Daeffler shows it to be a defensive construction to support anti-boarding nets. His dissertation also shows a reconstruction, including the walkway between the castles.<sup>112</sup>

From this second deck of the castles, well equipped soldiers<sup>113</sup> were certainly also defending the gunners on the deck below and fighting enemies who had already boarded and reached the main deck. Therefore the gunners did not have to concentrate so much on defending themselves and could keep firing “continuously”, even though the firing frequency was rather low.

Reinhardt and Chatterton pointed out that even the tilt (*Kuhl*) was sometimes covered with a strong net, sometimes made from metal, so that pirates could not enter the ship in the

---

<sup>105</sup> Bigger trading vessels operated by the town councils of Hanseatic towns to operate against enemies, mostly pirates, in front of the harbour. Sometimes the ship remained outside the harbour and the crew was changed continually. Kammler, A., *Up Eventur, Untersuchungen zur Kaperschiffahrt 1471–1512, vornehmlich nach Hamburger und Lübecker Quellen*, St. Katharinen 2005.

<sup>106</sup> *ibid* p152.

<sup>107</sup> on Swedish skeppsgården (engl. naval base)

<sup>108</sup> E.g. in the so-called *skeppsgårds* of the Swedish state. A. Zettersten, *Svenska Flottans Historia*, Stockholm 1890, pp82-85.

<sup>109</sup> From the beginning of the 1540s crow's nest were placed on crossed timber constructions which lay on cheeks (*Mastschultern*), as we see in one of the depictions of the Sæby Kirke. Sometimes one half of the crow's nest is higher than the other. K. Reinhardt, 'Die Modellrekonstruktion des Adler von Lübeck' in: *Zeitschrift des Vereins für lübeckische Geschichte und Altertumskunde*, 29 (1938), pp 293–332, p 321.

<sup>110</sup> E.g. wente de schippher mit syner mersen off topkasteel unaffgenomen bynnen de kopstede off tacmarket is gesegelt und een lanttouw an de brugge heft gevestet sunder orloff, wowol wii dat doch buten orloff (if a captain has not dismantled his topcastle and sailed inside the town to visit the daymarket he should moor the ship near the entrance bridge)...10,344, p. 363. F. Techen, *Urkundenbuch der Stadt Lübeck. Wort- und Sachregister*, Lübeck 1932, p427; sometimes they were called *merssenschepe*, *ibid*, p424.

<sup>111</sup> This awning leads to controversial discussion amongst scientists. Concerning this construction F. Howard pointed out a differentiation between northern and southern Europe. In southern carracks he saw the awnings on the sterncastle only athwartships, in the north longitudinally (Frank Howard, *Segel-Kriegsschiffe 1400-1860, Koblenz 1989*, p23; *Sailing ships of war 1400-1860*, Greenwich 1979). Heinrich Stettner could not see such a distinction between the North and the South in his illustrative material (H. Stettner, 'Schiffe in Holz geschnitten', in *Deutsches Schifffahrtsarchiv* 20, 1997, pp49-79, p53 and footnote 13).

<sup>112</sup> M. Daeffler, *Formes de carène et navires de combat: l'invention du vaisseau de ligne en Angleterre (1560 - 1642)*, Paris 2004, Planches, Fig.212, supports for the boarding net (*filet d'abordage*). See also F. Moll, *Das Schiff in der bildenden Kunst*, 1929, p 81.

<sup>113</sup> We should not forget that in most of the Hanseatic cities military service aboard belonged to the compulsory tasks of special occupation groups like the so-called *Träger*. Springmann 2014, p. 1014.

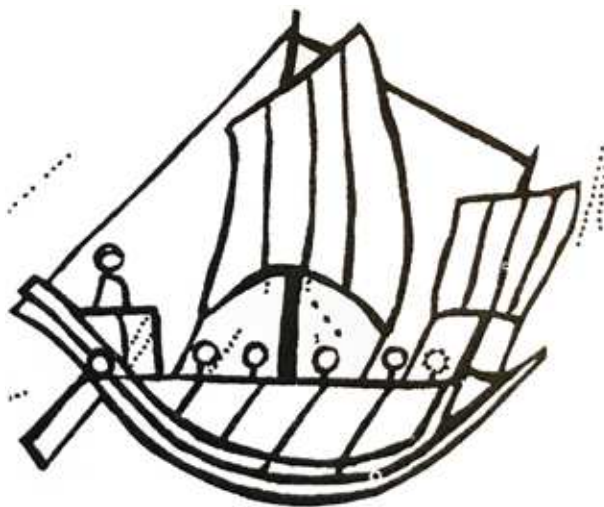


Fig. 13. The ship depiction on an ox bone from the Lower Weser near Bremen, dated to the early 5<sup>th</sup> century. The so-called *artemon* can be regarded as an early stage of the so-called spritsail (*Blinde*).

classical way of doing it, swinging across on a rope (Fig. 13).<sup>114</sup> The room under the castles certainly did not have a sliding door as Jorberg thought.<sup>115</sup> The Schlüsselfeld model shows a very heavy door which could only be opened from the inside (Fig. 2). Very curious is a sort of gallery or walkway along the bulwark, as we can also see in the *Kraeck* (Fig. 5). The stairs up to this walkway could be taken away. If pirates entered the waist they became easy targets.

From today's perspective it seems obvious that the developments in ordinary shipbuilding in the 16<sup>th</sup> century could not follow those of the military ones but we see in the Schlüsselfeld model that the defence of merchantmen in the early years of the 16<sup>th</sup> century was the basis of this development, which we later see decoupled from the development in military shipbuilding.

### Rig and sail

The best way to prevent pirates from taking ship and goods was certainly to escape. This could be done by two actions: 1. Increasing speed or 2. sailing closer to the wind than the pursuer. Apart from oared medieval galleys, ships at the end of the 16<sup>th</sup> century were mainly propelled by a single mast with a more or less square sail. In other words, north European ships of the 14<sup>th</sup> and 15<sup>th</sup> centuries mostly used downwind courses which restricted vessels to very limited course angles determined by a stern wind.<sup>116</sup> One mast with one square sail also limited the size of the vessel, especially if we think of the changes of course on leaving harbours. We know from sources that crews of ships from the German Hanse waited days for suitable winds in order to sail downwind courses.<sup>117</sup> Inside meandering fairways, especially near the sandy seaports of the southern Baltic, they had to be aware of ad hoc situations of crossing wind and stream. Our sailing trials with the KIELER HANSEKOGGE off the coast of Bornholm faced the problem of becoming free of the Legerwall using only one square sail to manoeuvre.<sup>118</sup> The need for a quite manoeuvrable ship which could also sail to windward was the main challenge in the 15<sup>th</sup> century as ships became bigger and bigger. The employment of another mast for such a task was the solution. This development is revealed when taking a closer look at the Schlüsselfeld model.

The eve of the 16<sup>th</sup> century marked years of great inventions in rigging. A look at the Burghley model in the Victoria and Albert Museum, made in 1527-28 and therefore dated a bit later than the Schlüsselfeld model, illustrates the great innovations which could be considered mainly around the lateen sail on the mizzen mast, the topsail, and the spritsail (in German *Blinde*) rigged

<sup>114</sup>K. Reinhardt, Die Modellrekonstruktion des Adler von Lübeck. In: Zeitschrift des Vereins für lübeckische Geschichte und Altertumskunde 29 (1938), S. 293–332, p. 328; E.K. Chatterton, *Sailing ships. The story of their development from the earliest times to the present day*, London 1909, p75.

<sup>115</sup>Jorberg 1955, p68.

<sup>116</sup>Sailing tests with the so-called KIELER HANSEKOGGE in comparison with sailing tests of the Skudelev replicas at the Viking ship museum in Roskilde showed that medieval ships in Hanseatic times maybe lost the capability of close-hauled sailing into the wind.

<sup>117</sup>M.-J. Springmann & Sebastian Schreier, 'The Ebersdorfer Cog Model as a basis for a reconstruction of a late medieval sailing vessel', in *Historical boat and ship replicas, conference proceedings on the scientific perspectives and the limits of boat and ship replicas*, Torgelow 2007, pp105-116.

<sup>118</sup>Springmann 2014, p. 517



Fig. 14. Left: Sailing trials with the LISA VON LÜBECK demonstrate the usage of the lateen only during tacking windwards (Photos: M.-J. Springmann). Right: the same could be interpreted from a copper engraving of the Admiral ship MARS from the sea disaster of 31<sup>st</sup> May 1569.

below a kind of bowsprit forward of the forecastle (Fig. 4). The mast of such a spritsail could be seen as an adoption of the Mediterranean *artemon*. Maybe this innovation came north in conjunction with river transport on the Rhine and Danube at the end of the Roman empire, as is probably evident from a depiction on a bone from the Lower Weser area from the early fifth century (Fig. 13).

