7. DISCUSSIONS AND CONCLUSIONS[9]

The swords have been examined using X-radiographs and metallography, as well as hardness measurements. This, along with a detailed archaeological study of the weapons their context have provided new insights of the swords of Telemark. However, these investigations have, for several reasons, continued for many years. During this time research interest in, and general knowledge about, societal conditions for specialised craft production have developed significantly. One basic assumption is that all swords were forged by trained blacksmiths even though their skills and knowledge of materials varied considerably, not least depending on their social relations and attachments. It is also assumed that such knowledge, as well as more advanced smithing techniques, were spread from blacksmiths working in centres to others working farther away. The small number of swords and spearheads, not classifiable as ordinary types, strongly indicates that the number of weaponsmiths was never very great, and that there was some level of contact among them.

One premise is that indigenously made weapons at the beginning of the Viking Age in general were of simple construction. The radiographs indicate a certain amount of technical development during this period.

What is meant by more advanced smithing techniques? As stated in Chapter 1, a good point of departure is Pleiner's division into simple, advanced and top techniques (Pleiner 2006:Chapter XI). His division is his answer to the problem of how to arrange a selection of extensive data in order to illustrate the technical level of early and ancient smiths (2006:196).

Simple techniques include the working of low carbon and heterogeneous wrought iron, either by forming one piece of material or by forge welding carbon-poor iron (2006:196–200).

Advanced techniques were commonly used to make critical parts of tools effective by increasing the hardness of cutting edges and points. Such techniques consist of additional carburising and forge welding of iron and hardenable steel, for example into an iron-steel-iron "sandwich". The methods employed were steel shells, scarf welding and butt welding (2006:200–212).

Top techniques required a perfect empirical differentiating of various ferrous materials, and an extraordinary mastery in performing minute-scale processes, as well as managing work with larger pieces of material.

One relevant process produced striped blades, achieved by joining iron bands or wires by means of butt welding. Another applicable process requiring the mastery of top techniques was pattern welding with twisted iron and steel rods. Also, yet another speciality was locksmithing, although making plate armour and clocks first occurred after the Viking Age, and thus is not very pertinent here.

It is important to note that unlike Selirand and Solberg, Pleiner distinguishes between strip welding and pattern welding (strips are patterns 1–3 by Selirand and Solberg, 3 being a serrated strip). Pattern welding means the twisting of iron and steel rods or wires. Both are categorised as top techniques. This distinction is interesting to our work as some spearhead types (Petersen 1919, types I,K, D,J; Solberg 1984:165–170, types VII.2, IX and some variants) have such strips on the blade, among them 16 out of 18 K-type spearheads from Telemark (Solberg 1984:107). Strips were found only on 10th century and later spearheads and were widely distributed in Scandinavia, Finland and the Baltic countries, on the same spearhead types (Selirand 1975:174; Solberg 1984:108). In addition, the serrated strip on a pattern-welded spearhead from Haithabu was made from a twisted rod, a feature also described by Selirand. Such strips were often parts of more complicated patterns (Thomsen 1971:79 and Figure 5; Pleiner 2006:3–4, Plate XXXVI). Their origin is uncertain.

Moreover, we stress the importance of considering forging techniques, and inlays of other metals, for spearheads as well as for swords when discussing the knowledge and skills of Norwegian weaponsmiths. Solberg only discusses pattern welding in her thesis on spearheads, and does not consider welded-on edges on

9 Although written by Martens, many of the insights are the result of long-lasting collaboration and numerous discussions with Astrup.

non pattern-welded items. These questions depend on the societal position of practicing specialist craftsmen, and thus the technical skill of Norwegian weaponsmiths at the beginning of the period is important.

7.1 NORWEGIAN SWORD TYPES C, M AND Q + X: DEVELOPMENT THROUGHOUT THE PERIOD

No technically advanced features like welded-on edges, pattern welding or heat treatment were observed through the X-ray investigations of Danish single-edged swords from the Merovingian and early Viking periods (Nørgård Jørgensen 1999). They have a straight back, and the edge curves to the tip without metal hilts, similar to the Norwegian type R 498. Our premise is that such Norwegian swords were of the same technical standard, in accordance with Solberg's results for spearheads of her type groups V.2 and 3 from the 8th century, which she sees as indigenous (1984:47–51).

