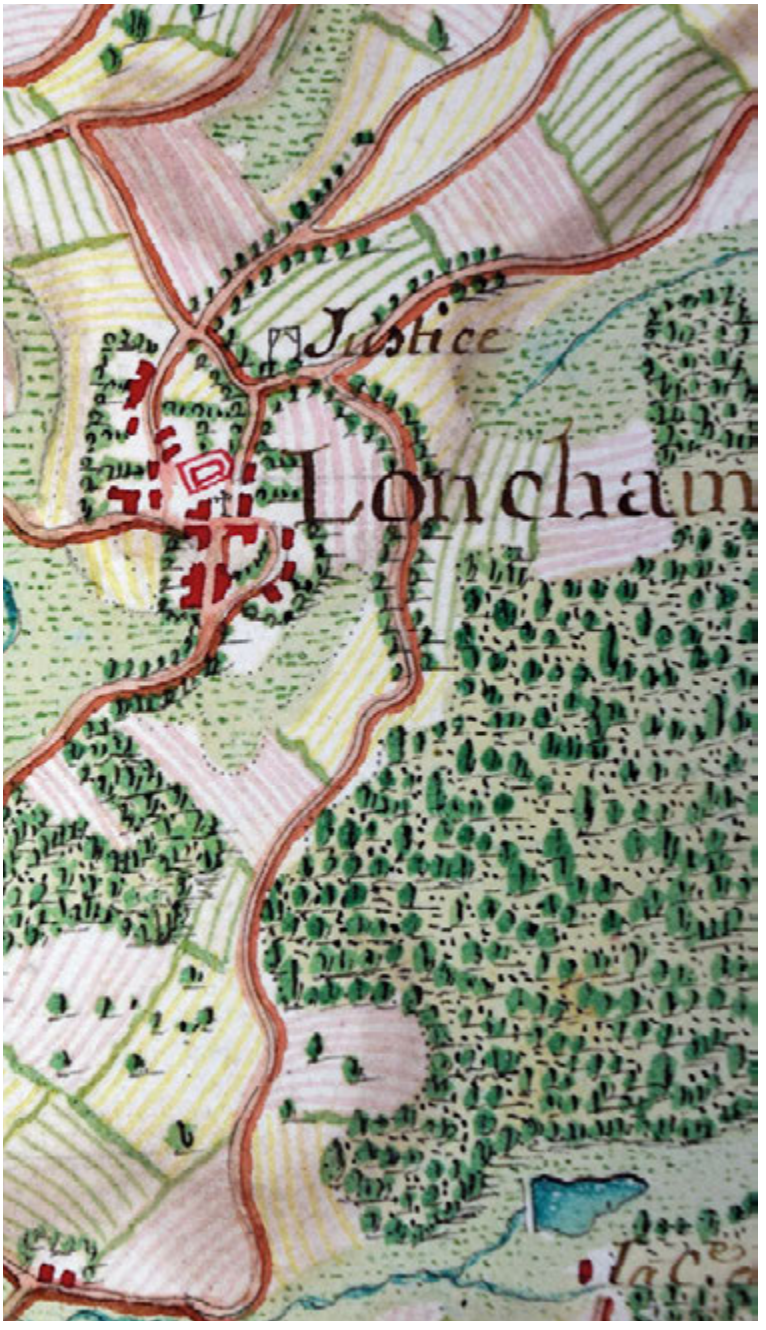
Beata Medyńska-Gulij and Tadeusz J. Żuchowski

European Topography in Eighteenth-Century Manuscript Maps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Flat as the table
It's placed on.
Nothing moves beneath it
and its place doesn't change.
Above – my human breath
creates no stirring air
and nothing muddies its pure colors.
...
I like maps, because they lie.
Because they give no access to the vicious truth.
Because great-heartedly, good-naturedly
they spread before me a world
not of this world.

Wisława Szymborska, 'Map'

From the primal version 'Map' published in the 'Tygodnik Powszechny', 6th February 2012. The last poem by the recipient of the 1996 Nobel Prize in Literature, Courtesy of the Wisława Szymborska Foundation, translated from the Polish by Clare Cavanagh

Contents

1. Introduction

The subject matter addressed in this book is the result of new research on eighteenth-century manuscript topographic maps. The research was conducted from a variety of perspectives: studies concerning cartographic and graphic communication; of history and culture; as well as of art in relation to the technology of map production. Traditionally viewed, map content includes landscape elements such as particular field objects (e.g. roads, housing areas or rivers) and landforms, recorded on an appropriate surface, predominantly paper. The maps analysed here were studied in relation to the various ways in which topographic space was recorded in eighteenth-century Europe. Topographic maps usually comprise a multi-element work consisting of a number of map segments from over a dozen up to a few hundred. Topographic maps are not only valuable historical and cultural sources, but also – a fact which has frequently been forgotten – works of drawing and of art. In this perspective, maps may allow for a more precise understanding of the ways that European space was perceived and recorded.

The maps analysed here resulted from collective efforts made by military topographers, who used broadly similar survey and observation methods, and draughtsmen employing equivalent materials and drawing techniques. It is for these reasons that this study so strongly emphasizes the artistic quality of the maps. Draughtsmen made preliminary

graphite-pencil field sketches, later to produce fair copies of maps using Indian ink or watercolours inside their studios. Research into these drawing techniques has played an important role in determining the specificity of cartographic communication, and in understanding the role of maps in visual communication historically and culturally, as well as in understanding their aesthetic and utilitarian significance.

Were we to put all the sheets of the topographic maps here analysed together, we would create a consistent picture-albeit with some blank spots – but one including several countries and regions, (i.e. Bohemia, Brandenburg, England, Hungary, Lorraine, Lower Saxony, the Netherlands, Piedmont, Pomerania, Scotland, Sicily, and Silesia). In part and as a whole, this is a visual record of the eighteenth-century European *habitus*. These maps should be treated, we argue, as a unified representation of European topographic space. At the same time the maps are astonishingly visually attractive with their distinctive, individual features stemming from the local landscape and cultural specificity of each region, and the graphic styles developed by particular authors.

The research presented here expands our knowledge of the history of drawing in the Enlightenment in two specific ways. First, it emphasizes the role played by both the theory of cartographic drawing and the scientific approach to mapping in the development of eighteenth-century drawing techniques. The texts analysed as a central feature of this study show this to be so. Another aim was to reconstruct the map-drawing process from the in-the-field graphic recording performed during observations, reconnaissance survey or plane-table drawing to the completed version. This research shows how specifying dash-, dot- or line-based graphical means of expression as well as methods for colouring outlined shapes or strengthening contours with broad colourful strokes were of fundamental importance in this period. Secondly, this study aims at recognizing and organizing both the general and individual graphical means of expression that proved decisive in giving character to specific particular maps. After all, as we show, these maps constituted work by specific teams of topographic draughtsmen and so reveal their authors' artistic predispositions.

The maps analysed here were developed in the Enlightenment – broadly, the 'long' eighteenth century – when the perception and recording of geographic space became closely connected with authors' education and professionalism, in greater geographical understanding, and in draughtsmen's cosmopolitan views and military organisation (Withers 2007). Of key significance was the fact of military engineers' service to 'enlightened' commanders and the monarchs of different countries, and, often career changes in terms of their place of service. The resulting transfer of knowledge and professional skills – exceptional in its nature – produced general trends for topographic-map-making evident throughout Europe. The significance of this phenomenon has only been understood by researchers in the last decade.

Although the history of military cartography had long been a subject of study, the practice itself was thoroughly recognized and understood for Napoleonic period. This was a period when military victories could be depend upon accurate information necessary for tactical decision-making (Black 2009). Mapping was part of the development of new directions in military doctrine (Svenningsen 2016). Maps functioned as an important medium for solving various military problems (Engberg-Pedersen 2015). The history of military cartography in earlier modern times has in turn become a subject of research only recently, especially of studies focusing on the main responsibilities of military engineers that included constructing fortresses and fortifications, and preparing battle plans, although initial country-specific analyses related to military cartography have also appeared (Franchini 2008; Military Engineers 2013; Cámara Muñoz 2016). Much of this research has concentrated on *architectura militaris*. The amount of paper used in the eighteenth century for developing fortress and fortification plans greatly outweighed the amount of material devoted to producing manuscript topographic maps.

The importance of the political context to topographic maps has been recognised in a exhibition catalogue on the cartography of Savoy (*Il teatro delle terre* 2006). This catalogue is noteworthy also because of the presentation of the eighteenth-century topographic maps alongside

contemporary photographs of the same landscape and abstract works of art. As a result, the relationship between cartographers' practice and the artistic aspects of their work, as well as the role of aesthetic experience gained while reading maps, has become clearer.

In all the above studies, little attention has been paid to graphic techniques: if such techniques were considered at all, it was usually to specify the main colours used to represent woods or forests, rivers, settlements, etc. (d'Orgeix 1994). Only some exhibition catalogues include basic information concerning the technique, e.g., 'pen, wash and watercolour over graphite' (Bonehill and Daniels 2009). The aesthetic quality of maps has usually been associated with their design, as topographic maps which articulate aesthetic values inspired by different landscapes (Harley 1991; Kent 2005). Research on the relationship between art and historical cartography has also concentrated on problems related to decoration in the latter; a question of the drawing techniques used to produce manuscript maps has been however overlooked (*Art and Cartography* 1987; Verdier and Besse 2019).

The research presented in this study has wider significance for cartography viewed as an independent field. The still-dominant notion of cartographic communication theory (Koláčný 1969; Ratajski 1973) played the key part in determining the research methodology regarding semiotic questions – that is, syntactic, semantic and pragmatic relations (Bertin 1967; Freitag 2001). Our analyses include attention to the pragmatic aspects of cartographic works. Pragmatics in cartography may be understood in both a practical and a more limited sense pertaining to semiotics. According to Morris (1971), the pragmatic is the relationship between the sign and the interpreter, and concerns in particular the problem of how the intended designation is understood by the perceiver. Freitag (1971) associated the research area of pragmatic cartography with the map's function as a vehicle for information.

The military function of eighteenth-century topographic maps did not, however, constrain drawing techniques to produce only certain variations of sign or symbol. Quite the contrary – it provoked cartographers to develop a new system of symbol design with a diverse use of

colour. Establishing the principles of graphic design necessary to create geographic space visually has always been one main goal in understanding cartographic design (Robinson et al. 1995; Dent 1999). A significant part of cartographic research concerns the connections between graphic techniques, perception theories and the artistic dimension of cartographic images (Woodward 1987; Goss 1994). Perception studies, taking a holistic view of different map segments, are especially fruitful in that respect, and include key issues about colours in relation to issues of harmony, contrast and associations, as well as the colour-use conventions employed in maps (Robinson et al. 1978; Dent 1999; Arntson 2003; Koch and Medyńska-Gulij 2013). This field of research has drawn methodological inspirations from work in the history of art, i.e. psychology of perception, symbolic understanding and representation of space, and from semiotics (Arnheim 1965; Panofsky 1991; Eco 2003).

Art history has mostly situated maps, including the manuscript topographic maps analysed here, outside of its interests. One main reason for that is Gombrich's definition of a map as a visual object devoid of creative potential (Gombrich 1984). This unequivocal perspective resulting in the elimination of maps from the scope of art history has only been challenged recently in texts by Braedekamp (2005, 2007, 2015), who focused on scientific illustrations. Even so, maps by themselves do not constitute a separate research subject within art history, and awareness of the unique character of the eighteenth-century manuscript topographic works has as a result remained low. It is worth noting, however, as early as 1923, Meder, a specialist in the field of drawing, appreciated the contribution of eighteenth-century cartographic treatises to the development of artistic drawing. More recently, Kemp (1990) emphasized the significance of eighteenth-century engineering knowledge – especially French and German – to the accuracy of perspective in painting.

There is a further unique quality to manuscript topographic maps. These works, executed by topographer officers by order of their monarchs and for military and administrative purposes, usually remained confidential for years and, usually, there was only one fair copy of each map. These conditions – of secrecy and uniqueness – contributed to the

lack of information about these maps among cartographic researchers until the early twentieth century. What was more, a considerable part of this manuscript cartographic output was analysed and described only as late as the mid-twentieth century, and some items is still await for proper study. Although the most important collections have now been carefully researched, some analyses have been restricted only to factual information (we review the literature related to the descriptions of particular works in Chapter 3). The specific nature of the maps has sometimes discouraged researchers from producing synthetic studies of the subject as a whole. Thus, the phenomenon of manuscript topographic maps and their cartographic language presents opportunities for in-depth studies: this book is an important but partial contribution.

Taking into consideration visual attractiveness means also paying attention to the aesthetics of the map as well as to various graphical means of expression characteristic of different 'schools' of cartographic drawing. This consideration refers also to the practical use of different graphical means of expression as they represent geographical features on the map. This, in turn, is connected to the idea of holistic representation in cartography inspired by gestalt theory (Medyńska-Gulij 2013). Graphical means of expression in map making are those elementary components of graphical procedure used by cartographers to represent geographical features using specific tools, materials and principles of map design. These are closely connected with the drawing tool, the liquid used, and the method of publication.