Another sailing trial with the JESUS VON LÜBECK, which was rigged following the sail plan of a Hanseatic vessel from 1476 published by Hermann Winter,<sup>119</sup> showed that the lateen sail on the mizzen mast was a priority, maybe solely used to turn to windward while tacking, let us say as an aid to the rudder like an added “windrudder” (Fig. 15).

It did not influence the speed of the vessel at all and was maybe only set during manoeuvres. In connection with the spritsail a tack through the wind could be more easily managed. The boatbuilder Hermann Sternberg already mentioned this in his quotation of the year 1561 for a 150 last ship, the *Moisan Spreth*, of 9 fathoms length.<sup>120</sup> This could also be noticed as a clear indication for a lateen sail in the Baltic.

The Schlüsselfeld centrepiece shows a three-masted ship with different mast heights (Fig. 2). Several masts allow the setting of various different sails at the same time. A closer look at the model lets us expect that the goldsmith would demonstrate a ship which had already left the harbour and started its voyage.<sup>121</sup> Only the square sail on the foremast is set. On that sail you can also see the assayer’s mark of the goldsmith in Nürnberg. The main and mizzen sails are still furled. The main mast is certainly rigged with a square sail. It is difficult to say whether the mizzen mast, the shortest of the three, also carried an ordinary square sail as depicted in the well-known painting “Embarkation of Henry VIII at Dover, 1520” by an unknown artist in 1545, or if the mizzen mast is already rigged with a lateen sail or a so-called *Querkantbesan* or settee sail.



Fig. 15. The glass painting from the church of Groß Zicker, dated early 16<sup>th</sup> century, shows how risky the seaman’s life became through working in the rigging.

<sup>119</sup>H. Winter, *Das Hanseschiff im ausgehenden 15. Jahrhundert*, Rostock 1970; E. Lehmann, *Lisa von Lübeck*, Lübeck 2016.

<sup>120</sup>K.F. Olechnowitz 1960, Appendix XLI, p200.

<sup>121</sup>The travellers sitting together on the deck of the aftcastle. The seamen seem to be climbing up not down.

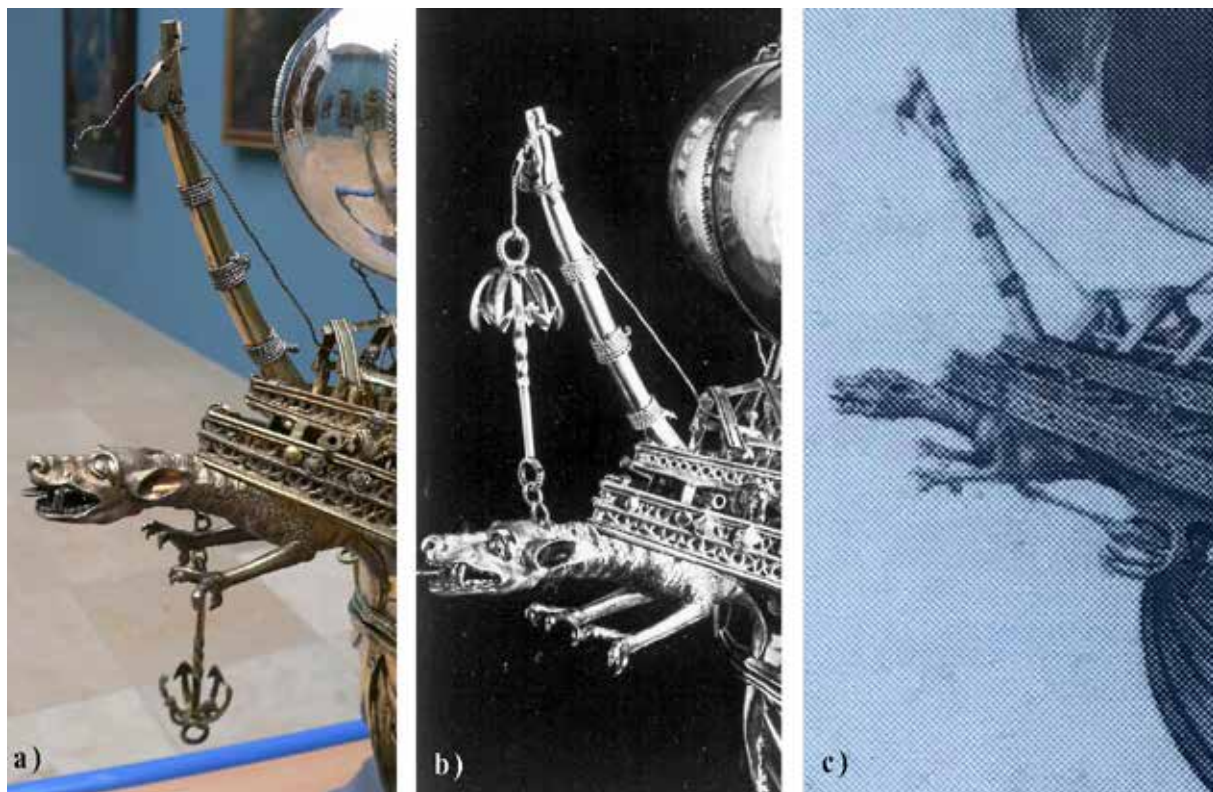


Fig. 16. Several illustrations of the Schlüsselfeld model of different times show different positions of the so-called *grapnel* as a bow anchor. a. nowadays, b. 1976, c. around 1920.

The settee sail (Fig. 16) could be considered as a north European hybrid solution of a lateen and a normal square sail as we already recognize in the *regni neapolitani verissima* by Pirro Ligorio from 1558. In the age of the full-rigged ship, the settee sail could be considered as one step towards the invention of the gaff sail in the way that the upper triangle was remote, as Reinhardt already mentioned in the general developments to the gaff sail in 1937.<sup>122</sup>

### Illustration

A very impressive detail in the Schlüsselfeld model is certainly the bowsprit above the very formidable dragon as a figurehead, but in contrast with the Burghley model from Paris there is no sail set on it. In the already mentioned quotation of a 150 last ship for the Duke of Mecklenburg, the foremast (*Fogkenholt*) of 15 fathoms length (circa 27 m) is only one fathom longer than the bowsprit (*Bouckspreth*) with 14 fathoms (circa 25 m).<sup>123</sup> I saw no indications that a spritsail<sup>124</sup> was set on the Schlüsselfeld model.<sup>125</sup> In one older photograph of the Schlüsselfeld model we see that a grapnel is fixed on the bowsprit, in a way quite similar to the depiction of the *kraeck* of Willem de Cruce (Fig. 5). With this construction, casting anchor in an emergency seems an easy task. Also using it as a kedge anchor would help the crew to tow the ship to the anchorage. But on closer examination it seems to have been used more as a grapnel in military actions to grapple another ship while boarding so that it could not escape. The iron chain fixed at the grapnel could be a further indicator of military usage.

<sup>122</sup>Reinhardt 1937, p325.

<sup>123</sup>K.F. Olechnowitz 1960, Appendix XLI, p200.

<sup>124</sup>*Blinde* comes from blind because the crew would rather not see this sail, especially in the later development of this sail.

<sup>125</sup>Brünning Rulves called this sail in front of the ship: *Blynder... der um die Klammer ging einzunehmen*, J. Focke, 'Das Seefahrtenbuch des Brünning Rulves', in *Bremisches Jahrbuch* vol. 26, 1916, pp91-144, p97.

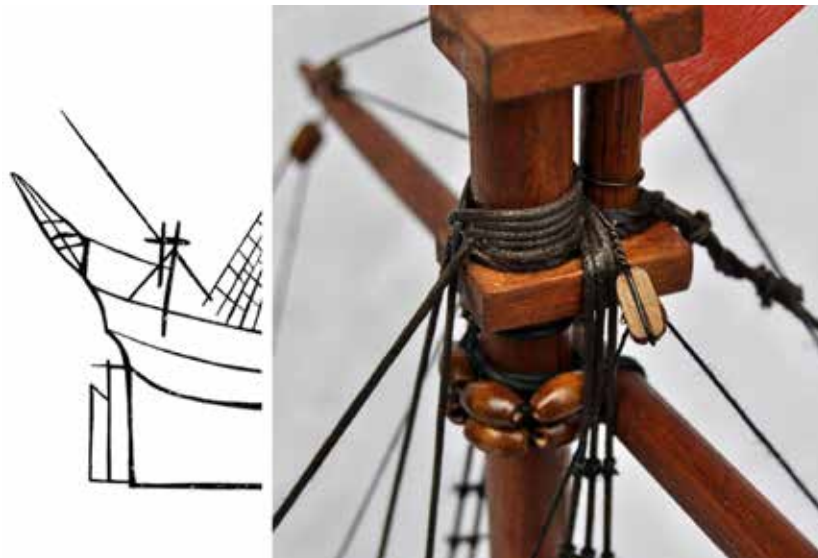


Fig. 17. The illustration from the 15<sup>th</sup> century from the Sæby church from Gotland (left) shows an early mast cap (in German *Eselshaupt*) as a connection between the topmast and the mainmast (after Christensen 1990).