The radiographs of C-type swords, the earliest indigenous hilt type, are generally in accordance with this. Eleven C-type swords were single-edged, and of these nine specimens show no signs of advanced techniques; one has a distinct and one an uncertain welded-on edge. The former is C.24217, which is pattern-welded. Only three have double-edged blades, one with and two without welded-on edges (Table 7.1).

The pattern-welded C-type swords

Before discussing the development of welded-on edges based on the radiographs, the pattern-welded single-edged swords deserve special attention. A few more are known from Eastern Norway, another four from Sogn and Fjordane in Western Norway, and five in Trøndelag (Moberg 1992:145, Stalsberg 1988:16ff). It is likely that more will be discovered through radiograph examination.

Of the Sogn examples, one blade is not a usual blade type with a straight back, and is probably not indigenous (B 1184), which may be the case for other items too. Of the others, two have C-type, and one E-type hilts. Of the Trøndelag specimens, three have H and one H/I-type hilts, while the last one has a Norwegian F-type hilt. Pattern-welded single-edged swords have emerged over a large part of Southern Norway, indicating that a small number of Norwegian weaponsmiths mastered this technique in the 9th century, although more precise dating is not possible. The Trøndelag finds are not from the earliest part of the century. Internal production is supported by a very small number of pattern-welded type group VI.2 spearheads, interpreted by Solberg as indigenous (1991:250–252). Moreover, some pattern-welded double-edged swords were also probably indigenous.

The most interesting question arising from this is how this technique came to be practiced in a society that most likely was unfamiliar with advanced smithing techniques. It can be learned only through practice under the tutorship of an experienced person. One possible answer is that such experienced and attractive weaponsmiths were brought to Norway by Vikings, perhaps as hostages. Another possibility is that weaponsmiths who took part in Viking raids had the opportunity to learn advanced techniques abroad.

In order to study the development of advanced smithing techniques, we will start with the increase in welded-on edges (construction type III) detected on radiographs. Table 7.1 summarises the results for swords with the indigenous hilt-types C, M, Q, X and Æ, split into single and double-edged blades, and including H/I types as a contrast. In Table 7.2 we have separated the four Telemark regions to find differences between them. The numbers are, however, too small for more than indications.

Table 7.1. *Interpretations According to Types*

Hilt type	**Single-edged**				**Double-edged**			
	Number	**Interpretation**			**Number**	**Interpretation**		
C-type	11	1 A	1 B	9 0	3	1A		2 0
H/I-type	5			5 0	10	2 A	2B	6 0
M-type	21		1 B	20 0	29	4 A	7 B	18 0 + x
Q-type	4		1 B	3 0	22	9 A	2 B	11 0
X-type	0				7	3 A		4 0
Æ-type					2	1 A		1 0
Total	**41**	**1 A**	**3 B**	**37**	**73**	**20 A**	**11 B**	**42 + x**

Table 7.2. *Interpretations According to Types and Regions*

Region	Number	1A	1B	0	Number	1A	1B	0
C-type								
Grenland	3			3	1	1		
Øst-Telem	6	1		5	0			
V-Telem	1			1	2			2
SV-Telem	1		1		0			
Total	**11**	**1**	**1**	**9**	**3**	**1**		**0**
H/I type								
Grenland	3			3	6	1	2	3
Øst-Telem	0			0	2	1		1
V-Telem	2			2	1			1
Sv-Telem	0				1			1
Total	**5**	**0**	**0**	**5**	**10**	**2**	**2**	**6**
M-type								
Grenland	10			10	18	4	4	9+ (1un)
Øst-Telem	2			2	1			1
V-Telem	8		1	7	8		3	5
SV-Telem	1				2			2
Total	**21**		**1**	**19**	**29**	**4**	**7**	**17 +1un**
Q-type								
Grenland	1			1	5	1		4
Øst-Telem	2		1	1	2	1		1
V-Telem	0				15	7	2	6
SV-Telem	1			1				
Total	**4**		**1**	**3**	**22**	**9**	**2**	**11**
X-type								
Grenland	0							
Øst-Telem	0				3			3
V-Telem	0				4	3		1
SV-Telem								
Total	**0**				**7**	**3**		**4**
Æ-type								
Øst-Telem	**0**				**2**	**1**		**1**