In relation to these issues, we have sought to construct the first consistent visualization of European topographic space. It did so thanks to the role of observation and accuracy and recording for military and administrative purposes, and because such work enabled the presentation of common and distinctive features of European countries and regions. To achieve this consistent visualisation, it was essential that we accomplish several complementary objectives and tasks. These included:

- Research over 30 multi-segment (multi-sheet) manuscript topographic maps produced in Europe in the eighteenth century and displaying areas located in the continent;

- The development of a research method applied to manuscript topographic maps taking into consideration the methodologies used in cartography and in the history of art;
- The establishment of criteria describing the features of manuscript topographic works;
- The determination of the specific circumstances under which topographic maps were created – from the pan-European perspective and with regard to cartographers' artistic education and draughtsmen's role in the map-making process;
- An awareness of such aspects as graphical means of expression, drawing techniques and the specificity of map draughtsmen's education. These issues have so far remained outside art historians' reflection – if they were addressed at all, they were narrowed down to singular maps rather than considered in relation to the map-making phenomenon as a whole;
- The identification of style-related differences between manuscript maps that stemmed from the work of individual draughtsmen who represented different artistic environments, notwithstanding the fact that such work was a part of a shared mapping system and obeyed similar topographic-map making principles;
- The descriptions of particular examples of maps or their segments, taking into consideration the map-drawing methods used and the degree to which the fair copy was depend upon the initial survey sketches;
- The determination of the graphical means of expression used for manuscript map-making based on specific tools, techniques and pigments;
- The identification of the features typical of various topographic-map-making schools according to the graphical means of expression and any shared and individual characteristics (that is, how far it is possible to personalize the distinctive features of cartographic artists and draughtsmen).

In this book we first consider the circumstances of the development of topographic geography in relation to eighteenth-century geopolitical

events, the functioning of engineer corps and the work of topographers in European rulers' courts (Chapter 2). This is followed by the description of the field mapping process and the determination of the nature of topographic works (Chapter 3). In Chapter 4, based on textual and cartographic sources, we discuss the uniqueness of European cartographers' education in drawing. From this perspective we have provided an overview of the most important institutions responsible for the process of map drawing and elaborated on the drawing techniques and materials used in eighteenth-century map-making. Chapter 5 justifies the criteria employed and, here, we select the eleven topographic works whose origin and features are described in detail in Chapter 6. In this way we offer several research perspectives on an wide range of topics and show the stages of development of each selected topographic image. This allows us to reflect on the graphical means of expression (Chapter 8).

It is worth emphasizing that because of the lack of comparable studies, one major challenge lay in presenting the principal issues from the angle of the analysed objects themselves, and, simultaneously, to specify the main changes in tools and materials used in eighteenth-century drawing and cartographic production. Without this knowledge, and without understanding of the educational systems and practical matters, our study of the selected eleven maps would appear to be in something of a vacuum, and their drawing (linearity) and painterly aspects, viewed here as distinctive means of artistic expression, would seem only isolated, even vague. In fact, they constitute key factors determining the specificity and individuality of the maps and allow us to capture the styles and manners of distinct schools or, even, individual authors behind the development of eighteenth-century manuscript topographic maps.

Additional work has involved producing 3D digital models of selected fragments of the eleven maps using geoinformation technology. This enables users to view the flat surface of a map from a given perspective or a specific point of observation, with adjusted altitude regarding the landform thus presented. The development of multimedia visualisation allowed us to examine the details represented on the eighteenth-century originals and to compare the 3D model with the field survey records

from the same location. We decided to confront the 'flat' graphic work developed on sheets of paper with the natural perception of land topography from the perspective provided by multimedia visualisation. In doing so we have sought to capture the significance of contemporaries means of expression as they used it to represent natural or associated colours. In these ways, our research has gone beyond the traditional examination of topographic fidelity and cartographic realism to find inspiration from the interdisciplinary, historical and anthropological studies of 'mapping' (Jacob 2006).

2. The development of topographic cartography

Topographic cartography: its subject matter and outcome

The substance of cartography – understood as the art, science and technology of map-making (ICA 1973; Robinson and Petchenik 1975; RHoMaC 2018) that are together supposed to produce a map of a particular territory – depends on various factors. A map is a special example of a graphic work of art. Topographic mapping, executed with high precision and covering large areas, requires specialist knowledge to perform the task (Harvey 1980). Because this is so, studies of topographic maps should in turn demonstrate the connections between the map's components and the context to its production. The present research considers those map-making processes which resulted in manuscript cartographic works as particularly significant.

The watercolour painting of 1720 by John Henri Bastide (Fig. 1) aptly captures the core of topographic work, i.e. the cartographer, the subject of his study or survey – a landscape with topographic objects, a particular setting, and its result – a map. The map maker (here seated, sketching) is wearing a uniform which suggests his military status. His other accoutrements include a sheet of paper in his hand and drawing utensils. These attributes not only complement the viewer's knowledge about his

work and his presumed competence, but also help explain the reason for his presence in such an exposed location (Medyńska-Gulij 2017).

The notion of topographic cartography indicates large-scale detailed mapping, usually from scales between 1:10,000 to 1:100,000. To facilitate this in the period in question, the mapped area was divided into sections represented on numerous segments constituting a set of complementary boards. The term 'segment' is used here as opposed to the usually employed 'sheet' that also relates to a standard-size paper and thereby appears imprecise and confusing. A segment is a paper surface, appropriately sized for a particular map, that often consists of a few gummed sheets or their parts. Because of their large scale, topographic maps presented numerous details whose recording from the landscape required special knowledge, skills and tools. Logistics played an important role here. Mapping included various stages – from performing field surveys and making rough sketches to transposing the latter into a recognisable the final product – a map.

The development of topographic maps was closely connected with the institution and transformation of a new military position – the soldier-cartographer. Such an officer played a key role in the field, overseeing landscape sketching, and in the office, dealing with map production (Konvitz 1987; Andrews 2009). The relationship between cartography and the military is of special significance for the development of eighteenth-century topographic cartography. Before then, map-making was predominantly the domain of geographers, travellers, mathematicians or individual publishers, i.e. educated individuals often specializing in science. An eighteenth-century military cartographer was, by contrast, an educated engineer and a draughtsman, a member of the army and, to a large extent, represented new scientific and technological ideas (Harley 1978; Woodward 1987). As a trained professional he could act in support

Fig. 1 John Henri Bastide, *Part of 'A Prospect of that Part of the Land and Sea adjacent to ye Barrack to be Built in Glen Elg' with an enlargement of the inset map*, 1720. Edinburgh, Courtesy of the National Library of Scotland. NLS: MS1647 Z.03/07a.


EXPLANATION
A, Plan of the Country as Per Mr Lyon Survey
B, Situation of the Barrack.
C, Kirk Town of Glen-elg
D, Barnars. E, Gables.
E, Plain of Glen Elg.
F, River of Glen Elg.
G, Rubble Stone Quarry.
H, Lime Stone Quarry
I, Place where they land the Timber for Building the Barrack.
K, Part of the Ile of Sky.
L, South extream point of the Ile of Sky called Staff.
M, Part of the Ile of Rasa.
N, Houses built by Mr Patrick Strachan.
O, The Kyle, here the Tyde Ebbs and Flows so strong that no Ship can sail against it or lay at Anchor.
A PROSPECT
of that PART of the LAN
SEA adjacent to ye BARRA
to be BUILT in GLEN EL
taken and Drawn,
By John Bastide
1720
B
F
E
A
F
D


and
CK.
G
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of royal or institutional imperatives, effectively supervise members of his team and rationally distribute tasks.

It is worth noting that topographic cartography was most of all a substantial logistic and financial challenge for the commissioning party. Arranging cartographic operations that resulted in the production of topographic maps required a regulatory approach that was best executed by the military. After all, topographic maps were collaborative products that depended on the specialist skills of their individual co-authors. The history of eighteenth-century topographic mapping is closely connected with the establishment of state-funded engineer corps. These corps were strictly supervised by the rulers who ordered cartographers – military engineers – to prepare graphic images of land topography, further transform them and copy the material produced during the field survey. Particular map-making tasks were usually assigned to appropriate specialists according to a clear procedure modelled after military orders (Godlewska 1999).

The sources and literature of the subject normally employ the following terms in relation to military or civilian cartographers: engineer, military engineer, military surveyor, engineer topographer, topographer, draughtsman, copyist or watercolourist. The term 'cartographer' is here used to imply the widest range of potential duties. It refers both to surveyors and draughtsmen, and sometimes even to watercolour artists who coloured the maps. Most importantly though, however advanced his team's skills might have been, it was the cartographer's qualifications that proved decisive in the final aesthetic outcome of a given topographic work. For this reason, the map maker or cartographer in modern parlance constituted the key figure in production of the map: the present research concentrates particularly on the artistic and aesthetic competence of such men.

The strong dependence of these works of topographic representation on the needs of political rulers stemmed from the latter's military campaigns and territorial demands. The political situation in any given territory and the specificity of its military and administrative necessities gave an impetus to the development of topographic cartography. Matters of

scientific and technological progress additionally enhanced the process. Identifying the factors that triggered the decisions to map large areas requires, however, at least some background knowledge about the eighteenth-century European political scene.

The topographic that form the maps subject of this research were developed by appropriately trained teams of professionals. In the eighteenth century we may estimate the core to have consisted of 200 to 400 cartographers, each with a broadly similar education, and all of whom used comparable field survey methods and techniques. Nonetheless, the overall number of specialists involved is impossible to specify. They functioned within complex but broadly similar systems of knowledge acquisition and exchange even if they worked over large areas. By the late eighteenth-century, topographic maps covered over 70 percent of Europe – excluding Spain, Russia and the European territories subject to Turkey. It might be said, with some justification, that they helped unify an image of Europe at this time.

Interestingly, although military cartography in Europe was considered as classified, levels of secrecy and confidentiality varied depending on the country. The confidentiality of information about particular areas and objects could be valuable in case of potential warfare or dispute. It was for this reason that military maps were only produced in a few copies and yet made using broadly understood drawing techniques. Though particular copies offer the same information about the mapped area, they often differ in terms of their aesthetic standards and the quality of materials employed in their production. Map copies were kept in archives with restricted access, their use subject to control and restriction. Levels of secrecy and confidentiality varied depending on the country, however, military cartography also had its commercially-produced equivalents. The latter built upon and often extended others' work. Jobbing map-makers and publishers offered geographic, scientific, and – exceptionally – topographic maps. The maps developed by the Cassinis, French scientists and map publishers, included a multi-sheet map of France that was later the model for many European map-makers (Konvitz 1987). The circulation figures of the Cassini works were relatively

large. The maps were printed from detailed copper plates and while, they were originally black and white they were sometimes coloured *ex post*.

The working relationships between eighteenth-century rulers and cartographic engineers stemmed from the peculiar political situation of the period. It was a time of intense dynastic and territorial reshuffling that turned Europe into myriad territorial disputes, even a many-stages theatre of war. Following conflict, rulers proposed treaties with new borders and administrative divisions. Territories that managed to avoid warfare were regarded by active state leaders as potential objects of conflict, aggression or defence, which in turn required that these lands be precisely mapped as well. This shifting political situation was an important context to cartography since topographic engineers and map-makers could and did find their career paths influenced by such circumstances – from education to the subsequent levels of their *cursus honorum*.

One factor that proved especially significant for the development of topographic mapping was the change in Europe resulting from the growing position of monarchies functioning as administrative and military centres responsible for state politics, regardless of their type – that is, absolute monarchs, even enlightened despots, or those who sanctioned parliamentary role with strong governments. The different systems in the eighteenth century offered means to support forceful armies and make effective alliances. If one key to territorial aggrandisement was having a well-organized army, the key to managing that army lay in efficient quarterage and tax collection and, in turn, knowing the lie of the land. It is no wonder, then, that the possession of accurate maps for military and administrative purposes, including tax collection – came to be so highly valued in the eighteenth century. Naturally, the process did not take the form of a single collective revelation or revolution but, rather, followed numerous military victories (and defeats) and lasted the whole century.

Geopolitical events and the role of courts in the development of topographic cartography

The maps analysed in this book, hitherto generally referred to as 'eighteenth century', were produced in the period between 1713 and 1799. The first date marks an initial attempt to introduce order in Europe following the War of the Spanish Succession that started upon the cessation of the ruling Habsburg dynasty. The Spanish Habsburgs had wielded power not only over Spain and its overseas territories, but also over the Kingdom of Naples, Sicily, Sardinia, the Duchy of Milan, and the Southern Netherlands. The second date – the beginning of the Napoleonic era – definitively marks the end of European order based on alliances between the ruling dynasties usually interconnected by marriages. This period also marks the rise of field-survey methods based predominantly on reconnaissance which preceded the introduction of precise national triangulation rules and uniform instructions of topographic mapping.

The French Revolution initiated important changes in political and military praxis, especially during the Napoleonic Wars when maps more commonly became tools for solving military problems (Engberg-Pedersen 2015). The two dates identified here also signify a period in which specific artistic factors were conjoined to those of mapping. It was a time when both paper and drawing techniques were being refined, and a time of intense development in European watercolour painting. The technology for the production of paper and drawing materials evolved in the late eighteenth century. As we show, these changes directly influenced field-survey and map-making methods.

Political and territorial order in Europe in this period was created by a few states whose position stemmed from efficient political activity performed by their monarchs or ministers, as well as from their highly-organized armies. These countries included France, Prussia*, Great Britain and the Electorate of Hanover, Savoy (the Kingdom of Sardinia),

* 'Prussia' refers to electoral and royal state consisting of Brandenburg and Prussia, governed by the Hohenzollern family.

Austria (i.e. the territories under the Austrian Habsburgs' rule), as well as the united Denmark and Norway – the latter two being largely remote from the mainstream politics. This group was later joined by Russia whose strength developed differently even though at the time the Russian military training was based on the Prussian model. Figure 2 illustrates the territories controlled by these six players. Importantly for the research presented here, these courts decided to establish military engineer corps that, taken together, radically changed the character of European cartography and thus constituted the source of the most significant large-format topographic maps.