I have already mentioned that the Schlüsselfeld ship was restored during the 1970s and before that it had not been in the best condition.<sup>126</sup> The similarities between the *kraeck* of Willem de Cruce, a Flemish goldsmith, and the Schlüsselfeld ship, which was also made by a goldsmith, could have led the conservators in Nürnberg to wrong decisions during their restoration. In contrast to the *kraeck*, the grapnel of the Schlüsselfeld model will fall on the dragon's head carving during action. Old illustrations of the model lead to another fixing as Fig. 17 indicates. Whether this is a mistake made by the goldsmith or made during the restoration in such a way, this construction makes no sense at all, and could be a sign of an artist's impression without a real background of seafaring, and just copying a detail from another image during modelling. This maybe led the curators to change this detail to that presented in the model today (Fig. 2). As there is always the problem of breaking and abrasion, it is more likely that the anchor chain ran from the dragon's head, as evidenced by an old photo of the Schlüsselfeld model; it is rather clear is that the bowsprit is too small in diameter to hold the weight of this anchor during military actions. That such figureheads in those times could also have been seen in an active military context is evident from the clock-machine, where a gun juts out of the mouth of the dragon (Fig. 8), but it could also be such an artist's impression.

Sailing manoeuvres with such a big ship need the setting of the right sails. The right positions of the sails and the possibility of moving them at the right moment are the main factors, especially in the meandering waterways leading to harbours which sometimes lie miles from the coast. Anchors ready to fall are the main emergency aids.<sup>127</sup> Therefore four other anchors are fixed on the ship, ready to be dropped, two on the forecastle and two at the transom of the sterncastle. The crew's aim was that such an emergency should never arise.

There is no capstan visible aboard the Schlüsselfeld model, so it is not clear how, for example, the yards were raised. If we indicate that the model tried to reflect the situation aboard a real ship, then maybe we can suggest that one capstan was on the main deck under the forecastle, the other on the main gun deck, as in many of the VOC ships, and made evident in the replica of the *Amsterdam*.

---

<sup>126</sup>Over the 400 years the model was sometimes kept in poor conditions. The reconstruction in the 1970s was unfortunately not done with the assistance of a ship model builder.

<sup>127</sup>The laws of the Hanseatic cities were very strict in the matter of the clearance of their waterways. If a pilot took a ship aground carelessly he could be hanged. M.-J. Springmann, 'Development in Harbour Construction, Infrastructure and Topography on the Eve of the Early Modern Age in the Baltic (1450-1600)', in *Archaeologica Baltica*, Vol 23, pp244-258, p254.

In the 15<sup>th</sup> century, a ship's rigging was not automatically included in the shipbuilding contract. Manuscripts like those of Michael of Rhodes and the study of the so-called "Bestecke" make it obvious that this changed during the 16<sup>th</sup> century.<sup>128</sup> A good hull design was one thing, but to adapt it to regional sailing circumstances with special wind directions etc., with such traditions embedded in the building concepts of local areas, was another. In several places sailmakers and seamen came to different solutions to find the right approach, as a comparison of the Burghley and the Schlüsselfeld models indicates (Figs. 2 and 4; see also Fig. 3). If we are interpreting the shape of sails correctly, then depictions of the 15<sup>th</sup> century show sails with more belly. This bellied shape was supported with additional tackle connected to the side leeches.<sup>129</sup> With more windward sailing it seemed that sailmakers tried to avoid such a bellied shape. This could also be deduced from the middle leech of the foresail of the Schlüsselfeld model (Fig. 2).

In contrast to downwind sailing in which the ship will be pressed forward, the ship on windward courses will be sucked by the wind which results from a difference of air pressure on the two sides of the sail. This is the same principle which keeps an aircraft in the sky. The requirement is that a sail has a shape like the wing of an aircraft in its horizontal section, so that the wind travels farther around the outer side of the sail than around the inner side. In other words, a sail should have a good roach. Using a tacking boom (*beiti ass*) to stiffen the sail in Viking times could indicate the importance of the shape of the sails on windward courses, even if people did not know the aerodynamic principles of windward sailing in such early times.<sup>130</sup> In the Schlüsselfeld model the middle leech is one alternative to the tacking boom. It should certainly have stabilised the windward course by shaping the sail.

This was an interim solution to the development of the jib sail as a north European adoption of the lateen sail at the end of the 16<sup>th</sup> century. One of the first examples can be seen on the clock-machine from Paris (Fig. 8). It significantly improved windward sailing.

Before the differentiation of sails on each mast and the use of lighter materials, sails were very heavy.<sup>131</sup> For these heavy sails strong yards and flexible masts were needed.

If we look at the masts of the Schlüsselfeld model in detail, we see that they were made out of one trunk. According to several archaeological investigations the main mast reached down to the keel. The approximate length of such a big mast was around 30–40 m. Masts of around 30 m length are recorded for ships of the Duke of Mecklenburg.<sup>132</sup> So the original height of the trees must have been around 35–40 m. In medieval toll accounts the so-called *kocghemast* was the tallest one.<sup>133</sup> Such straight and non-twisted trunks are difficult to find. To find out more I visited the Rominter heath [Puszcza Romińska] 100 km south of Kaliningrad. Here grow some of the tallest pines normally used to make masts. The biggest is still 46 m tall. Also the diameters are enormous. The mast of the Grace Dieu in 1418 is reputed to have been 6 feet in diameter.<sup>134</sup> This area and the forests in Masuria (area of Osterode [Ostróda], Poland) and near Riga were traditionally places where ship's masts were harvested for the international market. From a peripheral view such 250-year old pine trees are difficult to harvest especially in the middle of nowhere. How people brought 40 m long trees to shipyards a hundred kilometres from the forest or even transported them overseas is still an open question, which our timber project

<sup>128</sup>Springmann 2011, 2015. I am grateful to Werner Ulrich for the discussion about early shipbuilding manuals, especially about his studies in the Netherlands archives.

<sup>129</sup>A. Moore, 'Rigging in the Seventeenth Century standing Rigging and Tackles', in *The Mariner's Mirror*, Vol. 2, Issue 10, 1912, pp301-308.1914, and *MM* Vol.4, pp260-26; L.G. Carr Laughton, 'The inventory of the Great Bark' 1531, in *The Mariner's Mirror*, Vol.5, 1919, pp21-22; Reinhardt 1937, p236, footnote 87.

<sup>130</sup>About the *beiti ass* see M.-J. Springmann & S. Schreier, 'Klucz Niedamir - Vom archäologischen Rest zum schwimmenden Symbol' in *Die Lagomar Lagunen, einzigartige maritime Kulturlandschaften, ihre Geschichte und Zukunft*, Torgelow 2009, pp240-274.

<sup>131</sup>About the different material used, see Springmann 2014, pp.450-460; Springmann 2015, pp153-155.

<sup>132</sup>Springmann 2015, pp155-58.

<sup>133</sup>Following the toll account of Dordrecht, traders have to pay for: *enen kleinen mast 2 d Holl. Enen groten mast 9 d Holl., eenen kocghemast 4 β, Holl* (= 80 d). Hansisches Urkundenbuch I, Nr. 1033.

<sup>134</sup>*Pers. comm.* Richard Barker.



Fig. 18. The yards aboard vessels like the Bremen type from 1380 could be lowered in the way demonstrated in this photo of the replica of the ship KIELER HANSEKOGGE.