In order to measure the influence of the practice of pattern welding found on single-edged C-type swords on indigenous blacksmithing, the M-type swords are important. Their production started around 850 AD, while C-type swords were still in use, and it is natural to see the M-type as their immediate successor. None of the 50 M-type swords from Telemark were pattern-welded, and this corresponds to Moberg's results for the 19 M-swords from Sogn and Fjordane (Moberg 1992:105). However, it ought to be remembered that only a small part of the Norwegian M-type swords have been X-radiographed.

The majority of the Telemark M-type swords are most likely from the 10th century, and the pattern welding technique with twisted rods went out of use c. 900 AD, a change that was not sudden over a large area. If the pattern welding technique was spread to many Norwegian weaponsmiths in the 9th century, one would expect to find it on some of the 69 X-radiographed M-type swords.

Welded-on edges do appear on several M-Type swords, possibly as the earliest indigenous sword type (Table 7.1). All four with a certain interpretation (A) were found in the Grenland area, and Astrup found

that one of them was also carburised and quenched. Four out of seven with uncertain (B) interpretations were also found in Grenland. Three more out of seven with uncertain interpretations are from western Telemark, such as the single-edged specimen.

Grenland is a large area, and the swords with A and B interpretations were widely distributed within the area. Of those from western Telemark, three were found in the Lårdal concentration and one in Seljord.

The M and Q-type swords were contemporaneous, the Q-type coming into use c. 900 AD and lasting throughout the century. The variant P 110 was developed directly from the M-type (see Chapter 4), while P 111 was influenced by hilts like the R and S-types.

When the M and Q-types are seen together, a development in blade types and construction can be plainly observed. Single-edged blades went out of use during the 10th century, and even though welded-on edges are rare on these blades, this does not necessarily mean that all such blades were of construction type I. One must always make allowances for which construction types can be detected on radiographs.

On the other hand, the frequency of welded-on edges increased markedly from M to Q-type blades, as did carburisation and quenching. This is the case for the Q/X type sword from Porsgrunn, and the Q-type sword from Bø. One blade from Vinje (15) and one from Tokke (17) with welded-on edges were carburised, but not quenched.

7.2 COMPARISONS OF SWORDS WITH OTHER HILT-TYPES

It is interesting to compare the C and M-type swords to the H/I ones. The earliest H-type hilts were made before 800 AD, but they lasted into the 10th century, and the I-type is a later development of the H-type.

The H-type had a wide distribution outside Norway and was certainly not of Norwegian origin. It is the most numerous type found in Norway. Out of 194 specimens, 73% are double-edged and 27% single-edged (Petersen 1919:89 and 94). Most likely, many of the sword blades of both kinds were produced indigenously. Even inlay decoration, which is common on these hilts, can be made locally, but no conclusions on this point can be drawn without special investigation.

In Telemark, the number of finds has doubled from eight to 20 during the last hundred years. Only five are single-edged and 14 double-edged; on the last one only the hilt was preserved. Of these, four single-edged and ten double-edged have been X-rayed. None of the single-edged objects had welded-on edges, and of the double-edged objects, one has distinct and two have uncertain welded-on edges. The other six, including the one with the remains of an inscription on the blade, showed no traces of welded-on edges.

We have compared our observations to Swedish ones. Interpretations of the large number of radiographed H/I-type swords from different parts of the country for the Helgö investigations are presented (see Tables 3, 6, 9 and 10 in Thålin-Bergman 2005). All the Swedish swords were double-edged. One such sword was selected for metallography, SHM 8974, Hedesunda (Thålin Bergman 2005:92–94). The blade structure is of great interest to our investigation.