Eighteenth-century European history has been the subject of considerable study (for a summary, see Black 1999). The issues essential for the present study have to do with those factors influencing territorial change in Europe and the political positions of those states that became the main centres of cartographic activity. Several eighteenth-century treaties or peace resolutions were influential, since they determined new territorial divisions and marked new borders, so triggering topographic cartographers' work. Significant in this respect are:

- The 1713–1715 Utrecht treaties following the War of Spanish Succession that resulted in the Bourbons ruling Spain and the Savoy dynasty (of the Duchy of Savoy and Piedmont) taking over the Sicilian crown. The Austrian Habsburgs received part of the Netherlands, then called the Austrian or Habsburg Netherlands; 1715–1797, the crowns of Naples and Sardinia, as well as the Duchy of Milan.
- The 1720 Hague treaty, which amended the Utrecht treaty included the provisions of the 1718 London treaty, so ending the Quadruple Alliance war against Spain. As a result of the treaty, the House of Savoy and the Habsburgs exchanged the islands of Sardinia (formerly Habsburgian) and Sicily, previously under Savoy rule. Savoy became kings of Sardinia with the capital in Turin. In 1743 the kingdom, included the territories of Sardinia, Savoy and Piedmont.
- The 1738 peace treaty of Vienna codified the political alliances after the War of Polish Succession. The Habsburgs obtained the Duchy of Parma with Piacenza and Guastalla, as well as the Duchy of Toscana.

Fig. 2 The map of Europe with dominions of six European dynasties between 1714 and 1795 with their capital cities marked and the main seats of engineers' corps (comp. by B. Medyńska-Gulij).

The latter became the possession of Francis Stephen of Lorraine (1708–1765) to compensate for his lost duchy. It is worth noting that Francis Stephen, husband to Maria Theresa Habsburg (1717–1780), became Holy Roman Emperor Francis I in 1745. The sons of the couple

ruled the empire until the end of the period under consideration. The Duchy of Lorraine in turn was taken over by France, to become its formal possession in 1766 and came into the hands of Stanisław Leszczyński, Louis XV's father-in-law. The kingdoms of Naples and Sicily were handed over as a *secundogeniture* to the Spanish Bourbons formerly ruling the Duchy of Parma.

- The provisions resulting from the failed 1745–1746 Scottish Jacobite rising. The Jacobites opted for the Stuarts and came out against British King George II of the Hanover dynasty (1683–1760). The conflict broke out during the War of Austrian Succession that Great Britain was involved in. George II was the second Hanoverian on the British throne and his father and predecessor ruled simultaneously in Great Britain and the Electorate of Hanover from 1714. A few years earlier, in 1707, the parliaments of England and Scotland joined to become Great Britain, having been a united Kingdom from 1603.
- The 1748 peace conference of Aachen at the end of the War of Austrian Succession that lasted from 1740 (initially as a conflict between Great Britain and Spain). The House of Habsburg won a Pyrrhic victory with heavy territorial losses; although the Aachen conference recognized Francis Stephen of Lorraine and Maria Theresa's rights to the imperial crown, the Habsburgs suffered heavy territorial losses. The actual 'winner' was Prussia ruled by Frederick II of Hohenzollern (1712–1786). He managed to keep the annexed Silesia as well as the County of Glatz (Kłodzko) that, previously, had belonged to the Habsburgs as the Bohemian monarchs. According to the provisions of the 1742 Breslau (now Wrocław) peace treaty, both territories were formally handed over to Prussia by Maria Theresa. The involvement of George II, King of Great Britain, stemmed from his concern about the future of the Electorate of Hanover ruled in the framework of a personal union. Additionally, the Duchy of Savoy and Piedmont managed to expand its territories eastwards.
- Two peace conferences of 1763 – one in Paris, regulating the issues related to the overseas territories, and the other – the Peace of Hubertusburg – concluding the Seven Years' War of 1756–1763 – also

referred to as the Third Silesian War – between Austria (ruled by Maria Theresa) and Prussia (lead by Frederick II) that involved a few powerful European countries. France, Russia, most of the states of the Holy Roman Empire, and Sweden supported Austria, whereas the Electorate of Hanover (and, therefore, Great Britain took the Prussian side. The Treaty of Hubertusburg maintained the resolutions of 1748, but Austria retained the south-eastern part of Silesia.

- The 1768 Versailles treaty expanded the territory of France that had earlier seized Corsica, the property of the Republic of Genoa, as an alleged compensation for debts.
- Three consecutive partitions of Poland (1772–1795) each time resulted in provisions concerning Prussia, Austria and Russia that further expanded their territories.

These wars and, consequently, treaty or peace resolutions, were complemented by others of smaller scale or significance, e.g. disputes between Savoy and its neighbouring countries resulting in borderline corrections; the agreements following conflicts and unrest at the Swedish-Norwegian border culminating in the years 1772–1795 or England's preparation for a French invasion after the outbreak of the French Revolution (1789–1799).

This all shows Prussia's involvement in most conflicts resulting in rearrangements of borders. The country consistently took action aimed at strengthening its position in Europe and – under the circumstances – reaped the greatest advantage from such situations. Other beneficiaries of eighteenth-century warfare were Great Britain and the Electorate of Hanover, the Duchy of Savoy and – a little later – France, a country past its courtly glory days but – like Austria – with a still impressive military.

The main assets of these countries lay in their well-trained armies as well as in scientific attitudes towards warfare. They recruited well-educated and talented officers. Their military campaigns were often overseen, if not supervised directly, by their monarchs. Since warfare was viewed as a scientific problem, the role of the quartermaster service deserves similar attention, considering its responsibilities regarding the relocation

of troops, distribution of supplies and preparation for battles or retreats. Military activity quite frequently inspired topographic mapping (e.g. the Military Survey of Scotland) and the newly commissioned maps proved how useful they could have been, had they been available previously, at the time of actual campaigns (Harley 1978). Few rulers demonstrated enough farsightedness to order the preparation of topographic maps beforehand. The exception was Frederick II who ordered field surveys in Silesia and Greater Poland, and who used the resulting maps successfully during the war with Austria and the annexation of western Poland.

The disappearance of Poland, formerly one of the largest European countries from the eighteenth-century map of the continent stemmed – among other reasons – from its lack of strong central authority and a standing army with appropriately trained engineer corps guaranteeing effective topographic mapping. Poland was mapped by other powerful states. King Frederick II of Prussia and Emperor Joseph II Habsburg ordered the annexed Polish territories mapped immediately after the First Partition. Frederick II also ordered to map of a part of the territory of the Poland that he would seize in the Second Partition.

Engineer corps in royal courts

Monarchs' planned military activity and administration of their territories the country in peaceful times also contributed to the development of special engineer corps. The core duties of military engineers included the construction and maintenance of fortifications and fortresses and – naturally – detailed, large-scale planning and sketching of these buildings (Military Engineers 2013). By the mid eighteenth-century rulers developed separate engineer corps (in France, Great Britain and in Prussia), quartermaster corps (in Austria, Denmark, and Norway, the Duchy of Savoy) and – exceptionally – an artillery corps (in the Austrian Netherlands) that specialized in field surveys and topographic mapping.

These corps mostly consisted of officers who served one monarch throughout their whole careers, although there were occasional cases

when officers changed their units or even rulers to advance their career. In terms of status and career, royal or imperial court service was usually perceived as a dignified culmination to one's military career. Courtly positions were especially prominent in France, Brandenburg-Prussia, Austria, Great Britain and the Electorate of Hanover, Denmark and Norway, and the Duchy of Savoy and Piedmont. The list below contains essential information about the above countries' ruling dynasties. The royal residences were also the locations of engineer corps that played a significant part in this study.

- House of Bourbon of France (the Bourbons of France); the Kingdom of France; King Louis XV (1715–1774); Paris.
- House of Brandenburg (the Hohenzollerns); Elector of Brandenburg and King of Prussia Frederick II (1740–1786); Berlin.
- House of Habsburg (House of Austria); the Danubian Monarchy; Charles VI (1711–1740), Maria Theresa (1745–1780), Joseph II (1765–1790); Vienna.
- House of Hanover (the Hanoverians); the Kingdom of Great Britain and the Electorate of Hanover; George II (1727–1760), George III (1760–1820); London and Hanover.
- House of Oldenburg (the Oldenburgs); the Kingdom of Denmark and Norway; Christian VII (1766–1808); Copenhagen and Christiania (Oslo).
- House of Savoy (the Savoys); Piedmont, the Kingdom of Sardinia; King of Sardinia Charles Emmanuel III (1730–1773); Turin.

The map of dominions ruled by these six dynasties includes their monarchs' residences with engineer corps, as well as cities which were the headquarters of such corps or which enjoyed a varied level of autonomy (Fig. 2). The names of particular territories are supplemented with information about the periods of their subordination to given dynasties. Court residences such as Paris, Berlin, Vienna, or Turin were often where the corps were stationed. In the countries joined by personal union as in Denmark and Norway or in Great Britain and the Electorate of Hanover, however, things developed in different ways. Engineer corps that had

their headquarters in Copenhagen and in Christiania (now Oslo), were organised in a similar way but the Norwegian one was much more influential because of the constant conflict with Sweden. Officers of the latter prepared topographic maps of the disputed border area, and as a result, this corps had numerous expert cartographers at its service.

In the case of Great Britain and the Electorate of Hanover, two entirely independent corps existed. The King of Great Britain and simultaneously Elector of Hanover supported a large corps in Hanover, the capital of the electorate, that undertook a great deal of mapping of the area. In Great Britain the Hanoverians had two mapping corps at their disposal: one was stationed in London and was responsible for mapping England. It produced new maps and copied old ones for the king; and the maps were normally stored in the Tower of London. The other was based in Edinburgh, initially to undertake field surveys and to chart routes between forts in Northern England and Scotland for potential military activity, and after the suppression of the last Jacobite rising in 1745–1746, to produce topographic maps of Scotland, which would later be a stimulus to mapping the whole island by order of King George II.

How did military engineer corps operate and develop? The answer to this question can be derived from attention to the context of their work. Some of the information below will also appear elsewhere in this book, where cartographers' drawing education is discussed in more exact detail. The first corps of the kind was already established in seventeenth-century France, under King Louis XIV, on the initiative of Sébastien Vauban (1633–1707). This began in 1688 as the *Dépôt de la Guerre*, and usually functioned as the *corps des ingénieurs militaries.* It served as the source of terminology describing the new profession within the military system, referring to officers responsible for field surveys and related calculations, as well as the development of fortress construction plans and topographic maps. The terminology coined there was adopted by similar units in other European countries. From 1726, the term *ingénieurs géographes des camps et armées du Roi* was officially used. From 1769, this was replaced by *ingénieurs géographes du Roi,* itself later changed to *ingénieurs géographes militaries* in 1777, and used until the

introduction of the name *topographes militaires* in 1800 (*La France vue par les militaires*… 2002).

Topographic maps prepared by the *Dépôt de la Guerre* included all borderline areas of the Kingdom of France as well as its northern and western coastline. They mostly displayed border strips that were several dozen kilometres wide. The maps were produced in five topographic scales that – according to today's norms – can be written as 1:10,800, 1:21,600, 1:28,800, 1:43,200, and 1:86,400 (see Chapter 5 for information on scale). Additionally, the corps was provided with a special textbook first published in 1695 in Paris (it went into several editions) that contained the basics of triangulation. Its author, Jean-Baptiste Naudin the Elder (ca. 1674–1744) hidden behind the initial 'N', admitted in the title that Vauban's method in fact served as the foundation for his work. Naudin is one of the key figures of French topographic cartography. He embodied the tradition of King Louis XIV's time combined with the change from the period of Louis XV's rule. From 1733 to 1743 he held the position of the Head of *Dépôt des cartes et plans* (Naudin 1695; *La France vue par les militaires*… 2002).

Apart from the military engineer corps operating in Versailles, mapping education was also performed in the Paris-based *Bureau de dessinateurs* established for this purpose in 1744 and lead by Jean-Rodolphe Perronet (1708–1794), a renowned architect and engineer. In 1747 Perronet reorganized the *Bureau* into an engineering education institution that produced a group of map-making draughtsmen. It also admitted foreigners.

In 1717, or, perhaps, a year later – on the initiative of Prince Eugene of Savoy (1663–1736), who headed the Court Military Council (*Hofkriegsrat*) directly supervised by the emperor and held the position of chief military commander of the imperial army – an establishment called the *Ingenieur-Academia* was founded in Vienna (Dörflinger 1989). A few years earlier, in 1711, the War Archive was instituted to support the Council. The Academy was intended to train officers to serve in engineer corps. Initially, it had only limited success (Gatti 1901). Only from 1758, after Frederick II's annexation of Silesia, did Maria Theresa establish

General Quarterage Headquarters (*Generalquartiermeisterstab).* This institution was responsible for the preparation of topographic maps essential for tactical military operations (Paldus 1919).

Austria's defeat following the Seven Years' War (1756–1763) was a turning point. *Generalfeldmarschall* Franz Moritz von Lacy (1725–1801) realized the usefulness of quality maps in warfare, this view being supported by the Head of the Court Military Council Leopold von Daun (1705–1766). Consequently, Maria Theresa approved attempts to produce initial maps based on field survey (displaying a small part of Silesia) and later – in May 1764 – she ordered the mapping of the whole monarchy (Hofstätter 1989). The result was the most monumental of eighteenth-century topographic works, commonly referred to in the literature as the Josephine survey (*Josephinische Landesaufnahme*). Field Marshall von Lacy took up fundamental reforms of the Austrian quarterage service, including the engineer corps, wholly reforming its structure (Zeinar 2006). In 1765, Emperor Joseph II became the supervisor of its works which lasted many years and which would produce over 3,000 segments of a 1:28,800 scale map. The mapping of particular Habsburg-owned territories was mainly lead by seven commanders with their own teams of engineers, with between 20 and 50 engineers working at a time. The works were performed simultaneously with other activities. In 1776 the War Archive (with its collection of maps) supervised by the Court Military Council formally and physically merged with the engineering archive (*Geniearchiv*) and the Chancellery Archive (Paldus 1919).