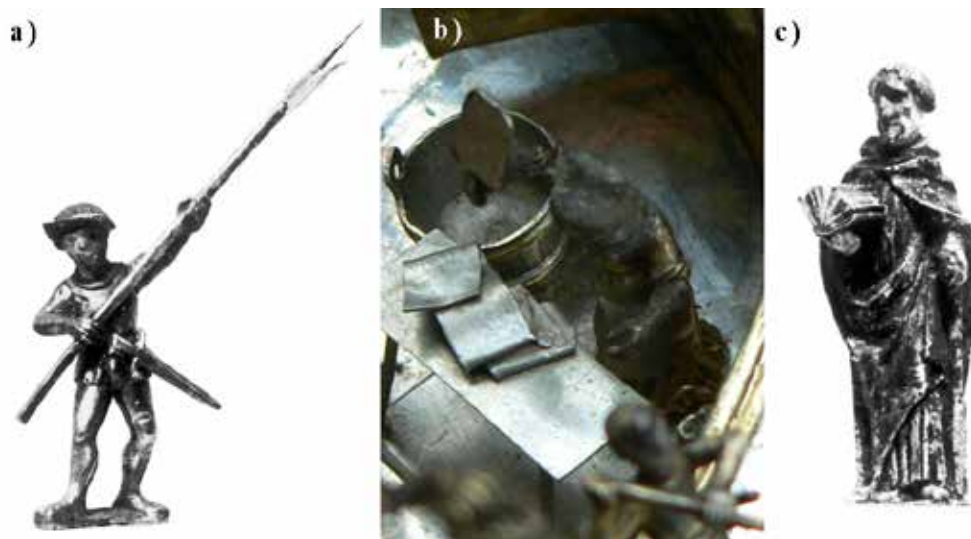


Fig. 19 A selected compilation of crew members aboard the Schlüsselfeld model: a) soldier with a jerkin and spear, b) washerwoman with washboard, c) priest

at the University of Copenhagen, Saxo Institute, would like to address. The 24 m long ship's mast from the Torgelow reconstruction of the Ebersdorf model from the 15<sup>th</sup> century, which Jerzy Litwin visited quite often, weighed about 3 tonnes.<sup>135</sup> Such soft wood trees are even difficult to season without cracks forming inside the trunk. We get no answer to such questions as we look at our model. But we get an idea of how much we do not know about this special question, about an important part of a sailing ship which can seldom be investigated in archaeological investigations.<sup>136</sup>

Upwards of a height of 20 m, the inner heartwood part (*Kern*) becomes smaller and smaller in relation to the sapwood. If we examine the working sailing boats of the 19<sup>th</sup> century, the sap wood was not taken away to form a single mast. Also, the requirements of a ship's mast as regards the inner tree rings differ from those usually demanded of timber for shipbuilding purposes. Normally we see that hardwood shipbuilders searched for narrow tree rings. But a ship's mast made out of a pine trunk, a tree with wider tree rings, will be much more flexible. From the point of view of the requirements of a sailing mast, a dried pine trunk will be more cracked and brittle, and less and less able to provide such flexibility. We have also to consider that at the top of the mast the wind is stronger than near the water level. Moreover, if we recall that the yard is fixed at the highest point of the mast, a remarkably big wind load is to be expected, which points to the importance of a strong mast. There is, for example, the research question of the so-called woodings in illustrations of the 15<sup>th</sup> and 16<sup>th</sup> century and therefore also their significance in the Schlüsselfeld model. Did woodings prevent the mast, probably already vibrating internally, from splitting during a storm (Figs. 2 and 12) or were woodings already indications of a composite mast, as Detlev Ellmers has suggested?<sup>137</sup> A composite mast as nowadays constructed by laminating wood with different grain directions is more flexible than a mast made out of a single trunk.

<sup>135</sup> 26 m high, 60 cm diameter at the bottom. Conservators estimate the length of the mast of the 23 m long Bremen ship from 1370 as 21 m. The mast of the Kieler Hansekogge (a reconstruction of the Bremen ship) is 25 m long and weighs 2.2 tonnes. U. Baykowski, *Die Kieler Hansekogge. Der Nachbau eines historischen Segelschiffes von 1380*, Kiel 1992, pp54-59.

<sup>136</sup> In the Stockholm Archipelago near the island of Franska Stenarna, a wreck was investigated dated to around 1520 in which a complete pine mast was documented. It was the main mast with a length of 18-19 m, which matched the 2.5 m width of the vessel (Adams, J. & Rönnby, J., *Furstens Fartyg*, Stockholm 1995, p.29) Also, a pine main mast 10.20 m in length and a smaller mizzen mast, dated to three decades earlier, were investigated at the Ringaren wreck site (Svenwall, N., *Ringaren*, Stockholm 1994). These finds emphasise the rarity of mast finds in archaeological records.

<sup>137</sup> D.Ellmers, 'Hansischer Handel mit Schiffbauholz. Ein Beitrag zu Wörter- und Sachenforschung', in Baum, Leng, Schneider (eds.), *Wirtschaft-Gesellschaft-Mentalitäten*, 2006, p69.

During the construction of such big ships it must have been very clear that such mast trees were seldom to be had and quickly sold. Through the interpretation of Danish sources, it cannot be ruled out that the shortage of such big mast trees of great diameter and length initiated the decision to build masts, especially the long main mast, out of several pieces before the time of the Schlüsselfeld model. The “invention” of the composite mast is usually ascribed to the Dutchman Krein Wouterz in 1570.<sup>138</sup> But there were already indications that the Danish pirate Søren Norby used a composite mast.<sup>139</sup> This question is connected to another big open problem of the development of masts and rigging on the eve of 16<sup>th</sup> century: specifically, whether the mast was built of several pieces vertically and bound tightly together as a composite construction, or whether we have here an indication of a mast already divided into main mast, main topmast and topgallant mast, such as we see in the Augsburg clock-machine from 1580/90. In this model woodings are also visible, especially on the main mast (Fig. 8). Woodings can already be seen on the Elbinger seal of 1433.<sup>140</sup> According to Detlev Ellmers, the oldest written evidence is from 1362<sup>141</sup>: he sees, in contrast to Reinhard Paulsen, the word *sparen* in the context of *pro sparen tho der mast* as an indication of a composite mast.<sup>142</sup>

Concerning the rig and sails of those times, our Schlüsselfeld model certainly does not present the latest state of the art. But the two large, long flagpoles on the fore and main masts of our model could be the forerunner of a topmast. Certainly, it was simply tied with a rope and not embedded in a mast-cap (*Eselshaupt*) as first depicted in the Sæby church graffiti, dated by Christensen to the 16<sup>th</sup> century (Fig. 19).<sup>143</sup> In the Schlüsselfeld model we still see wound rope instead of a mast cap (Fig. 2) to connect the flagpole with the mainmast. Therefore it was possible to cut this rope and bring down the upper mast more or less easily as necessary in a heavy storm. This was pointed out in the memoirs of the seaman Brünning Rulves from the 16<sup>th</sup> century.<sup>144</sup>

It seems that in the mid-16<sup>th</sup> century the division of masts into main mast and topmasts was no longer a curiosity.<sup>145</sup> A depiction on bricks in the basement of the Carmelite monastery in Helsingör, dated around 1430, shows a four-masted ship already with lateen sails. But none of the masts are divided.<sup>146</sup>

According to historical and pictorial sources, the assembly of such masts started in the second half of the 15<sup>th</sup> century. During an explosion on a privateer of Hamburg in 1472 a topmast was destroyed.<sup>147</sup> The altar piece from Reval, painted in 1482, shows a main topmast already with a topsail. Also, the Lübeck Bergenfahrer altarpiece from 1489 shows this development of masts, evidently assembled from several single pieces. Therefore we can assume that in northern Europe the division of the mast on big warships took place between 1450 and 1500.

If we take a closer look, then we see not only the heavy ships' masts. The yards are also huge and certainly heavy. The yard of the mizzen has quite the same diameter as the other two yards on the other masts. Jerzy in his student days made intensive studies and a drawing of a 300

---

<sup>138</sup>Separated into *De Fokke-mast, De groote mast, De middel mast, De Besaans-mast, De voor-steng, De Groote steng, De Voor-bram-steng, De groote-bram-steng*. Konijnenburg 1911-14, Vol. I, p46.

<sup>139</sup>The Lords of the Admiralty (Admiralitetsherren) of the Danish King Johann I (1481-1513) asked the privateer Søren Norby to try such a mast. The three masts of his flagship were composed of nine pieces (C. F. Allen, *De tre nordiske Rigers*, Copenhagen 1864-70, p562).

<sup>140</sup>Ewe 1972, Nr. 43, p. 123

<sup>141</sup>*pro claviculis ad referendam malam in coggonis*. Hansisches Urkundenbuch cited after D. Ellmers, Die schriftliche Überlieferung zu den Schiffbauteilen von Binnen- und Seeschiffen der Hanse, in: D. Ellmers, Die Hanse der deutschen Kaufleute und ausgewählte Beiträge zur Geschichte der Seefahrt, Hansische Studien XXVI, 2018, pp317-362, p. 330. Ellmers translated *claviculis* (in German Ranke) as a wooding.

<sup>142</sup>Ellmers 2018, p330, Reinhard Paulsen, *Schiffahrt, Hanse und Europa im Mittelalter*, Köln 2016, p830.

<sup>143</sup>Arne-Emil Christensen JR., *Skipsristningene i Sæby Kirke, Handels- og Søfartsmuseet på Kronborg 1969*, pp , Reinhardt mentioned the year 1578. Reinhardt 1937, p306.

<sup>144</sup>Focke 1916, p102.

<sup>145</sup>In the equipment list of the GREIF from 1564 a ropemaker is mentioned who made a rope for a *overmasten* MLHA 2.12-2/10, Nr. 21, Springmann 2011, 2015. This could be a hint that for this ship no mast cap was used.