> The illustrations show that the same type of material was used throughout the whole blade. There is no pattern welding … Figures 3–15 show the microstructure. The dark areas consist of a very fine pearlite in which individual plates of cementite in ferritic matrix do not show up at this magnification. The light areas consist of ferrite.
>
> Figures 3–15 show the rather uneven distribution of the pearlite. The microstructure did not indicate any obvious differences in alloy content … In Figures 5–8 clear streaks of non-metallic inclusions show up as dark, almost ribbon-shaped areas.
>
> Figures 13 and 14 show the cutting edges. They do not appear to have been treated in any special way. Testing with a 5 kg weight gives the following Vickers hardness values: HV 78, 74 100 and 101. HV 101is from very near to one edge. The hardness is evidently not very high. [Modin and Modin in Thålin Bergman 2005:92–94]

The sword belongs to construction type I, like the H-type sword Met.No. 16, with the remains of an inscription on the blade. Another important point to be gained from the Swedish tables is that quite a few swords with inscriptions did not show any traces of welded-on edges or other advanced techniques. Other H/I-type swords have welded-on edges and some are pattern-welded. X-ray photographs of a greater number of Norwegian H/I-type swords would probably reveal the same variations.

The most distinct difference between the C-type and the H/I-type swords from Telemark is the number of single-edged and double-edged blades. This is due partly to the H/I swords being in use for a longer period, since the frequency of double-edged blades increased during the period, and due partly to their different origins.

7.3 OTHER BLADE CONSTRUCTIONS

The other blade construction verified on metallographically investigated swords is construction type II a–b with an outer steel coating. IIa was found on two M-type swords from Skien (1 and 2); none were more precisely datable. Construction II is not detectable on X-rays, and so there are probably more M and Q-type swords with this construction.

Construction type IIb was found on two, possibly three, blades with X-type hilts (Met. Nos. 13, 14 and possibly 12), all from Tinn. The X-type swords were widespread in Europe, and certainly not of Norwegian origin. Outside Norway, several blades have ULFBERHT inscriptions (Stalsberg 2008). In Telemark, there are few X-type swords, only six or eight. Some of them have very high lower guards.

The Tinn specimens are of special interest. Swords 12 and 13 are part of the Mårem find C.29700 with two sets of weapons, and both spearheads have fishbone inlay patterns (Ge 1) on the socket. Sword 14, from Vestfjorddalen in Tinn, has an inlay pattern on the hilt, forming open rhombi, a pattern which was found only on this sword (Figure 3.4). Taken together, these swords and spearheads are most likely of indigenous fabrication.

The two metallographically examined swords with possible type IV construction were too few in number, with insufficient information for further comment. Also sword 10, construction type V, was not of Norwegian origin.

With the introduction of Solberg's VII.2A spearheads (Petersen's type I), a new set of fully developed elements appears on the blades: patterns consisting of plain and serrated V-shaped strips between the centre and the edges of the blades, and cross-sections with concave sides meeting in a marked keel. VII.2B, a very numerous type, contains the same elements, and both subtypes, as well as VII.2C can have inlay decorations on the socket. These spearheads were very widely distributed in Northern Europe and were not Norwegian in origin, but they were very likely produced in highly specialised workshops in Norway (Solberg 1984:112–13).

Solberg's X-radiograph studies revealed that the three decorated spearheads from Byggland were forged with plain or serrated strips (PW1 and PW3), and she used them as support for indigenous mastering of this advanced technique (see figure 3.5). We can add to this that six or seven of the other decorated items from Telemark were made with such strips, and they are in fact very common on Norwegian spearheads (Solberg 1984:Table 11).

In summary, we find that at the beginning of the Viking Age the majority of weaponsmiths most probably mastered only simple techniques, working with low carbon and heterogeneous wrought iron during most of the 9th century. The pattern-welded single-edged blades contradict this viewpoint, but they do not seem to have had any long-lasting impact on development, and may be examples of "production secrets" dying with their creators. The H-type swords are also intriguing, having partly imported and partly indigenously made blades. A special investigation of these factors, as well as of the inlay decorations on the hilts, is necessary.