The Prussian *Ingenieurkorps* established in 1728 by King of Prussia and Elector of Brandenburg Frederick William I (1688–1740) amounted to 45 officers at the time of the monarch's death (Albrecht 2001). The king's son and successor, Frederick II (1712–1786), directly supervised the corps from the start of his rule, and focused his attention predominantly on cartographic output. He became directly involved in map production. The king's views regarding map-making remained unchanged for years and his last will expressed his views that he considered cartography especially significant. He mentioned the necessity to form an additional corps of engineer geographers specializing in cartographic and

topographic works (Hanke 1935). The king appointed the head of the corps, who was obliged to deliver written reports on the activity of the unit. The corps recruited candidates almost exclusively from Brandenburg and Prussia. A further institution of fundamental significance to the functioning of the corps was the Map Room (*Plankammer*), located in Potsdam. Only with the personal permission of the king the visitors were allowed to enter the *Plankammer* which archived all new maps as well as duplicates and copies of others that the King borrowed, appropriated or purchased from across Europe. The room where the maps could be viewed was situated next to the King's chambers, which additionally enabled him to monitor the visitors. Even the formal heads of the *Plankammer* needed Frederick II's approval to make use of particular maps (Hanke 1935).

Over time the engineer corps became a well-organized and efficient institution that, by the end of the Prussian King's rule, had a staff of 120 engineers (Albrecht 2001). Frederick II was relatively well-educated in mathematics and geography. He used to draw and – before taking his place upon the throne – made campaign plans by himself (Hanke 1935). Preparing for warfare in Silesia, he needed detailed topographic maps of high quality. This is why the war map of Silesia, i.e. the *Kriegskarte von Schlesien* (1746–1753) was the first work he decided to order from the Glatz (Kłodzko) Fortress engineer Christian Friedrich von Wrede (1702– after 1764). The map was prepared in time for the Third Silesian War. The second important map produced in Prussia was the *Spezialkarte der Kurmark Brandenburg* (1748–1749) ordered by the king, this time by the *Ingenieurkorps* specialist Johann Friedrich de Balbi (1700–1779) (Scharfe 1972).

In order to facilitate the rapid mapping of a particular area, Frederick II involved engineers from the *Generalquartiermeisterstab* (Albrecht 2001). One example of such rapid cartographic work was a field survey in Poland, conducted in 1772 under the supervision of Major Theodor Philipp von Pfau (1725–1794) of the quartermaster service. Accompanied by four officers, he prepared reconnaissance sketches enabling the King of Prussia to plan the Second Partition of Poland. Based on these

drawings forty-one segments of the manuscript 'Confidential map of Poland' were executed. They included, mainly, the territory of the future Southern Prussia at a scale of 1:87,500 (Hanke 1935). Its military nature is confirmed by the fact that when the decision about its publication was finally made in 1778, the map was drawn with south-based orientation in order to make reading place names easier for Prussian officers advancing from the north (Buczek 1935).

The main royal corps operating within the British army and dealing with field surveys and mapping – the so-called Ordnance Survey – included the offices, Drawing Room and stores, all of them located in the Tower of London (Hewitt 2010). The Tower was also home to the map archive. The first large topographic work was commissioned by the king only following the suppression of the last Jacobite rising in 1746 (Anderson 2009). William Roy was appointed Head of the *Military Survey of Scotland*. Officers performed the field survey in the summer and produced fair copies of the map in Edinburgh Castle. The position of the London corps grew with the initiation of *Ordnance Survey Drawings* in England in 1789. The high status of maps in the House of Hanover, ruling the united Great Britain and the Electorate of Hanover, was evident from George II's topographic map collection. This collection was extended by the king's grandson and successor, George III, and included the work of such eminent geographers such as William Faden (1749–1836) and Thomas Jefferys (ca. 1719–1771). The collection grew to over 60,000 maps and views, and is held in London in the British Library (Lacey 2005).

The engineer corps established by Hanoverian Elector George Louis in turn consisted of a team of educated engineers and preserved its independence following the personal union with Great Britain. Its first significant topographic works were undertaken in the years 1698–1732 (Torge 2003). The Hanoverian corps amounted to about twenty officers within an army of 16,000 soldiers. The head of the corps was Wilhelm Georg Josua du Plat (1722–1795), the son of military cartographer Pierre Joseph du Plat (1691–1753). He resided in Hanover and was appointed to the position in 1759 (Wagner 1924). Wilhelm Georg Josua's three brothers were also Hanoverian-Electorate engineer officers and took part in

field surveys as well as in construction works of roads, fortresses and canals. The Hanover corps performed field surveys and produced maps of the Electorate and its neighbouring areas (Frieseler 2013).

The Kingdom of Denmark and Norway ruled by the Oldenburgs remained politically neutral following the devastating wars with Sweden (1643–1721). From the year 1721 until the end of the eighteenth century, the monarchy, despite its reduced significance in the European arena, experienced prosperity thanks to its policy of neutrality and as a result of economic reforms. Stable governments added to the country's growth and provided it with a well-organized state administration. The General Quarterage in Copenhagen did not initiate any topographic mapping of Denmark until the early nineteenth century and its support of an engineer corps (*Jægerkorps*) in Christiania (now Oslo) was only justified by the threat of further military conflict at the Swedish-Norwegian border. As a result, since the eighteenth century military engineers had produced topographic maps of large tracts of land in Norway, notably along its borderline with Sweden. Mapping started in 1772 with square topographic segments called *Kvadratmilskartene* at the scale of 1:10,000 produced in Christiania. Another major topographic mapping in Norway took place in the period 1794–1798 and concentrated upon the country's eastern territories.

As for Savoy and Piedmont, most researchers assume that professional field surveys and map production begun there in 1752, with the establishment of the military engineer corps headed by Giuseppe Francesco Bertola (Masabò Ricci and Carassi 1987; Storrs 2013). Although the Savoy army undoubtedly included engineers of similar competence before – a map incorporating the borders determined by the peace treaty of 1714 can serve as proof of this – the real change did not occur until the late 1730s, with its culmination in 1738 when the Royal Topographic Office (*Ufficio Topograpico*) was founded by Charles Emmanuel III (1701–1773). The coincidence of the king's decision and the end of the War of Polish Succession was not accidental.

Since its formation, the corps was stationed in Turin, also home to the map archive. The engineers performed detailed field surveys in the Alps,

which resulted in a few dozen coloured topographic-map segments constituting *Carta della Savoia*, using two scales of 1:12,000 and 1:48,000. In addition, especially detailed 1:9,400 scale maps were developed that displayed the French border following its delimitation in 1761 (Garis 2006): representative maps include ones presenting strategic Alpine valleys, particularly the Susa Valley and the main route from Turin to France.

3. Field surveys and cartographic production

Field surveys: instrumentation, measurement techniques, and the scope of fieldwork

Since the early eighteenth century, triangulation has been a commonplace calculative and geometric method in the performance of field surveys. It is based on the essential principles of trigonometry, i.e. angle measurements and length calculations of triangles. Landmarks in the field, such as chapels, crossroads or spots determining the shapes of forests or housing areas, were used to constitute triangles as nodes of measurement. There became the foundations of maps drawn based on these specific systems of measurements. Military engineers were commonly taught the use of this method from at least the early eighteenth century. The military corps functioned in this sense as educational institutions. The essential role of this method in the training topographic cartographers' was confirmed by numerous textbooks in different languages, from *L'ingénieur françois* by Naudin the Elder, first published in 1695, later by Marinoni and by Hogrewe (Hogreve), to textbooks by Rawert and Backenberg in the second half of the eighteenth century (Marinoni 1751; Hogreve 1773; Hogrewe 1785; Rawert 1793; Backenberg 1797, 1810). Such books offered access to knowledge about the principles of delineation used in technical drawing, not only those used for plans and views

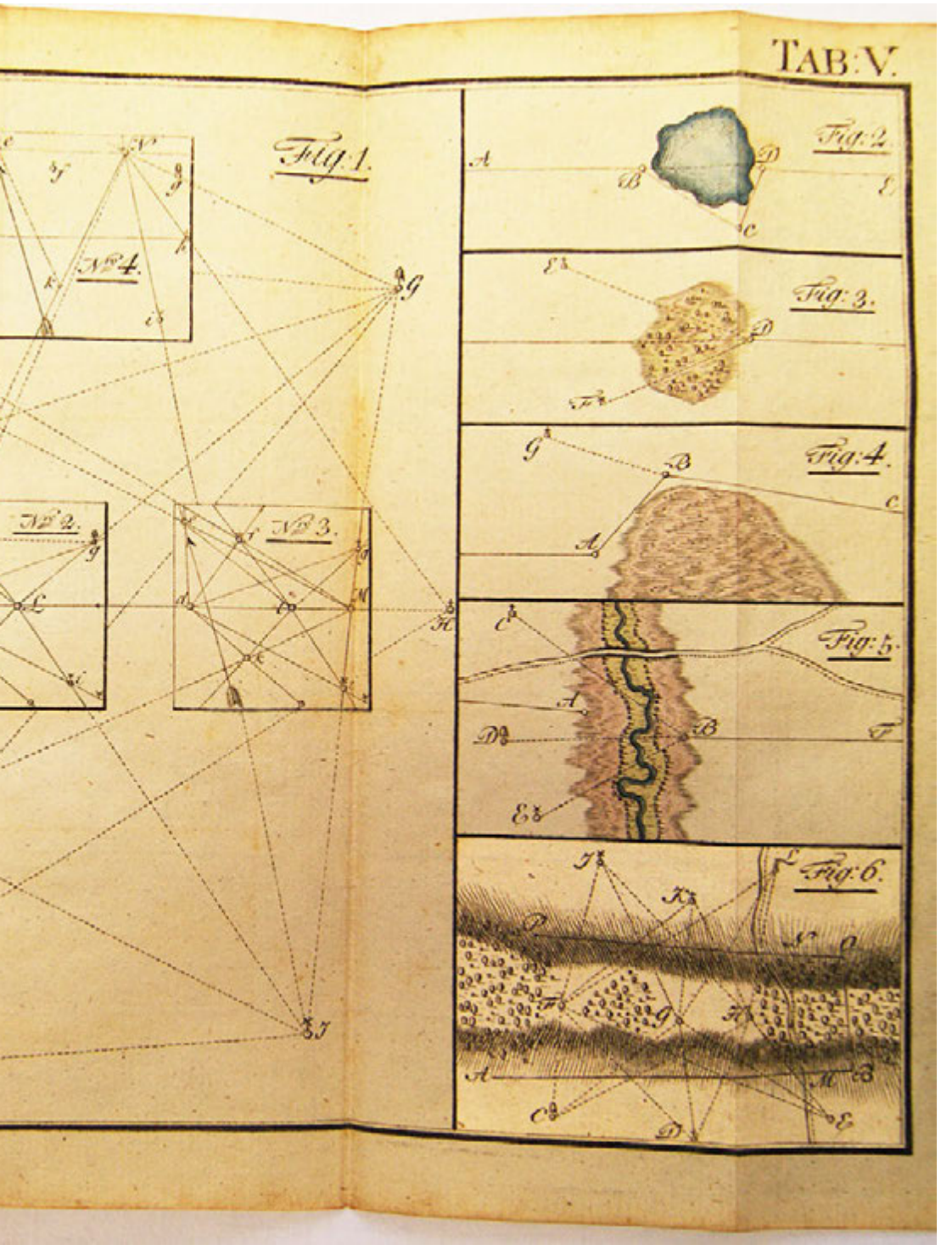


Fig. 3 Coloured copperplate from handbook by Johann Ludewig Hogrewe *Theoretische und praktische Anweisung zur militairischen Aufnahme oder Vermessung im Felde,* Hannover 1785, Pl. V.

of fortifications, but also in map making, that is, in providing a conventional system of cartographic symbols that enabled readers to recognize the location of objects in a given topographic space (Fig. 3).

As a rule, a professional topographic map so derived did not include perspective, since it was made by use of the horizontal projection of objects on a flat surface. Field survey and topography teachers emphasized the importance of acute observation, correct distance evaluation and sketching, both in rough sketchbooks and on plane table (*mensula pretoriana*) sheets (Edney 2018). Because of the imperative of mapping rapidly to meet their monarchs' needs concerning prospective warfare tactics, officers able to map particular areas within a short time and performing by-eye reconnaissance (French: à vue and German: *nach Augenmaß*) enjoyed the highest status (Klöffler 2012).

Mapping a given area in the form of one multi-segment work was usually preceded by the ruler's order to a high-ranking officer from the engineer corps. This would include a general instruction regarding the territorial range of a map and its topographic content (Hanke 1935). The degree of details could influence the cost of the map-making and the levels of secrecy that might result. The head of the mapping unit received permission to conduct field surveys and was issued with appropriate letters of recommendation to local administrative officials who were ordered to support the mapping activity and grant cartographers access to all inventories and registers containing information about royal domains. The division of labour in such fieldwork depended on survey instrumentation, the methods of registering area measurements and observations, and the methods used to produce sketches or rough copies.