<sup>146</sup>C. Sölver, 'Ett betydelsefullt Fynd', in *Segel och Motor* Nr. 8, Stockholm 1936.

<sup>147</sup>Hansisches Urkundenbuch X, Nr. 111, 5 April 1472,

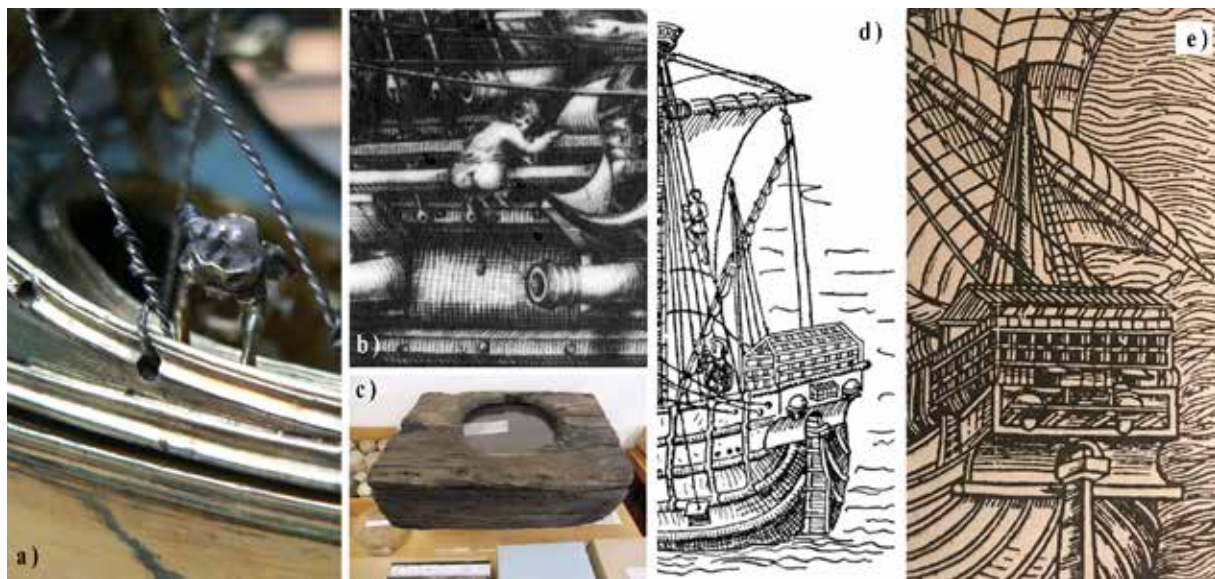


Fig. 20. The ordinary way of making toilets on board ships did not change over the centuries, as a comparison of the Schlüsselfeld model (a) and a detail from Jan Dircksen's "Trekroner" painting from 1611 demonstrates (b). Indications of a garderobe for travellers and ship's officers can be seen already on the Bremen type vessel from 1380 (after Lahn 2007) (c), in the two garderobes in the stern of the ship depicted on the altarpiece of Johannes Reixach, 1468, Barcelona, (d) and the ship in front of Modon from Breydenbachs Pilgrimage 1486 (e).

last ship from Wismar found in the appendix of the dissertation of Karl-Friedrich Olechnowitz based on a quotation of the master shipbuilder Hermann Sternberg from 1561 for the Duke of Mecklenburg, a quotation which I also studied in my dissertation work.<sup>148</sup> Sternberg calculated for a 150 last ship a main yard with a length of 30 ells (17.20 m).<sup>149</sup> The Schlüsselfeld model carries three of these, which again increases the weight of the masts themselves and therefore the loads on particular parts of the hull. How were yards raised and lowered in those days? All three yards in the Schlüsselfeld model indicate the moving of heavy yards. The model shows three lines of parrel beads on each of the masts to move the yard up and down (Fig. 2)

The yards could no longer be lowered and laid across the main deck as we see in a photo from the sailing trials of the KIELER HANSEKOGGE (Fig. 20). Ships like those presented by the Schlüsselfeld model could lower yards down to the gunwale in harbour or during anchoring, as the illustrations demonstrate. This allowed the crew to change the sail, add bonnets or reduce sail area. In these big ships the stops and the angle at which the ropes went into the blocks became very important to produce enough power. Here also the Schlüsselfeld model provides some indications of this.<sup>150</sup>

The invention of blocks and tackle allowed seamen to handle this great weight. But a so-called knight, a technical construction connected with a capstan allowing the yard to be raised more easily, is not visible on the Schlüsselfeld model, even though we see such knights illustrated in a list from around 1560.<sup>151</sup> It had already been invented in the 15<sup>th</sup> century Mediterranean, as a look at the manuscript of Michael of Rhodes from 1445 makes plain.<sup>152</sup> Henry B. Culver investigated a knight in the Mataro model before it was reduced from a two-masted to a one-masted version.<sup>153</sup>

<sup>148</sup> Litwin personal collection

<sup>149</sup> Olechnowitz 1960, Appendix XLII, p 200.

<sup>150</sup> In one of Pieter Bruegel's paintings we can see how shrouds and braces went inside the ship through a hole. See Frans Huys *Le monde de Jacques Cartier, L'aventure au XVI siècle Montreal*, 1984, p172. See also H. Arthur Klein, *Peter Brueghel the Elder Artist of Abundance*, New York, 1968, p63; Jose Maria Lopez Pinero, *El arte de navegar en la Espanol de Renacimiento*, Barcelona 1979, pp244-245.

<sup>151</sup> Springmann 2015, p140.

<sup>152</sup> Long 2009, p. ???

<sup>153</sup> H.B. Culver, 'A Contemporary Fifteenth Century Ship Model', in *Mariner's Mirror*, Vol.15, London 1929, pp213-221, p213.

In comparison with the centrepiece from the Schlüsselfeld family, the aforementioned Bergenfahrer altar piece is interesting, but for another reason. Both show early examples of shrouds to brace the heavy weight of the mast and wind forces, especially during windward courses. Until now the Schlüsselfeld model has not aroused much interest on the part of ship historians.<sup>154</sup> One exception was the important maritime historian from the Netherlands, André Sleswyk Wegener, who used the Schlüsselfeld model to describe the development from the gunwale to the chainwale in conjunction with the shrouds and deadeyes in the aforementioned depiction of Willem de Cruce showing a *kraek*.<sup>155</sup> Concerning the development of the chainwale, R. M. Nance stated as long ago as 1914, in relation to Christian Møller's drawing showing the "Great Dane" of around 1600, that concerning tackle and shoe blocks "they are all stropped; seized or knotted, but not spliced in".<sup>156</sup> This stands in contrast to Brüning Rulves, who refers in his authentic memoirs to a strop<sup>157</sup> used to connect a ship's boat (*Beiboot*) with a block to his ship.<sup>158</sup> Such a strop should be spliced!<sup>159</sup> You can follow the perception that this information is not so much relevant and important in an article about a model, but a strop secured a rigging "hard", so the shrouds could not re-stress further through a simple lanyard as we see in the Schlüsselfeld model. The usage of deadeyes was the next development step. In the centrepiece and also in the Mataro model, shrouds and other lines of the standing rigging were just fastened through simple knots (Fig. 2). But a further step to normal chainwales could already be noticed in the Mataro model.

In the Schlüsselfeld and Burghley models we recognise a still very primitive connection of the shrouds with the hull realised with a toggle (Figs. 2 and 4) known from the Viking period, for example, the excavation of Haithabu.<sup>160</sup>

It seems that even this primitive construction in the model followed a naturalistic impression.<sup>161</sup>

We see that such simple inventions as tackle and shrouds in conjunction with the tradition of making special knots should not be considered in isolation; rather one invention influenced another and sometimes gave the basis for different solutions in a chronological perspective and in a very small time frame. It is very, very seldom that we can study this through wreck research. Sometimes it can be investigated exclusively by a careful study of such models.

Because in this steadying of the mast through shrouds connected to chain plates we could recognise a holistic system of rigging, because the lever arm of such high masts in conjunction with more and more windward courses and new planking techniques must also change the very primitive kind of gunwales by reinforcing the hull at this specific part of the ship where the chainwales provide enormous strength for the hull. This strength significantly affects the hull as a sensitive and hollow half shell of thousands of parts fitting together to form a more or less stable mobile construction, fixed in a fluid whose surface changes just as soon as a little wind starts to blow.

Here, too, the Schlüsselfeld and Burghley models (Figs. 2 and 4) do not represent the state of the art that we have already noticed in the Mediterranean in the second half of the 15<sup>th</sup> century, a state of the art which we notice more than 100 years later in the Augsburg clock model from 1580/90 (Fig. 8). Here a kind of chainplate already including deadeyes with lanyards is recognisable.