Another interesting feature is the decoration on 9th century F-type (Solberg VII.1A–C) spearhead sockets. A large part of this indigenous type was decorated with horizontal circles in elevated areas on the socket. Solberg believed the decoration to be have been made on a lathe, thus in specialised workshops. Based on detailed studies of such sockets, another technique, drop forging, is more likely (personal comment V. Vike). This also a specialised technique.

Several more advanced blade constructions (II and III), as well as smithing techniques, came into use in Telemark in the Viking Age. Exact dating is difficult, and they were not necessarily introduced together. Most likely, the innovations took place shortly before or around 900 AD, or during the 10th century.

Pleiner categorises all the techniques found within construction types II and III: carburisation, forge welding of iron and hardenable steel, steel shells, and heat treatment as advanced smithing. On the basis of this definition we can conclude that advanced techniques were commonly utilised by weaponsmiths in Grenland, eastern and western Telemark, from the 10th century onwards, while not found in the southwestern region. The number of finds there is too small to draw any conclusions. The distribution of construction types II and III within Telemark indicate that the innovations came into use first in Grenland, but were subsequently spread to other parts of the county.

Strip welding, pattern welding and locksmithing are ranked among top techniques. Strip-welded spearheads, several with inlay decorations on the socket, were frequently found by Solberg on her spearhead types VII.2 (Petersen I and K), and she states that they represent highly specialised manufacturing (1984:170). Locksmithing is also interesting, since remains of keys and caskets, including padlocks, have been found in several Norwegian Viking Age graves, including the Byggland find (Petersen 1951:448ff; Kaland 1972:125ff). Some top technique elements

were most probably practiced in Telemark by a limited number of blacksmiths, and it is likely that the standard in Telemark was representative for other parts of Norway.

Placing our results into Pleiner's divisions of simple, advanced and top techniques is not a straightforward task. Pleiner only considers iron smithing, while inlay decoration techniques are not dealt with. These certainly required specialised skills, though the degree of advanced techniques needed lies beyond our competence to judge. The patterns vary so much in fineness as to indicate that a diversity of skills may be needed.

7.4 LOCATION OF SMITHIES

Efforts to locate smithies must be limited to those where top technical procedures and inlay decorations were employed. The more numerous ones where advanced techniques were used cannot, at least at this stage of research, be located.

The most specialised ones were attached to centres/central farms. Even though blacksmith graves have often been found outside such places (as discussed in Chapter 3), no centres have been excavated or localised in Telemark, though some probable ones have been pointed out in Chapter 2. The location of smithies is thus part of a much wider set of challenges. However, our results can still help to identify one localisation feature: a concentration of probably indigenously made weapons using top techniques within a limited area.

Our results enable the identification of three areas: Grenland, Tinn and western Telemark. All basic finds belong to the 10th century, but no attempt was made to look for long-lasting traditions.

In the large area of Grenland, there were certainly several centres/central farms, though archaeological finds are not very numerous, except for Gjerpen in Skien, bordering on and formerly a part of Vestfold. In the Telemark material, Grenland stands out as an innovation area, and in spite of a lack of any distinct weapon finds, several relevant finds in Gjerpen close to the border area of Vestfold (Larvik) suggest the existence of a specialised smithy.

The situation in Tinn is different. Swords number 25 in total, including in some cases only a guard or small fragments of the blade. The stock comprises an unusual number of swords of various types with hilt decorations (Martens 2009).

Astrup's investigations consist of five swords from Tinn (swords 10–14), and except for sword 10, they are interpreted as indigenous products. Notably, two of them have blade construction IIb (swords 13 and 14), while sword 12, which is from the same grave as sword 13, is the only one made of iron rich in phosphorus.

Two swords with decorated P-type hilts, not a numerous type, were found in Tinn. The type lacks a pommel and usually has vertical fishbone pattern (Ge 1) inlays on the guards, a pattern which, as far as we know, is unique to P-type sword hilts. Sword 14 also has an unusual (reconstructed) inlay pattern with open rhombi (Figure 3.4) on the hilt.