The officer in charge distributed tasks to particular members of his team and coordinated their work in accordance with a journal containing sketches, drawings, notes, and cadastral data. His subordinate officers – commonly captains or lieutenants – usually brought their own measuring tools, including proper compasses (different kinds of compasses were in common use, from the most basic, placed in wooden boxes with simple dials, needles and marked directions, through those housed in metal cases, to the most expensive devices with silver casing,

additional angle dials and straightedges or rulers), simple astrolabes with pointers or ones with spotting scopes that allowed users to see distant topographic objects more clearly. Expensive theodolites, already in use at the time, were predominantly employed in preparing fortress schemes or detailed maps of their surroundings, because they were used to measure horizontal and vertical angles. Measuring vertical angles was necessary for the plan views or vertical projections of fortresses, fortifications, bluffs or other land elevations. The height of objects was not usually a required parameter of topographic maps and thus, vertical angles were not measured in their production.

Compasses, astrolabes, astrolabes with spotting scopes and theodolites were fixed to plane tables that were based on tripod stands, with leveled 40- or 60-centimetres-wide square tabletops. The plane tables were used to produce 'scaled sketches', where measured angles were transformed into actual distances and divided by denominators of scales appropriate for the sketches (Bauer 1993). The scales mostly ranged from ca. 1:10,000 to ca. 1:30,000, since an area of about 10–30 square kilometres could be mapped from one position without moving the plane table. Measuring actual distances between particular points or spots (marked by poles) required at least two men who carried ca. 25-meter-long chains and put them up on the poles (Hanke 1935). In his watercolour from 1749 (Fig. 4), Paul Sandby depicts the division of field survey work on the Military Survey of Scotland, in which he participated as a draughtsman.

In association with the scaled sketches prepared on plane tables, engineers made rough-sketchbook drawings of views from different perspectives – central (bird's-eye and frog's-eye), or parallel (equestrian and military). Such drawings predominantly reflected the features of landform, such as hills, or steep or gradual hillsides in valleys. Since in the eighteenth century such features did not usually require surveying, reflections of their three-dimensionality depended solely on cartographers' skills to hachuring and shading. Whereas displaying fixed topographic objects with already agreed-upon cartographic symbols had to be consistent with textbook canons, the rendering of land morphology with its specific features could rely on cartographers' subjective observations.

This latter part of map production was particularly significant for developing manuscript coloured maps.

The scope of duties performed by the head of a mapping party and by its members often reflected individual skills and qualifications. The eighteenth century witnessed a growing number of graphic works, including field-survey iconography. In his watercolour, Jean Baptiste Berthier presents two topographers documenting their field survey and observations in different ways (Fig. 5). One is making vertical sketches, the other drawing views of their surroundings from different perspectives. Both methods served as complementary sources for preparing subsequent versions of a given cartographic image. If maps were needed urgently, draughtsmen engineers, specializing in drawing and watercolour painting who worked in indoor drawing rooms in winter, would join mapping teams already then employed in field surveys. Draughtsmen's main tasks lay in producing fair copies of maps based on their rough copies. Finished topographic maps did not include information about geographic coordinates or grid systems. The sheets would only provide a few limited mathematical and spatial details, such as a linear scale with particular units of measurement or an arrow indicating the north. Producing these maps did not require complex instrumentation – compasses to determine directions and simple theodolites to calculate horizontal angles proved entirely sufficient.

The final topographic image was created through combining and juxtaposing rough field sketches that were later multiplied and reduced to the required scale. The process was usually performed with the use of a pantograph, a drawing tool invented in the early seventeenth century which facilitated the scaled reproduction of mapped features. During the reduction and map-making stages cartographers referred to the notes and drawings from their rough sketchbooks and to their field drawings.

Fig. 4 Surveying party at the eastern end of Loch Rannoch, by Paul Sandby, 1749, pen and black ink with watercolour over graphite; 18.3 × 29.3 cm. London, British Library. Maps K.Top.50.83.2.

Fig. 5 Field mapping: drawing a sketch on the plane table with astrolabe and sketching while recording in the notebook. A frontispiece from Jean-Baptiste Berthier, *Plan de la bataille de Laffeldt en 23 plans particuliers, 1747*, ca 1755. Vincennes, Ministère des Armées, Service historique de la Défense. No: A2C 369.

Multi-segment topographic maps as cartographic works of art

Precise maps proved vital for eighteenth-century rulers, ministries, military commanders and their staff. The development of detailed multi-segment topographic images, including all crucial area information, required a number of specialists, and took considerable time and money. Producing a fair copy of a manuscript topographic map consisting even of a few or even over a dozen segments, which crowned the whole cartographic process, was highly expensive. For this reason, only one fair copy was usually commissioned although exceptionally multiple copies were made. The often prolonged duration and considerable cost of mapping could be justified if the result served the monarch's purposes. In such cases the significance of the aesthetic outcome of a given topographic image equalled, or even exceeded, its practical – military and administrative – value. The increasingly important visual attractiveness of maps depended on the cartographers' and draughtsmen's skills in drawing and painting techniques, especially their use of watercolour and other water-based media.

For practical and financial reasons, variations of manuscript topographic maps could depend on their end users, be they royal or military. The basics of the field surveys remained the same, however much we might also distinguish different categories of topographic mapping including field sketches, original or skeleton protractions ('protraction' copies), unfinished fair drawings and the finished plans – or fair copies (Hodson 1989; Anderson 2009). Military officers usually received fragmentary 'protraction' copies, since large cartographic works predominantly served tactical purposes. Such officer maps were not usually coloured. They contained systematized information derived from rough sketchbooks translated into a visual cartographic language. This is why they were much easier to draw and their production required only basic technical competence. One advantage of such 'protraction' copies that resembled rough field sketches was the smaller input of labour and time needed in their execution, since the latter was based on lines rather than

upon spots of colour. Thus, the essential tools for 'protraction' map development included quill pens and black, or sometimes red, Indian ink. Black lines marking roads and rivers were tinted brown and blue respectively. On occasion, discerning differences between particular categories and the unequivocal designation of aesthetic and graphic quality proved impossible. There were cases when commissioners resigned from developing fair copies of maps because of their costliness. The *Military Survey of Scotland*, for instance, was executed in two different formats, with a fair copy representing the Highlands and a more economical 'protraction' copy displaying the Lowlands (Fig. 6).

The most representative and attractive form of a topographic map was its multi-segment final version, that is, its fair copy. Multi-segment manuscript maps constitute special examples of topographic works typical of the eighteenth century. The present research defines them as topographic images containing a graphic representation of topographic objects and

Fig. 6 Two different stages of maps: fair copy and protraction copy; *Military Map of Scotland*, Lowlands – 1752–1755; Roy, Highlands – 1747–1752. London, British Library. Maps C.9.b 4/8f and Maps C.9.b 14/1c. https://maps.nls.uk/roy/index.html

landform of a large area, divided into a number of complementary segments. The inclusion of particular segments in one map is the key factor here. Thus, discussing multi-segment topographic maps, this study takes into account the whole image, not its single segments. The compatibility of rectangular segments enabled map users to put them next to one another and so obtain an image of the whole mapped area. This is why such a set of segments was, and is, treated as one consistent cartographic work. Perceiving particular segments as parts of a whole was obvious and natural, and the so-called tableau that accompanied maps additionally confirmed the segments' belonging to a given set. A tableau was a scheme of a multi-segment map representing the area divided into a row of numbered rectangles corresponding to particular segments. Such a drawing facilitated the use of maps and offered an overview of the whole mapped area, since the scale and size of all segments put together often made the entire map surface quite large – in exceptional cases amounting to a few hundred square metres. Sometimes tableau themselves constituted additional, less detailed maps. An indicative map for the *Schmettausches Kartenwerk* with its regular segment division and descriptions of the principal cities located in particular Prussian regions, serves as an example of such a tableau (Fig. 7).

Sometimes, when mapping initiatives were especially long-lasting and extensive in terms of the represented area, each region of the given territory was mapped separately by teams headed by different engineers. Each segment would include information about its neighbouring ones according to their numbers within particular regions. This method of segment arrangement was used to develop the largest eighteenth-century topographic work entitled *Josephinische Landesaufnahme* whose core part was produced over a twenty year period (1763–1785). Numbering each segment of a topographic map and marking it with the name of its largest city or town would become a common principle in the nineteenth century and it has remained within the cartographic canon to this day.

In the eighteenth century, however, it was not that evident. The *Minutes des cartes des Naudin* (1704–1746) which covered the territory of northern and north-eastern France (with Lorraine) was produced in

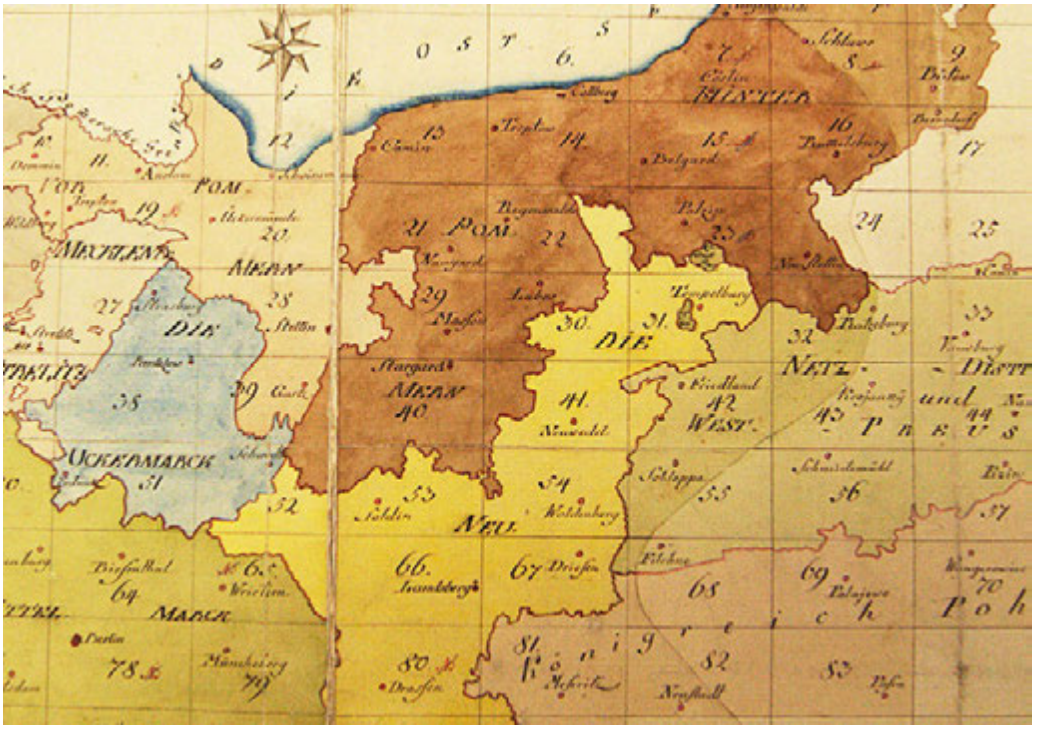


Fig. 7 Fragment of tableau for *Schmettausches Kartenwerk* with equal dimension segments, watermedia drawing. Berlin, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. SBB IIIC Kart L 5420/7.

several stages. Rectangular segments are clearly recognizable (Fig. 8). They are more or less overlapping in terms of the mapped area and lack individual descriptions both in the margins and in terms of their cartographic content. The map itself is surrounded by a broad frame. Segment No. 48, for instance, consists of three glued sheets of paper, together producing an elongated rectangle sized 192 × 48.5 cm (Fig. 9). Gluing together sheets of paper or their fragments to obtain a larger surface was a commonly employed technique although methods of joining pieces of paper differed. In some cases, the paper surface of particular segments was prepared first and then covered with the final topographic image.

The history of maps has been at times complicated as a result of the ways maps were stored and used. Sometimes a large sheet of paper consisting of smaller pieces was recut into more or less regular parts and

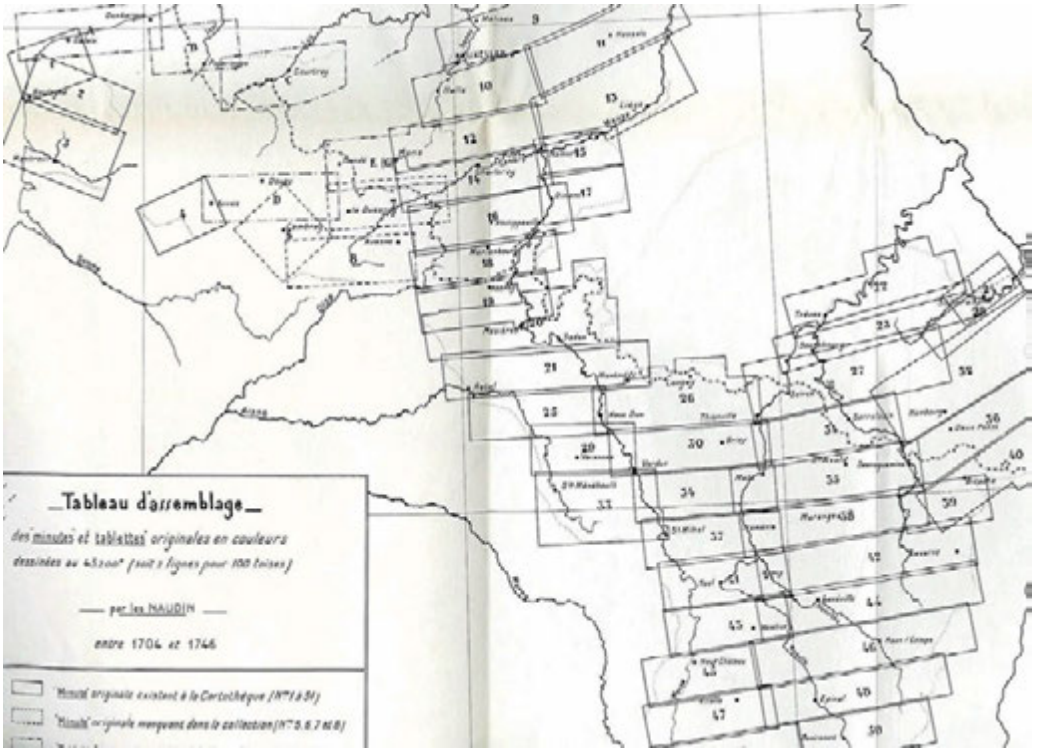


Fig. 8 Tableau of segments, groups of different scale, and orientation for *Minutes des cartes des Naudin.* After: Huguenin 1957. Paris Collection cartothèque IGN, Institut Géographique National.