---

<sup>154</sup>One example is the doyen of German ship archaeology Detlev Ellmers, see D. Ellmers, 'Aus den Sammlungen des DSM. Seeschiffe im Binnenland als Zeichen der Kaufleute', in *Deutsches Schifffahrtsarchiv*, 28, 2005, pp375-398, p380. See also J. Brennecke, *Schiffstypenkunde: Die Karacke*, in: *Schiff und Zeit*, Vol. 1978, p.12. Most of the interest concerning this model was connected with economic questions, see: U. Timann, 'Schlüsselfelder Schiff, um 1502/03', in Hermann Maué, *Quasi Centrum Europae. Europa kauft in Nürnberg. 1400—1800*, Nürnberg 2003.

<sup>155</sup>Wegener Sleswyk, 1991, p44.

<sup>156</sup>R.M.Nance, 'A great Dane of 1600', in *Mariner's Mirror*, Vol.4, 1914, pp225-232, p231.

<sup>157</sup>Following the Grimm brothers this is mentioned also as *Strupf*, as a technical term for knots and strops. Grimm, J. & W., *Das Deutsche Wörterbuch*, <http://dwb.unitrier.de/de/>, Vol. 20, Sp. 138, see also Schiller & Lübben 1881, Vol. 5, p.441.

<sup>158</sup>Focke, 1916, p97.

<sup>159</sup>So called Flemish splices were already used to connect an arrowhead on the bolt. A precursor of a so-called round splice was used to produce a fender, such as one found by Ole Crumlin Pedersen in the excavation of Haithabu (Crumlin-Pedersen, O., 'Viking-Age Ships and Shipbuilding in Hedeby/Haithabu und Schleswig', in *Ships and Boats of the North*, Schleswig & Roskilde 1997, pp144-45. Also in the archaeological record of Gokstad such splices were documented (T. Sjøvold, *Vikingskibene en kort orienteering om vikingeskipsfunnene*, Oslo 1952, pp24-25).

<sup>160</sup>Crumlin Pedersen 1997, p138.

<sup>161</sup>Such simple techniques could also be recognised in the ship painted by Hans Burgmaier from the year 1511.

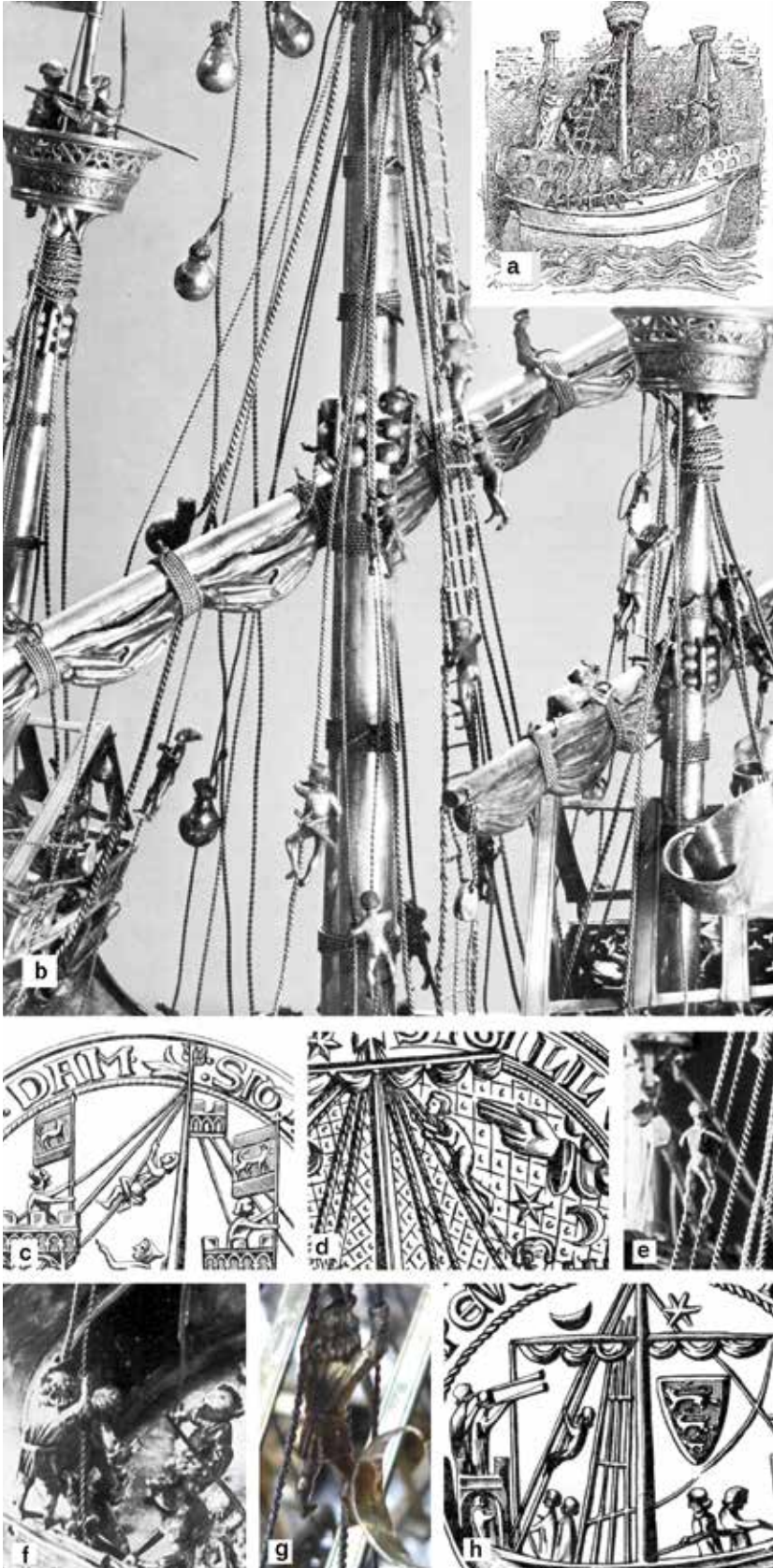


Fig. 21. In comparison with climbing seamen on ropes, visible on medieval seals, a scene aboard the Schlüsselfeld model shows a new way using a ladder.

## Social life

From my point of view, such centrepieces demonstrate a special way to “socialise” models, in other words to put life into dead technical objects and therefore impart to them another level of attractiveness.<sup>162</sup> The Schlüsselfeld model is an excellent example of this and therefore a wonderful opportunity for studying the social life aboard a very late medieval merchantmen. Exactly 74 persons<sup>163</sup> are depicted, moreover, in such an anecdotal but also precise way that you can even study the fashion of cutting beards at the beginning of the Renaissance in central Europe (see Fig. 2). Sometimes we can even identify the colour of the cloth of the crew’s clothing, showing that the time of the medieval *Gugel*<sup>164</sup> as a sort of uniform dress for seamen had already come to an end. The soldiers were also specially equipped with breast-plates which ordinary seamen never wore. As on the other figures, we can study and compare with other depictions even the colour of their clothes and the fashions in those times. With such a great number of figures aboard it is nearly impossible for me to describe all aspects of the social life they present in such a short paper. But I will outline some of the most interesting ones.

The first scene which strikes the eye and might show a parallel to the purpose of the centrepiece in general is the banquet that the travellers are holding on the deck of the sterncastle, entertained by musicians with their different musical instruments (Fig. 12). It cannot be ruled out that this scene harks back to an occasion on which the owner, the trader Wilhelm Schlüsselfeld, held a banquet himself.

By the way, you see that a good sea passage, even in those early days when ships were used more and more for travelling to different places in Europe, needed a good level of service aboard. Normally we know of such contracted services in Pilgrims’ travel books from the Mediterranean, reflecting the journey to Jerusalem.<sup>165</sup> Here we now have a north European reflection by way of fine art. Detlev Ellmers, reflecting on these travellers, mentioned that they had to see to their eating and drinking and bring their own food aboard.<sup>166</sup> This was especially the case if they did not own a part of the ship. The two barrels with the Schlüsselfeld trade mark on the main deck could refer to this tradition, but could also just be a symbol for trade in general.

An exception could be the tradition, described by the seaman and captain Brüning Rulves in his already mentioned memoirs, that an open water barrel was always kept near the main mast at the free disposal of all the crew members<sup>167</sup>. For this possibility a soldier taking something to drink can be quoted. (Fig. 21a) On longer voyages the water was supplemented by small beer as a way to stretch the water.<sup>168</sup> Amoebiasis (dysentery) was a dangerous illness aboard ships, and no antidote was found in the 16<sup>th</sup> century, as a message of the Swedish King Erik from 1565 makes evident.<sup>169</sup> As we see, sea journeys as an alternative to long and arduous overland journeys also had to include hygienic aspects, such as the washing of clothes on board ships. This might apply only to travellers and warriors (Fig. 21 b).