Type group VII.2 (Petersen I and K) spearheads from Tinn number only five, but all have plain or serrated strips in the blade. Two of them, from the large find C.29700 have the inlay pattern Ge 1 on the socket, and a third find with such inlays came from the same farm as sword C.23364 (Met.No. 14). A fourth spearhead, a mountain find, has a Ge 2/3 decoration.

Taken together these features are strong indications of specialised smithing traditions in Tinn in the 10th century. Two farms had central positions: Mårem by Lake Tinnsjø is strategically placed in relation to mountain hunting grounds; and Såem-Bøen, in Vestfjorddalen, is similarly placed in relation to iron extraction sites in side valleys and at Møsstrond. There is also a soapstone quarry, Bøuri, very close by. Tinn certainly had the economic basis for an advanced smithy with top-level knowledge and skills.

Again, the situation in western Telemark is different from the other two areas. Here sword types M and Q dominate, with 16 and 18 specimens respectively. Only two Q-type swords were subjected to metallographic examination, and both blades were construction type IIIa, but without quenching.

The many spearheads with inlay decorated sockets, in the area centred around the Byggland find, lead Blindheim to conclude that they were all made in the same workshop, or at least within the same tradition (Blindheim 1963:51). Solberg found through radiographs that plain and serrated strips on spearheads were very common, mostly of her type group VII.2 (Petersen I and K), and also that they appear to have been produced by Norwegian smiths. Her strongest proof was the Byggland find containing three spearheads with such strips and inlay decorated sockets (Solberg 1984:179). The studies carried out here, showing that inlay decoration patterns reveal regional variations, further support the idea of indigenous mastering of strip welding and inlay decorations in the 10th century. The premise is that a specialised smithy with top technical skills was located in the central part of either Seljord or Kviteseid (see Chapter 2). The distinct differences between Tinn and western Telemark were probably caused by differences in geographical, economic and social conditions.

7.5 FOREIGN INFLUENCES

The advanced smithing techniques employed in Norway in the Viking Age were widely distributed throughout Europe, and thus were certainly due to foreign influence. Construction type III with butt-welded-on edges were commonly used on pattern-welded swords in the previous period, thus tracing the origin of this construction is not relevant here.

There are very few metallographic investigations available to compare non-pattern-welded blades, prohibiting a detailed discussion. The most interesting one includes 16 swords from graves in Mikulcice, one of the main centres of Great Moravia, the first Slavic state north of the Danube, covering approximately one hundred years in the 9th and beginning of the 10th century (see Chapter 5). Except for one sword lacking guards, the rest fit into Petersen's typology very well. Four swords are pattern-welded, types K (2), H/I and X respectively. The other ones, types H (1), N (2) and X (8), have butt-welded-on edges, but varying constructions of the central parts. The last sword, X-type, consists mostly of iron with some steel along the edges. Most of the blades show traces of quenching.

Another pertinent investigation is Gilmour's study of Viking Age swords from England. The number is small and type determinations problematic, but some belong to well-known types. Of the 13 relevant swords, seven are pattern-welded. Remarkably, most of the blades, independent of whether they are pattern-welded or not, show blade constructions differing from the usual butt-welded-on edges. One sword, possibly with an X-type hilt, has an all-steel blade like the one (Met.No. 10) from Tinn (Gilmour 1986).

These two investigations indicate – not surprisingly – that there were several distinct smithing traditions in Europe, and that they probably were of long duration. One cannot draw any conclusions from just two investigations, but they certainly raise some interesting questions, including a challenge to the "well-established truth" repeated over and over again that the Carolingian Empire was the central area for advanced swordsmithing.

The problems relating to the origin and production of Viking Age swords are relevant for all European countries where such swords were found. The problems are complex, since production places were far more widespread than places of origin. Differences in blade constructions and smithing techniques can add valuable information to the discussion, and highlight the necessity of analysing smithing techniques for both blades and decorations.