Fig. 9 Segment with wide border. *Minutes des cartes des Naudin, 1704–1746, Epinal.* The reproduction is given in reduced size, real dimension: 192 × 48.5 cm. Paris, Collection cartothèque IGN, Institut Géographique National. LES NAUDIN: 48.

that is how a composite map, whose cartographic content was arranged on several adjoining sheets, was created. Such 'secondary' segments lack special sections outside the frames (Fig. 10). This issue is discussed further below as part of the analysis of draughtsmen's cartographic work.

In most cases, however, particular segments composing one map were produced on identically-sized paper sheets. In the case of the maps studied below, dominant formats proved close to the *Royal* (62 × 42 cm), *Imperial* (75 × 50 cm), *Grand Aigle* (90 × 60 cm), or the large *Grand-Aigle*-type (130 × 75 cm). Segment No. 14 of the *Schmettausches Kartenwerk* (Fig. 11) can serve as an example of a map section, one of numerous uniform parts of the whole work (in terms of size), that lacks additional descriptions on its narrow margins. The cartographic content of the segment is surrounded by a delicate line – the usual broader Indian ink

Fig. 10 The intersection of four sheets divided from one segment of *Nova et accurata Siciliae Regionum*, 1720–1721. Vienna, Österreichische Nationalbibliothek. ÖNB/KAR: AB 141, E19.585-D.

frame is absent here. The map also reveals the distinctive secondary cutting of segments whose fragments were later glued to the canvas. Such a flexible background allowed users to fold the map and store it in a box or case, thereby protecting the image. Each of the 3,000 segments of the *Josephinische Landesaufnahme*, drawn on a sheet of paper of dimensions 62 × 42 cm, was arranged according to these fixed composition principles, with the image surrounded with a black frame. The segments included sections with cartographic content and separate boxes with place names, linear scales and inventories. The margins outside the frames were covered with descriptions containing numbers of particular segments and the identifying numbers of the four neighbouring segments (Fig. 12). The segments of the map of Silesia were developed according to similar rules (Fig. 13). The author of this method was probably Giovanni Jacopo de Marinoni (1676–1755), who first used such a board structure

Fig. 11 Sheet from *Schmettausches Kartenwerk* without border, cut into 15 × 21.5 cm sheets, which were then glued to the canvas. The full dimensions of the original are 93 × 57 cm. Berlin, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. SBB IIIC Kart L 5420/ 14.

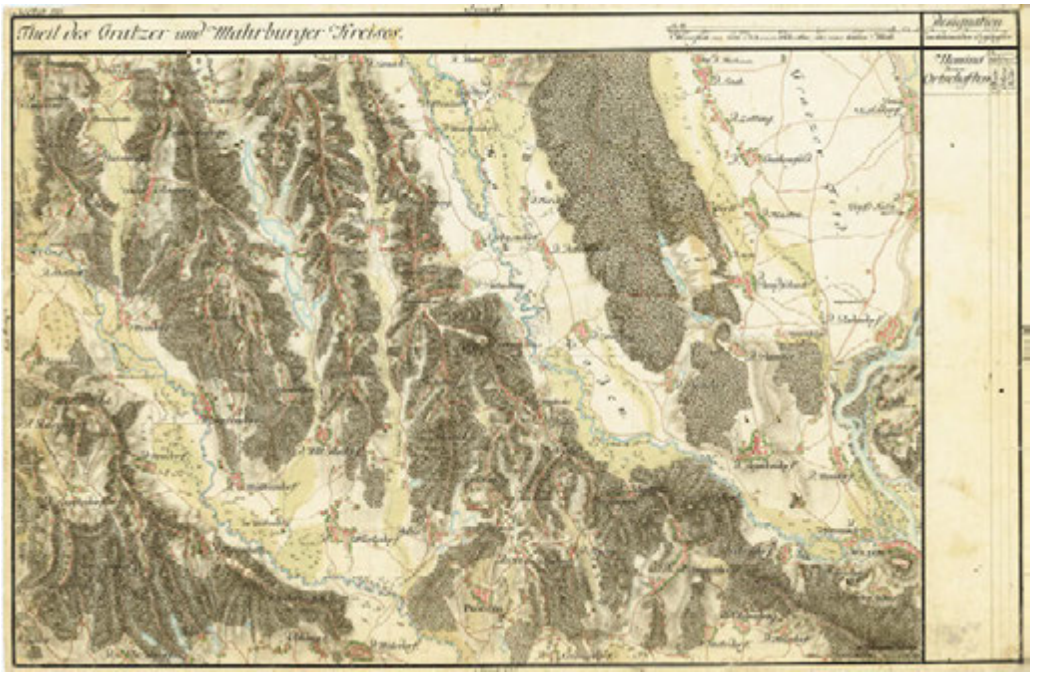


Fig. 12 Sheet from *Josephinische Landesaufnahme: Inneröesterreich* 1784–1787, Section nr 115-Stainz Widon. The full dimensions of the original are: 62×42 cm. Vienna, Österreichisches Staatsarchiv: Kriegsarchiv, BIXa: 54.

in his maps of the Habsburgs' hunting areas, the *Jagdatlas Kaiser Karl VI* of 1726 (*Neuer Atlas der Kayserl.en Wildban in Österreich unter der Ens*; ÖNB/KAR: K I 98480).

Topographic maps often resembled island maps, since their cartographic content was limited solely to the administrative borders of the mapped territory. The surface outside these borderlines remained 'empty', that is, devoid of any cartographic signs. The map of the Susa Valley developed by Savoy cartographers Avico and Carello to reflect the delimitation of the French-Savoy border in 1746 (Masabò Ricci and Carassi 1987), is a perfect example of such an 'island'-type work (Fig. 14). The large size of the finished map (254×106 cm) required smaller paper sheets to be glued together to obtain a surface that could then be drawn and painted on. Other map elements, such as their titles, compass roses or linear scales were placed in empty sections (those lacking cartographic

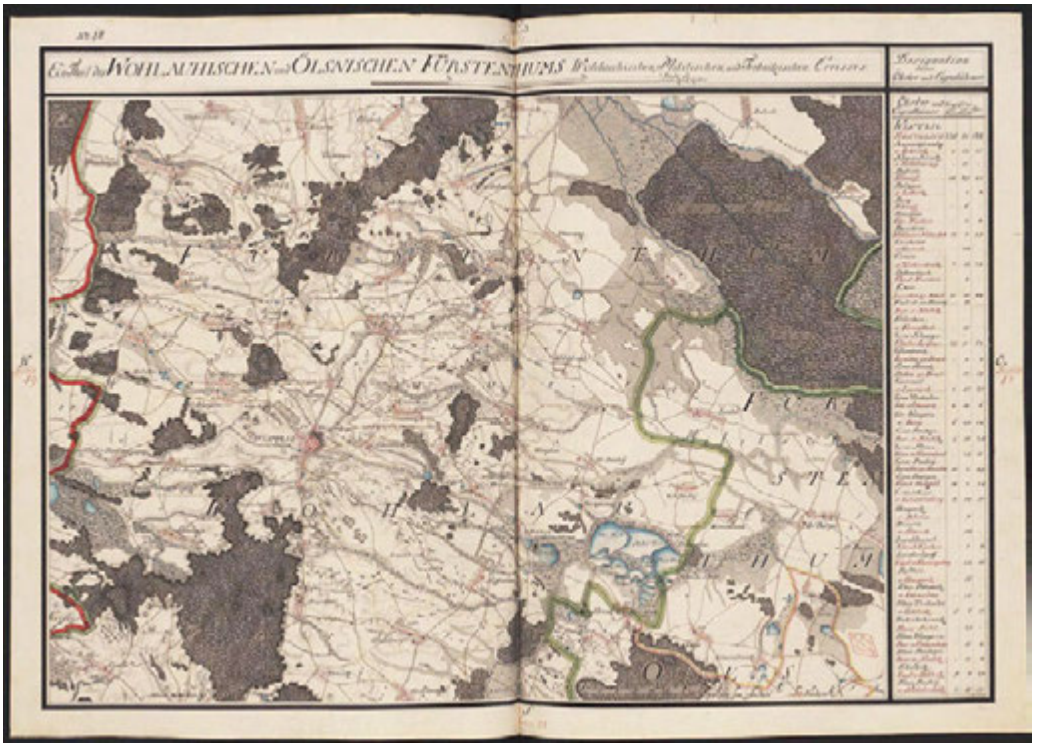


Fig. 13 Folio from *Kriegskarte von Schlesien*, 1747–1753, Band 5, Blatt 18. The full dimensions of the original are: 73 × 52 cm. Berlin, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. SBB IIIC Kart. N 15060.

images) of particular segments. To surround the whole segment composition with a black frame with margins made the images seem stable and complete. Storing such large maps could be problematic. Their rolling or folding might be difficult, even damaging, operations. Owners usually hung maps of considerably great size on the walls of their map cabinets, thereby decorating the interiors and enabling the overall viewing of cartographic images. The *Ufficio Topografico* in Savoy was arranged exactly according to the above principle. On the display of map as expressions of power, see Barber and Harper (2010) and *Il Teatro delle Terre* (2006).

The map of south-eastern Norway (Fig. 15) is another example of a work that consists of several dozen large 'island' maps. The cartographic content of each island map sheet was limited by the geographical boundaries of lakes, rivers, ranges of hills or by the borders of

Fig. 14 'Island' map of Susa Valley (*Carta topografica in misura, delle Valli di Cezana, e Bardoneche…*), 1764. The full dimensions of the original are: 254 × 106 cm. Turin, Archivio di Stato di Torino: Susa 7.

smaller administration units into which the entire area of Smaalenene (Smålenene) was divided.

Another significant factor influencing the final graphic manner or style of topographic images was the discovery of appropriate methods for an overview and the measurable presentation of topographical features, that is, to present relative heights and the spatial extent and size of slopes or hillsides. Eighteenth-century cartographers solved this problem in two ways: graphically and painterly. The first one included hachuring with a mapping pen and quill using Indian inks. The lines produced different thickness and different density, width and length, which allowed them to reflect differences in the height and steepness of hills or mountains, and the depth of valleys and gorges. The second method required shading of slopes with overlapping brushstrokes and introducing a variety of grey values to areas of colour.

The fair copies of two maps displaying Sicily provide examples of the use of these different graphic procedures. The images were based on the same field survey conducted by Samuel von Schmettau in the years 1720–1721 (Figs. 16 and 23). The draughtsmen employed differing watercolour techniques that resulted in a distinctive visual quality for each

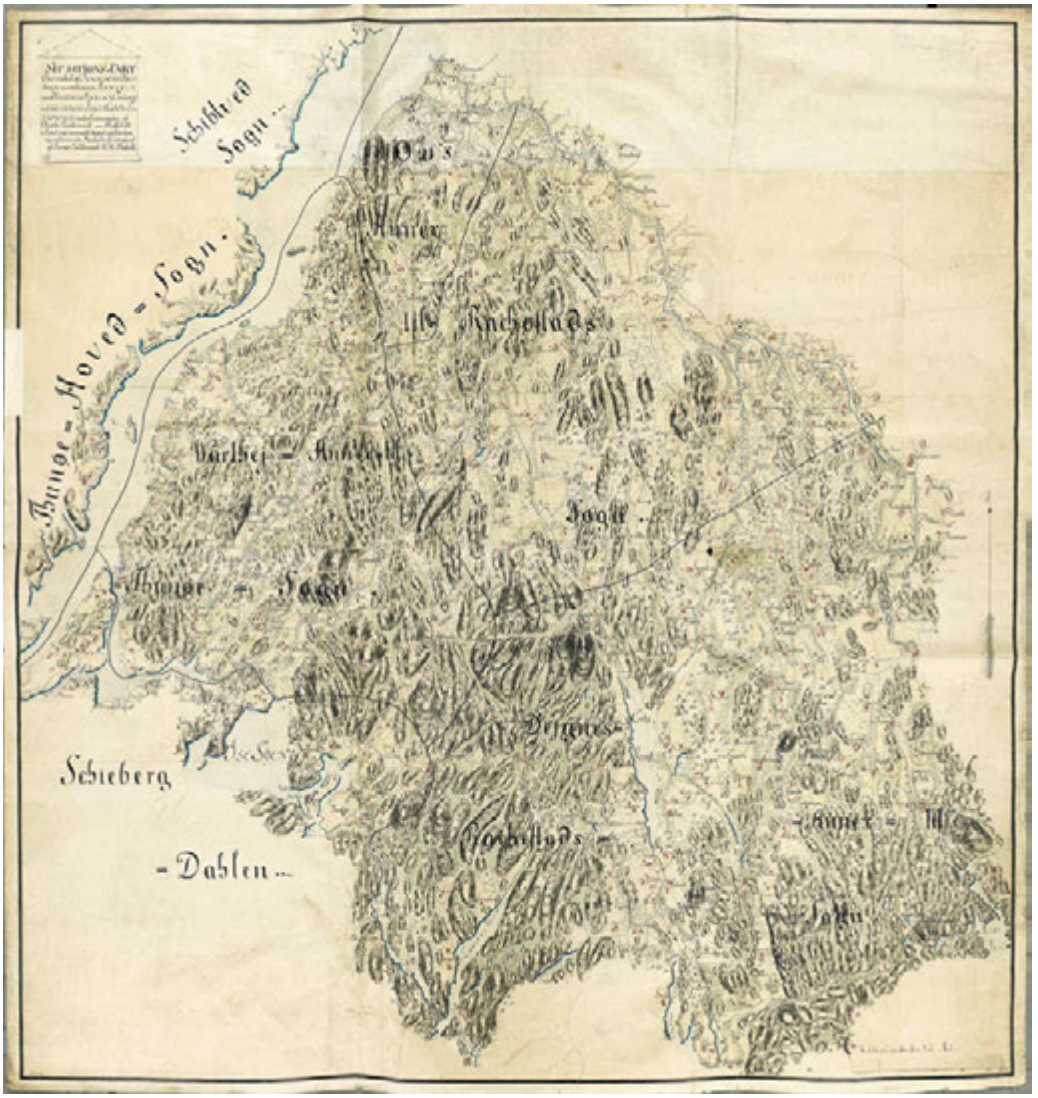


Fig. 15 One of twelve 'island' segments of *Situations Cart over Smålenene*, 1795–1797. The full dimensions of the original are: 170 × 180 cm. Copenhagen, Det Kongelige Bibliotek. KBK III2.127-0-1795-8.