---

<sup>162</sup>Some such models include special techniques like the clock model which plays music and has musicians like drummers moving to it. Priebe, C., *Eine Reise durch die Aufklärung. Maschinen, Manufakturen und Mätressen*, Norderstedt 2007.

<sup>163</sup>The goldsmith made an enormous effort. All the figures were first cast in lead and then enamelled and coloured.

<sup>164</sup>In medieval England sometimes called *towaille* [towelling], R. Ward, *The world of the medieval shipmaster. Law, business and the sea, c.1350 - c.1450*. Woodbridge 2009, p. 105; For the *Gugel*, see C. Deggim & S. Möller-Wiering, ‘Die Gugel - eine mittelalterliche Seemannskleidung?’ in *Hansische Geschichtsblätter*, Vol. 119, 2001, pp.163-187.

<sup>165</sup>Bernhard von Breydenbach, *Die Reise ins Heilige Land. Ein Reisebericht aus dem Jahre 1483*. Rostock 1970. Franz Fromholzer, Die venezianische Route in Pilgerberichten des 15. und 16. Jahrhunderts, Paper for the workshop entitled: „Die Verschiffung der Welt. Soziale Verdichtung und mediale Ordnungen an vormodernen Häfen, Konstanz, 16.-17.06 2016.

<sup>166</sup>D. Ellmers, Einmal Rostock – Malmö und zurück. Die Abrechnung einer Seereise aus dem Jahre 1375, in: *Hansische Geschichtsblätter*, 126, 2008, pp247-266.

<sup>167</sup>Focke 1916, p. 98.

<sup>168</sup>For alimentionation and drinking aboard, see Springmann 2014, pp769-783. Following inventories analysed by the author the per capita consumption of beer aboard ships of the 16<sup>th</sup> century could be estimated at around 3-5 litres per day. Springmann 2014, pp769-83. This accords with the data H. Henningsen collected for his research. H. Henningsen, ‘Sømandens drikkelse’, in *Handels- og Søfartsmuseet Årbog*, Helsingør 1977, pp7-67, p35.

<sup>169</sup>... *låtitt doktorerna tillpynta någon medicin för samma sjukdom*. King Erik to Admiral Horn, message from the 15<sup>th</sup> of July 1565 cited after A. Munthe, *Svenska Sjöhjaltar*, Stockholm 1899.1921, p. 82., see also Zettersten, 1890, p. 27.

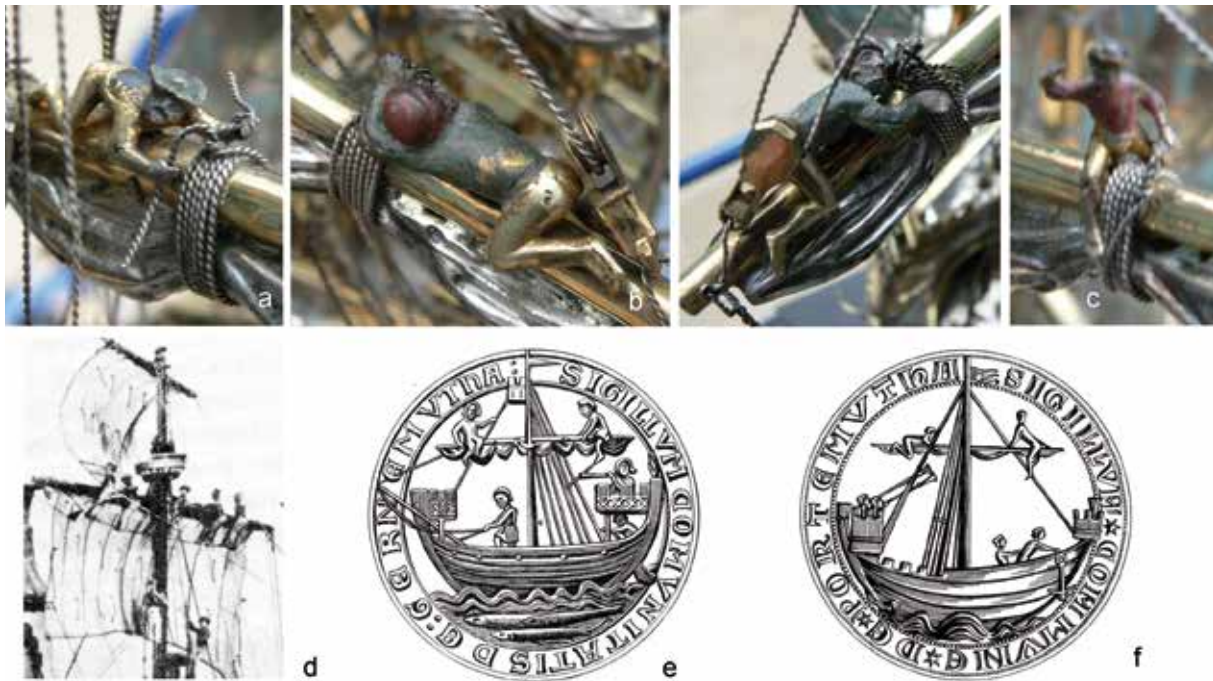


Fig. 22. The goldsmith of the Schlüsselfeld model created several scenes of crew members working in the rigging without any foot ropes, which first became visible in the Peller model of 1602 (d).

This model is also a good and rare example to a certain extent bearing witness to the role of women in shipping, in the early days of a more international transport, as we also recognize aboard the *Vasa*, but sometimes also in other depictions like a chalk painting in the cellar of the Town Hall in Wismar. We know already from the toilet found on the Bremen ship from 1380<sup>170</sup> that garderobes might only be used by captains, travellers etc. The rest of the crew made do in a more traditional way, as not only the Schlüsselfeld model suggests (Fig. 22). This was only a fair-weather alternative. Archaeological evidence shows that crew members used the ballast for a toilet – this place was certainly used during bad weather.

In those days travellers, soldiers and seamen were housed separately aboard ships.<sup>171</sup> The beginning of the 16<sup>th</sup> century marked a time of overcrowding aboard, especially for purely military actions.<sup>172</sup> In the years of the Nordic Seven Years War (1563-70) more than 1,000 people lived aboard a vessel which was no longer than 40-50 m.<sup>173</sup> The Schlüsselfeld model indicates indirectly that the soldiers lodged in the fore- and sterncastles. The travellers were certainly in cabins<sup>174</sup> at the first level of the sterncastle which provided the best climate, and the seamen inside the ship under the forecastle.

<sup>170</sup>Werner Lahn & Klaus Peter Kiedel, Zur Hanse Kogge von 1380: Beschreibung der ältesten Schiffstoilette der Welt, in: Deutsches Schifffahrtsarchiv 4, 1981, pp 9-16.

<sup>171</sup>On the basis of his research in the books of the finance department of Hamburg in the 15<sup>th</sup> century, Kammler shows that soldiers and crew were strictly separated; they were even separately listed in the onboard journals. A. Kammler, *Up Eventur, Untersuchungen zur Kaperschiffahrt 1471 - 1512, vornehmlich nach Hamburger und Lübecker Quellen*, St. Katharinen 2005, pp 56.

<sup>172</sup>In the Nordic Seven Years War already more than 1,000 people were aboard vessels such as the relocated MARS sunk in 1564 or their then opponent the ENGEL, which sank in 1565. Even aboard the PETER VON DANZIG there were more than 350 crew members and soldiers in 1472. *Lübisches Urkundenbuch* Bd. 7, no. 453 and no. 455; see also *Hansisches Urkundenbuch* 6, No. 1024.

<sup>173</sup>Zettersten 1890, p. 82.

<sup>174</sup>Sometimes these cabins were extraordinarily fitted into first class “coija” (bunk) furnished with special wainscot panelling (see also Barker in this volume), sometimes even with a toilet as a journey of Swedish Duke Johan to England in 1559 makes plain. He used the top level of the forecastle. Often a special chamber to keep the clothes dry was claimed by the clients. Zettersten 1890, p. 70. See also in General H. Henningsen, ‘Somandes lukaf og kaptajnenes kahyt’, in *Handels- og Søfartsmuseet Årbog*, Helsingborg 1980, pp17-79.



Fig. 23. Experimental sailing trials with the KIELER HANSEKOGGE and the multi-masted LISA VON LÜBECK as a rebuild of a 15<sup>th</sup> century ship allow comparison and indicate the simplification of the work with the running rigging through the invention of blocks and tackle. above) Hauling the sheet of the KIELER HANSEKOGGE, below) Hauling the sheet of the fore sail of the LISA VON LÜBECK.

The important group is certainly the seamen, whose lives changed rapidly through the invention of multi-masted ships, clew lines, foot ropes etc. especially when the yards were only occasionally lowered to reef the sails. Medieval ships were mostly sailed from the main deck. If we interpret seal depictions and experiences collected in experimental sailing trials of cogs of the Bremen type correctly, then seamen only went aloft in harbour (Fig. 23).