Jiří Kosta and Jiří Hosek are cautious when discussing the technical skills of great Moravian weaponsmiths, and question whether they were capable of producing high quality swords. Pleiner, on the other hand, states that the blacksmiths in Great Moravia learned to apply advanced techniques involving iron and steel welding in various construction schemes and heat treatment (Kosta and Hosek 2014:294ff; Pleiner 2006:237).

There are good reasons to question the place of origin for several hilt-types. There is a strong tendency – one may even call it a well-established truth – that inlay-decorated hilts from the 9th and 10th centuries are Carolingian, taking for granted that they originated and were spread from the Carolingian realm and its successors.

Studying pattern types in combination with the distribution of the their hilt-types has convinced me that it is high time to question this. There is no doubt that the geographical area of the Carolingian realm had a central position in advanced weapon production in the 8th and 9th centuries. Inlay patterns were varied, comprising tendrils, often in combination with vertical stripes as well as geometric patterns (Menghin 1980; Müller-Wille 1976, 1982).

When and where were the inlay techniques embraced in other parts of Central and Northern Europe, and were they spread along with top blade-smithing techniques? Fully answering these complicated questions lies beyond the scope of this study, and only some brief arguments are presented here, starting with the distribution of 10th century decorated hilt types.

Starting with Geibig (1991), he leaves out several of Petersen's types because they are not found in former West Germany. They are D, E, T, V and Z. He puts R and S together in his combination type 10, but the inlay patterns are very different (Martens 2004:Figure 8). His distribution map Abb.44 shows that the few R and S swords from West Germany were found near Hedeby (and the one in Hamburg, Müller-Wille et al. 1970, 1973). Geibig states that "… lässt sich im Gegensatz dazu feststellen, dass bei im fränkischen Raum gefertigten Gefässen offenbar recht früh, d.h.im Laufe des 9. Jahrhunderts, gänzlicher auf Dekor verzichtet wurde" (1991:138).

This is in accordance with Stalsberg (2008, Table 1), who includes all ULFBERHT swords she has managed to trace. The German specimens have mostly X and Y hilts, while decorated hilts of the types relevant here are lacking. Considering the five Hulterstad sword blades (Thålin-Bergman 2005:49–51), there are strong indications that ULFBERHT blades could have been

distributed without hilts, and that such blades cannot be used in discussions of the origin and production sites of 10th century decorated hilts.

The relevant hilt types were widely distributed in Central and Northern Europe (Chapters 3 and 4) and their origins must be sought outside the Carolingian Empire. In addition, this is a relevant problem for some earlier hilt types too, among them the H-type, which is the most numerous one in Sweden and Finland (Androshchuk 2014: List 1; Kivikoski 1973:112 and text Tafel 94: 831–32). One can also mention that the 9th century types also include the E-type, which developed into the T-type (pattern Ge 5). The E-type has a pommel with a rounded top, while the T-type, as well as the R, S and Z types, have nearly globular sections (see above Chapter 4).

The D-type is in several ways an enigmatic one. The hilts are made by means of a special technique, normally with two pattern layers: a lower one with bronze or copper, and an upper one with silver decoration. The cross-section of the pommel is convex with a rounded top.

These features are good indications that these types originated outside, probably east of, the Carolingian Empire. Political units with strong centres such as Great Moravia were potential areas for innovation of new types and for adapting technical skills.

7.6 CONCLUDING REMARKS

Weapons are only one category of items, but certainly an important one, in the research on European culture and relationships in the Viking Age. The development of weapon production in Norway relied on a combination of indigenous conditions and foreign influences. The great number of swords and spearheads found in a country with generally sparse settlement and few centres compared to most European countries, can illuminate production conditions in other countries as well.

The collaboration of two researchers from such different disciplines as chemistry and archaeology has been a continuous learning process for both of us. From the very beginning, the technical investigations attempted to elucidate archaeological problems, but during this process our mutual understanding of the broader elements inherent in detailed technical investigations developed considerably. Looking back, one very important lesson is that collaboration should start with a specified project plan, a necessity for enabling the selection of items for metallographic and other technical investigations. If our investigation can trigger new, advanced research on Viking Age weapons in Europe, then one principal aim of our study has been achieved.