map. Importantly, both authors used the same map symbols for housing areas, roads and rivers. Nonetheless, in one case (Fig. 16) the draughtsman used specific formulaic hachuring in black and painted forests using distinctive tree symbols with black outlines in-filled with green. In

Fig. 16 Fragment of map *Schmettau-Karte von Sizilien*, 1719–1721, Vienna, Österreichisches Staatsarchiv: Kriegsarchiv. B VII a 470.

the other, the cartographer rendered forest areas with multi-tone shading covering the layers of green spots below (Fig. 23).

Map symbols constitute an essential element of cartographic content. They have been used since the dawn of map making and in cartography and have always been either pictorial or graphically symbolic because in their use they derive from obvious and intuitive associations with actual objects. In the case of European maps, these symbols were broadly created by shared views over symbols and their cultural purpose with the result that their interpretation is, relatively, straightforward. As a result, eighteenth-century maps generally provide consistent visualization of European topographic space. Map symbols used to mark topographic objects were based on similar principles and were, in general, graphically alike.

Because the content of topographic maps could be read intuitively and given small numbers of their users, an additional explanation of the symbols in the form of legend was usually not necessary. It should also be kept in mind that the images produced were meant to remain confidential. For these several reasons, manuscript maps either did not

contain a legend, or included one in an abridged form to clarify symbols using spots and lines. It did not mean, however, that cartographers enjoyed freedom in this respect. Quite the contrary: they obeyed the rules for employing map symbols, or even their typology. General instructions regarding the scope of mapping were always included in orders and letters signed by monarchs or the authorized heads of engineer corps. Significantly, these commands or instructions also included the principles of map colouring. The one offered by Marinoni's textbook of 1751 discussed the core colours to be employed in cartography and indicated which colours corresponded with particular topographic objects. A manual for map-making surveyors of the Prussian corps published 20 years later advised them to use the following colours: light yellow for oak forests; greenish for beech forests; intense yellow for swamplands; yellowish for fields; grass green for meadows; stoneware red for country housing areas; Prussian blue for rivers, lakes and ponds; faded-ink black (i.e. grey) for peat moors; and greenish for coniferous forests (Hornung 1900).

A good example of such manuals is the one published in 1782 by Major Ludwig Müller (1734–1804), an engineer officer in the Prussian *Plankammer*. It offered a complete colouring legend for topographic maps produced by order of Frederick II. The juxtaposition of colours and objects (Fig. 17) contained the map colouring legend adopted by all of these working in Prussian cartography at the time. It was published in the form of twelve overview boards presenting all the painted map symbols. As Figure 14 shows, the legend contains instructions on the tripartite use of colours: 1. Determining specific colours for particular objects (e.g. red for housing); 2. Employing two shades of given colours for a specific symbols (e.g. blue for rivers); and 3. Mixed and overlapping colours of different shades to mark certain areas (e.g. green, blue, or green and blue for wetlands) (Müller 1782; Medyńska-Gulij 2016).

Researchers studying the colouring of manuscript topographic maps developed in the eighteenth century have emphasized the significance of these colour schemes. The maps normally reveal harmonious combinations of the commonly-used four or five colours of different brightness

Fig. 17 Coloured copperplate details from the legend of topographic signs used by the Prussian school. From Ludwig Müller, *Vorschriften zu miltärischen Plan- und Kartenzeichnungen in 12 Blatt*, Potsdam, 1782, Pl. VI.

and intensity. Generally, cartographers adopted distinctive and perceptive colours, i.e. the clearly visible ones with immediately recognizable names, such as blue, yellow, green, red, brown, or black (Robinson et al. 1978). This colouring system, however, requires further specification. Area surfaces were typically covered with lighter colours, whereas spots or lines were painted with darker ones. To facilitate their being noticed, spot symbols were usually surrounded with black or grey outlines to give greater contrast.

Sets of the dominant colours of given maps influenced their perception as warm or cold, fair or dark (Koch and Medyńska-Gulij 2013). Such differences in the recognition of colour 'temperature' and brightness of the whole cartographic image also stemmed from the differing use of watercolours. After all, this works were sometimes produced according to the same conventions determined by official instructions or other norms, but by different teams, engineer units or draughtsmen (Medyńska-Gulij 2017).

Colours proved of particular importance to the final legibility and readability of maps. Achieving a proper contrast was an essential way of preserving a visual hierarchy of the given graphic elements. This principle is consistent with Arnheim's gestalt psychology of visual perception. According to this author's theory, colours served to visually organize particular graphic elements into one holistic image – in the case of cartography, a map (Arnheim 1965; Medyńska-Gulij 2013). Arnheim adopted gestaltism as the basis of visual perception in art. He viewed perception not as the mechanical registration of elements, but, rather, as an aid in grasping the important structure of patterns and integral features. In cartography, reading maps is connected with grouping the elements of content. Therefore, their viewing yields similar problems. The basis of cartographic design is connected with graphic design, that is to say, the artistic image. According to Arntson (2003), 'the designer works not simply with lines on paper, but with perceptual structure'. Such holistic perception is only possible when a map, understood as an image, constitutes a consistent work in terms of graphical means of expression. A uniform technique is key here, since – being by no means a sine qua

non – it significantly adds to the overall consistency of final effect. For these reasons, the consistent use of the drawing and painterly techniques based on water-soluble binders prove critically significant to the final outcome of a given cartographic image. What is more, the technical homogeneity concerns not only reading particular graphic symbols, but also their complementary use (cf. the fragments of maps in Figs. 14–19 and 22–24).

In the case of manuscript topographic maps, the complementarity of the graphical means of expression is especially important and positions the analysed works between two spheres: one of artistic production, one of topographic documentation. The classic model of cartographic communication – cartographers' coding information about given geographic spaces in symbolic form of and handing the result to its users (Koláčný 1969; Freitag 1971; Ratajski 1973), who imagined this space by decoding particular symbols – is by its nature unique in respect to the works studied here in originating with cartographers' perception of landscape in the field and continuing in the form of field sketches and drawings. In this respect, these cartographic works met the requirements of documentary recording.

Nevertheless, using manuscript topographic maps introduced a certain ambivalence. The methods of their preparation and execution gave them the features of applied-arts objects. The format determined not only the practice of their storage, but also the ways of their viewing or reading. Depending on their function, topographic images could be hand-held, single-folded (e.g. folios folded in half) or folded into multiple panels and carried in saddlebags. Other variations of cartographic works included wall maps, sets of several maps in one binding, as well as sheet or board maps divided into sections. Each type demanded different viewing and reading, and appealed to various levels of perception. Some were meant to function as holistic works organized on one surface. Others provided their readers with book-like narratives. Yet others allowed either for joining their segments into a consistent whole or viewing them separately, rather like miniatures. Regardless of the type, the documentary status of a map could be weakened or even suspended.

Because the documentary status of maps as landform records might be lessened in these ways, other elements constituting cartographic works could become important. Particular colours, apart from the cartographic associations they evoked with the natural palette of the landscape (associative colours), provided a pictorial field with a certain optical order and – through shading – indicated a sense of spatiality and of dimensions. Such an effect was achieved thanks to their authors' skilful balancing between chromatic and achromatic contrasting which would produce clear (high) and weak (low) contrasts. These effects were nuanced by the degree to which the paints were diluted, a fact which allowed for gradations of colour brightness and intensity. It becomes apparent that the draughtsmen produced the effect of spatiality by preserving harmonious relationships between colours and simultaneously retaining an adherence to nature. This effect was heightened in other visualisation techniques used in relation to given cartographic content: graphic density resulting from varied hachuring or intensity achieved by condensing graphic elements. Without a structure that proved decisive for the visual perception of particular works the visual symbols (image) and inscriptions could lose their raison d'être. Images based in associations constituted an independent system, rather like mottos in emblems. Inscriptions, by the use of miscellaneous shapes, colours and sizes, explained the images like epigrams.

4. Map draughtsmen and drawing techniques

Training and education of map draughtsmen

The training of map draughtsmen has never been the subject of in-depth scholarly enquiry. For researchers in the history of cartography, it has always been more significant to look at issues such as refining measurement, shape distortions and the location of geographical elements, as well as the way in which they are codified. Similarly, for art historians, map draughtsmen remain outside their areas of interests. The perception of training of draughtsmen positions them somewhere between artistic and technical educational systems. Developing an interest in maps and investigating that interest usually implies working within a given paradigm, and for cartographers who deal with topographic maps, the way in which a map has been devised and made is usually less of an issue than is attention to the methods of taking measurements, applying the topographical signs and understanding the content of the map itself. Some attention to the issue of training has appeared in studies of Italian cartography (Liva 1984, 1987; Concina 1987; Vivoli and Toccafondi 1987), and there is also some information provided by research related to French cartography (Bousquet-Bresolier 1993, 2003, 2008a; Jacob 2008; Warmoes 2008, 2016).

Special emphasis, however, ought to be placed on the findings brought to light by Anderson (2009), regarding the education and training of British draughtsmen. In order to establish the state of knowledge and the level of education of the time, we can refer to the surviving drawing manuals, as they provide a clear reflection of contemporaneous didactic practices (Oznam 1693; Gautier 1697; Buchotte 1722; and Dinsdale 1748, a free translation of the latter). The majority of recommendations in these manuals remained unchanged until the end of the eighteenth century. When, in 1796, Franz Heinrich Backenberg, the long-time head of the Saxon Cadet Corps in Dresden, published his manual for military engineers, he reiterated in his remarks on drawing the fundamental recommendations by Buchotte proposed ninety years earlier.

Given its political significance, modern topographic cartography has since its inception been under the control of the political authorities and subject to the specific will of a monarch or the rule of the state. The best example of such regulations are patents granted to land surveyors. Admission to the profession of military or topographical engineer was often carried out through a series of exams, and apprentices were generally military people; similar patterns can be discerned with regard to those trained in building fortifications. However, the fact that a variety of bodies were instituted and put in charge of planning and mapping did not mean that these bodies automatically became places of training. Institutions devised primarily to inspect and supervise played a major role in the formation of map draughtsmanship as a distinct occupation.

A case in point was the English Board of Ordnance, established in 1597, which was initially a quartermaster service. A similar role had the Turin-based *Azienda Fabbriche e Fortificazioni*, created from several lesser entities in 1717 and the *Generalquartiermeisterstab,* set up in Vienna (formally in existence from 1758). Additionally, in the small Italian states, there were institutions, often communal by nature, that enjoyed the status of privileged collegial bodies empowered to keep an eye on the production and the quality of maps, such as the *Collegio degli architetti ingeneri e agrimensori* in Milan (Liva 1984, 1987).

It comes as no surprise then that also the training of draughtsmen, who were expected to develop maps, was in many European countries subjected to a similar rigour. Even in places where people from outside the military structures were permitted to become draughtsmen, the process of education and training was kept under the control of the state. The educational system of military engineers, including those land surveyors developing maps, was, in fact, the first state educational system to be popularised across Europe. The eighteenth century was the period in which the major European schools that offered training to engineering surveyors, including those specializing in drawing maps, took their shape. Often, the schools that provided training in drawing and handling colour to a high level were the predecessors of the academies of fine arts and similar institutions in which artists were trained under the supervision of the state. The centralisation of the educational system in this respect is indeed its distinctive feature as opposed to the artistic education system, still centred around guilds (Pevsner 1973). An educated draughtsman-cartographer was required to achieve a complete mastery of technical knowledge, not to mention the ability to master the drawing techniques at hand: in the eighteenth century it was watercolour that was unquestionably to the fore (Bosquet-Bresolier 1993). Given the characteristics of the areas to be drawn, draughtsmen were expected to be conversant in the ways of rendering them accurately. For example, the map draughtsmen in Venice were required to have the skills needed to draw the lagoon, and a proper rendering of the relationship between the *terraferma* and the sea (Bevilaqua 1987).