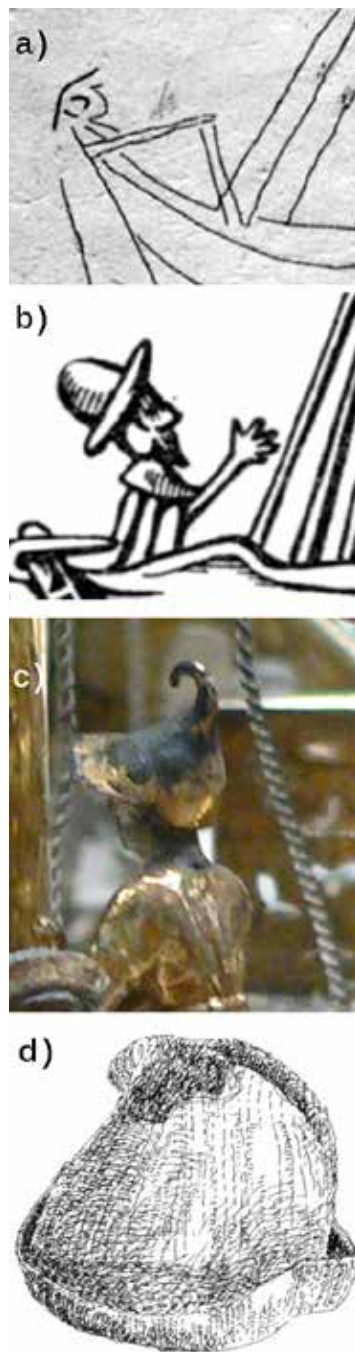


Fig. 24. A selection of hats on medieval seals in comparison with the captain's hat from the Schlüsselfeld model and a similar one from an archaeological excavation on Spitzbergen dated to the 16<sup>th</sup> century (after Albrethsen 1991) shows how impressive captains' hats have always been through different styles and types.

The Schlüsselfeld model also shows us how seamen's lives changed dramatically into a very risky job – how risky can be seen also in the glass painting by Zicker from around 1560 (Fig. 16).

Seamen slipped off slippery yards without foot ropes (*Fußpardunen*); these had not yet been invented. They can first be seen in the Peller model from around 1603 (Fig. 24).<sup>175</sup> Seamen in those times seemed to be climbing artists, even using their teeth to tie the ropes around the sails and the yards using a figure-of-eight knot. The Schlüsselfeld centrepiece shows us further that the shrouds were not yet made into a ladder with ratlines, as seen in the Augsburg clock-machine from 1580/90 (Fig. 8). In our model, seamen climbed a ladder which was connected to the crow's nest (see Fig. 2).

We spoke above about how heavy the loads of sails and yards became. This could only be managed by the adoption of inventions made on land, especially connected to blocks etc. Our sailing trials with the one-masted KIELER HANSEKOGGE and the three-masted JESUS VON LÜBECK made it clear how important the invention of the tackle and the multi-sheave blocks became for the raising of yards etc. (Fig. 25).

The sailing trials with both ships also made it evident how important it was for a proper command structure to be established on that long vessel. Therefore it is maybe not a surprise that the most important person aboard, the captain, is presented aboard the Schlüsselfeld model in greater size in proportion to the other figures. He is also wearing an impressive hat, which looks similar to those found in excavations in burials and those depicted on the seals of some harbour towns (Figs. 12 and 26).<sup>176</sup> As I already said: on bigger ships with lower speed, especially before harbours, the right moment to shift the sail is the main indicator to have success in tacking. On the basis of the Bayeux tapestry and through sailing trials with the 30 m long replica of the Skudelev 2, Morten Ravn made it clear that even aboard Viking longships someone had to work to transmit commands forward.<sup>177</sup> Aboard such huge vessels as the Schlüsselfeld, the captain's signal might not be heard everywhere. The division of the command structure into watches<sup>178</sup> on each mast led by an officer guaranteed that the captain's orders were conveyed to the seamen at each mast, for example, to brace the sails at the right moment. Even here the Schlüsselfeld model refers to the importance of such a person, as illustration 27 makes clear. The boatswain's whistle from one of the Lübeck ships sunk off the coast of Visby in 1566 in a thunderstorm shows that even shouting could not guarantee that commands reached the ears of the seamen on the forecastle or up in the rigging (Fig. 26).

<sup>175</sup> W. Jaeger, *Das Peller-Modell von 1603*, Rostock 1973, p14.

<sup>176</sup> S. Albrethsen, 1600-tallets hvalfangst ved Svalbard og Jan Mayen - arkaeologiske undersøgelser, Hikuin Bd. 18, 1991, pp269-288. See also Springmann 2014, p763

<sup>177</sup> M. Ravn, *Om bord på vikingetidens langskibe. En analyse af beatningsorganisation og kommunikation*, Kuml 2016, pp131-152.

<sup>178</sup> H. Henningsen, 'Über den Ursprung des Wachsystems', in *Deutsches Schifffahrtsarchiv* 7, 1984, pp99-116.



Fig. 25. The Schlüsselfeld model and other centrepieces also mark a differentiation in dress. Crew members are dressed according to their different social status and tasks aboard: a) the Captain of the Schlüsselfeld model, b) a Crew member of the Burghley model with impressive cotton wool trousers giving shelter against the cold, c) Master Gunner (*bossemester*), d) Ordinary soldier wearing a breast plate, e) Ordinary seaman with close-fitting clothes for a risky job.

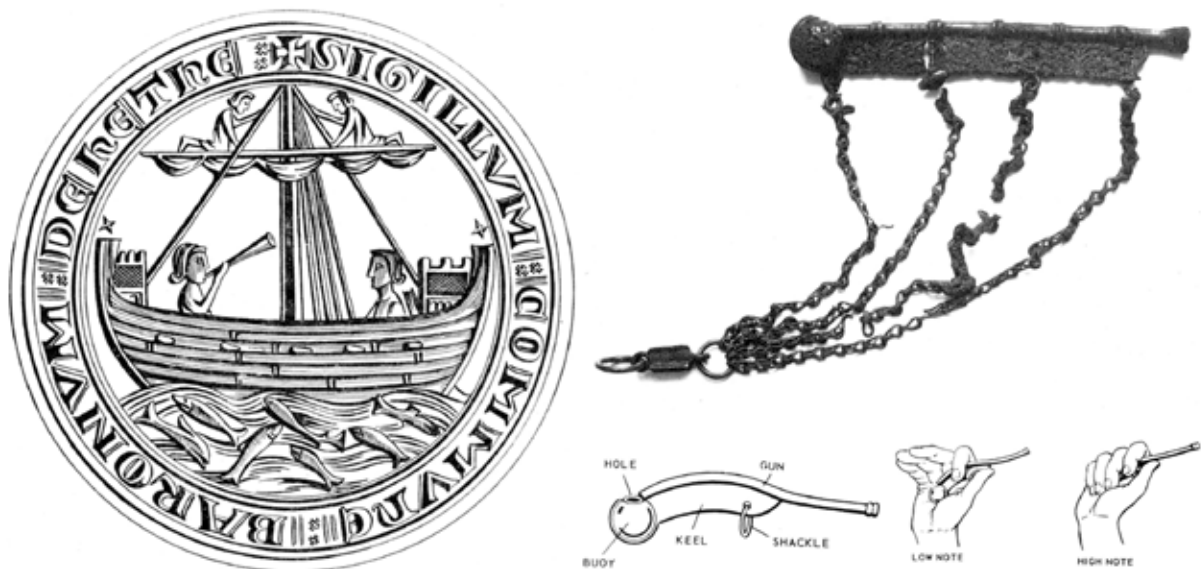


Fig. 26. The boatswain's whistle from a ship of the Danish-Lübeck fleet, sunk in a storm off Visby in 1566, shows the transmission of commands through acoustic signals.

Of course, belief was also very important in the very unique society aboard vessels that sometimes did not see land for weeks. We in Germany speak even today about Christian seafaring “(*christliche Seefahrt*)”. How deeply the symbolism of ships is connected to the Christian religion is also visible aboard the Schlüsselfeld model: we see a priest saying Mass (Fig. 21c).

Though I could not mention all of Jerzy’s combined talents, neither could I neglect all the facets that this wonderful model presents, concealing all the aspects this centrepiece shows us concerning the important changes in shipbuilding and seafaring on the eve of the 16<sup>th</sup> century. This could be a task for the future even through wreck research and maritime history in general. I am sure Jerzy will contribute to it. We all look forward to discovering Jerzy’s future publications referring to the interesting period of seafaring which this model reflects, at a time when he is not opening one museum after another.

### Acknowledgement

This paper was written in the Timber project. The project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No. 677152).