The origins of training draughtsmen-cartographers can be traced back to the school of pages at the court of Florence (*Paggeria*). In the sixteenth and seventeenth centuries it provided an education to people who were preparing for military service. Drawing masters were mostly professors of the *Accademia del Disegno*, the first-ever fully institutionalised academy of fine arts. It is noteworthy that mathematics was taught at a high level, by professors from the University of Pisa. Drawing was indeed the essence of scientific thinking in Florentine social and humanistic circles from the fifteenth century. Its standing was enhanced

by a major impulse (originating from the Galilean School where additional emphasis was placed on mathematics, and importantly geometry). Drawing was most probably taught following principles that were common in the Florentine circle of artists, so it should come as no surprise to us that so much value and importance was attached to this particular skill, primarily for those who pursued training in artillery and mapping. The place also attracted people who had previously been trained for an artistic profession, such as Giovan Pietro della Bella, a disciple of the sculptor Pietro Tacca. In the seventeenth century, the *Paggeria* was headed by a number of members of the Fantoni family, renowned set designers. The last of the Fantonis, Stefano taught the art of drawing there, and after him the position was assigned to Remigio Cantagallina (ca. 1582–1656), a well-known etcher, draughtsman, and painter (Vivoli and Toccafondi 1987). The person whose work marked the end to the *Paggeria* was Giuliano Ceccheri (1644–1705), an educated draughtsman-engineer who studied mathematics in the School of Vincenzo Viviani, a disciple of Galileo.

If map drawing in Tuscany moved towards mathematical schematism, in France – heavily influenced by Jesuit educational values – it became an intrinsic part of the education of the elites and the middle class. Here, a major role was played by the Clermont School in Paris, and especially by Pierre Père Bourdin (1595–1653). Bourdin placed emphasis not only on the practical side of drawing, but also on the relations between drawing and its application as a base pattern for prints. Amongst other things, students practiced red chalk (sanguine) drawings, or printed compositions on paper. Following Bourdin's death teaching passed on to Georges Fautrel, and – from 1661 – to Nicolas d'Harrouys. Without the Clermont school, which laid the foundations for the skills of future engineers, it is impossible to fully understand the advances that occurred in military drawing, including mapping, as a result oft the illustrious Sébastien Vauban and his circle. The key to these changes stemmed from the easier access to funding in science in seventeenth-century France, and – at the same time – thanks to the emphasis that was placed on mathematical training, which together with Latin was considered the

basis for the education of the new *gentilhomme*. France sought and produced talented individuals, irrespective of their social origins (Ariew 2003; Bousquet-Bressolier 2008a).

The changes that took place within the organisation of military bodies accelerated the training of military engineers. Vauban strove to create a consolidated system for teaching the art of drawing. Drawing was indeed a form of record of the knowledge acquired as a result of observation. It was engineers operating in the Vauban circle who developed the possibilities of watercolour painting and they who paved the way for the modern development of this painting and drawing technique (d'Orgeix 1994). In his posthumously-published manual, Vauban set out the key tenets of his theory. Despite the fact that maps – in contrast to fortification designs – were treated rather marginally by him, the direction of changes was clearly defined, and had a major impact on cartography. Vauban postulated a unified system for presenting the component parts on a map: from relief to roads and buildings. For him, even the paper format was of significance. The drawing ought to be precise and accurate, as its value increased in relation to its exactness. The information that appeared in the drawing had to be clear, precise and unequivocal. What mattered was not only the colour applied, but also the degree of its intensity or, possibly, its wash. The draughtsman was also expected to leave margins on the paper sheet to allow for additional comments or notes (Vauban 1714; Warmoes 2008, 2016).

The changes that took place in France effected a transition from drawing understood as a rhetorical and persuasive skill – a fact clearly related to Jesuit teaching – towards drawing understood as a rational and educative activity with, possibly, utilitarian ends. While it is true that in the Renaissance maths and geometry were perceived as 'pure' sciences derived from the tradition of the quadrivium that draughtsmen needed to prove the scientific accuracy of their works, the Enlightenment treated each action through the lens of science: drawing, including map drawing, was meant to be the visualisation of rational scientific procedures.

One key beginning in this respect was the *L'École d'artilerie de la Fère*, formed by Vauban and established in 1679 in the Paris Armoury. The

main specialist in drawing was Claude Masse (1652–1737), officially designated as *dessinateur* (Bousquet-Bresolier 1993, 2003). Thanks also go to Vauban who in 1696 witnessed the appointment of the *Ingenieurs des Camps et Armes,* the central service which dealt with developing maps and which, innovatively, sought cooperation between military engineers and civilian land surveyors. Within this system, independent cartographic enterprises carried out a variety of tasks commissioned by the state, one example being the family-run business of Naudin. Further reform of the educational system in France in 1720 led to the creation of a group of officers for the ordnance corps. The formation of the *Bureau de dessinateurs* took place in 1744, organised by Daniel-Charles Trudaine, whose key task was to make maps (De Coene et al. 2012). The crowning achievement of this re-shaping of the educational system was the foundation of the *L'École royale du génie de Mézières* in 1748, followed by the *L'École royale militaire* in Paris two years later. In Paris, drawing was taught to young adepts in classrooms early in the morning, and older students learning to draw landscapes in the afternoon. All the skills acquired were later tested by examination (de Saillet 1843; Jacob 2008).

Given its outstanding level of professionalism and teaching effectiveness, the French system, supported scientifically by the French Royal Academy, was imitated in other countries across Europe. It was adopted, among others, by the Kingdom of Sardinia (the Savoyard State), the Republic of Venice, and Britain (Anderson 2009). Inspiration was drawn primarily from a number of solutions devised at the School of Mézières. Not only was the epithet '*genie*' adopted instead of '*ingenieur*' – which signified for both engineer and a latent talent – but also an array of recommendations were proposed related to the art of drawing, especially the application of paints diluted with water (ink, Indian ink, and watercolours). Here, a major role was played by French manuals (Oznam 1693; Gautier 1697; Buchotte 1722). Gautier's manual was later re-edited and published in 1708, and in Buchotte's case, there were several later editions (1743, 1754, 1773; cf. d'Orgeix 2016). They were translated into Italian (Gautier 1760), German (Gautier 1751), and into English (Dinsdale 1748). These works not only helped to disseminate specific drawing techniques,

they also helped standardise the ways in which lines, signs and colours were applied to render the information about the mapped territory accurately. According to De Coene, Buchotte's manual provided the system of symbols and a key for the topographic map of the Netherlands, which was carried out by de Ferraris' team (De Coene et al. 2012).

In the Savoyard State, the main duchy of the Kingdom of Sardinia, a decisive factor was the appointment of the Topographic Office (*Ufficio Topografico*) within the already extant *Azienda Fabbriche e Fortificazioni*. It was established in 1738, but two years before, Giuseppe Ignazio Bertola had put forward a version of the rules and regulations of the Military Fortification School. The School took shape within three years from his presentation. The Turin Academy, started operating in 1739. Drawing was here deemed a relevant component of the education of the military engineers in the Italian states. The first drawing masters were two painters: Luigi Filippo Brambilla, and his deputy Gioacchino Brambilla (Franchini 2008). The former was a renowned painter working for the royal court.

Over time the Kingdom of Sardinia saw the appearance of an independent institution dedicated to training draughtsmen. This commonly referred to as the drawing school, worked closely with the Topographical Office, which was in charge of preparing maps. The drawing school was founded in 1777 on the existing core of draughtsmen. Their goal was to train officer-topographers from the *Legione degli Accampamenti*. The official seat of the school, headed by the *maestro disegnatore*, was in Chambéry. Drawing was also taught by draughtsmen employed at the Topographical Office. According to documents of 1777, Carlo Bosio and Ignazio Gavuzzi were obliged to provide training in drawing, including the *chiaroscuro* technique, as well as in the application of various painting techniques. The office of the *maestro disegnatore* was variously held by Luigi Grinjet (Gringet), from 1791 by Carlo Vergnasco, and from 1792 the position of the chief master in drawing at the School was held by Bossio. Draughtsmen were responsible for the execution of maps based on measurements, and for making any potential reductions in scale. The school was in operation until 1792, that is, until the first annexation of

the Savoyard State by France. In 1833, the school was transformed into an academy of art (Masabò Ricci and Carassi 1987).

There were numerous attempts to set up a state military school in Venice, but only in the 1730s did these ideas begin to take shape and then were heavily influenced by Vauban's work. A key figure who sent plans for the proposed school to Serenissima was Marshal Johann Matthias von Schulenburg. The engineering corps was eventually founded only in 1770; the school's organiser was Matthew Dixon, a Scot. The main inspiration was sought in the school in Mézières. At an earlier stage, Venetian ambassadors in Turin and Vienna, and obviously in Paris, were requested to send relevant reports on the military schools there. It must not escape notice that the Republic was also host to the *Scuola Militare* in Verona. From the information collected by Concina, it is clear that in 1778, cadets staged a protest against their drawing teachers, mostly against a man called Castellazzi. We may presume that in the Verona circles the French models served as a point of reference, and in schools, that French was regarded as a specialist language. Seven years on, however further unrest happened – this time against the teaching of French (Concina 1987).

The dissemination of the French model in non-Catholic countries was facilitated by the fact that many Huguenot officers emigrated after 1690s (Virol 2010). Some of them, after moving through the United Provinces, relocated to Great Britain. Information about teaching the art of drawing in Britain has been collected by Anderson (2009). In 1741 the *Royal Military Academy* was established in Woolwich, and three years later, Gamaliel Massiot was entrusted with the position of drawing master there. He was an accomplished artist, with experience gained in the Paris ordnance school. Draughtsmen employed at the Drawing Room of the Tower of London whose tasks included, among other things, re-drawing maps, were also affiliated with the Academy. The Royal Military Academy offered training to draughtsmen such as the notable brothers Paul and Thomas Sandby. In 1768 Massiot was replaced in his position as drawing master by Paul Sandby. The Sandby brothers received training from Clement Lemprière, who was a draughtsman in the Tower since

1717, and who, from 1727, was assisted by Peter Desmaretz, later his successor. Both Massiot and Lemprière were established and well-known watercolour painters.

With respect to the British selection of staff, emphasis was placed on the drawing talent of the potential map makers, rather than on their mastery of technical skills. In 1765, in order to take their first-grade exam, cadets had to draw a landscape using graphite. This was also the case of the second-grade candidates (most probably in watercolour); and the third and fourth class had to produce a landscape and a perspective drawing (most probably by applying watercolour as well). In Woolwich, the system of French teaching continued to be a matter of interest, and in its academic library, at least in 1806, Buchotte's manual was listed, as also its English translation (Catalogue Woolwich 1825; Anderson 2009).

Paul Sandby's work at the Academy initiated further changes in training of topographers in Britain. The drawing master was expected to impart the skills of rendering space in line with the rules of the art. Cadets had classes in perspective and landscape on Tuesday, Thursday and Saturday mornings, based on the idea that the best possible light was available at that time. During the classes run by Sandby, cadets learned about the ways in which the Earth's shape could be rendered by dint of a drawing, how to compose views and how to draw lay architecture. Thanks to these classes, cadets were expected to understand the great weight attached to the drawing process, as well as the objectiveness and usefulness of the resultant picture. Sandby believed that it was necessary to teach them to look both at the effects of light, to master the ways of presenting such effects, and to help them render the drawn area from a position of height – a bird's-eye-view perspective. Teaching was based on specific examples taken from the surrounding environment. Throughout his teaching, Sandby used the French notion of 'the soldier's look', which came down to a particular way of observing an area so as to grasp what was of essence to a soldier looking at a map and a landscape, that is the possible paths of marching to be used by troops, or points of importance in a battle. This was in fact a fairly unaltered set of principles, already known from Vauban's.

In 1772 a number of structural changes led to the establishment of the Lower Academy and the Higher Academy. Each of the academies relied on a programme based on four grades. Different teachers would teach drawing in the lower grade, i.e. the rudiments of graphite and ink drawing, copying landscapes, drawing military insignia, and the rudiments of perspective. The Higher Academy was in the hands of Sandby, who organised it in detail. He taught cadets to draw landscape using Indian ink and indigo ink and to apply various shapes. He felt it was essential to teach students to draw modern fortifications by adopting the appropriate perspective. All this was made possible by acquiring a knowledge of geodesy and by practicing drawing techniques. Cross-section drawings that showed geological structures were also taught there (Anderson 2009).

It is hard to determine the general framework of a drawing education for engineer-land surveyors in the states of the German Empire. Electors in Hanover, Dresden and Berlin had teams dealing with the collection of maps for their sovereigns. Yet, until the Seven Years' War, there had not been any specialist cartography service (Torge 2003). In part, basic education was provided by the corps of cadets then springing up at that time, but the one founded at the orders of the Prussian king in Brandenburg following the 1765 reform did not include drawing in its syllabus. Drawing taught only in the reformed corps of cadets, commonly referred to as the *Academie Militaire*. From 1777, the position of drawing master was held by Johann Moritz Stuten, who was also teaching the art of drawing to the *Cadetten-Corps* (Adreß-Kalender 1759, 1777, 1798). At the end of the century, he was assisted by the renowned architect Friedrich Gotllieb Schadow (1761–1831), who specialised in architectural drawing. Stuten was a historical painter, a portraitist and a miniaturist, and his daughter, Mademoseille Stuten, was widely known for her landscape drawings (Nagler 1847).

Towards the end of the eighteenth century, an officer and engineer Karl Ludwig von Lecoq (1754–1829), highlighted the numerous achievements of Isaak Jacob von Petri (1701–1776) with respect to post-1763 cartography in German speaking countries. Petri, an engineer and officer

from the Prussian *Genie-Korps*, known for his rather unsuccessful maps of Saxony, was nevertheless, according to Lecoq, a key figure in teaching modern cartography. Lecoq notes that until the Seven Years' War drawing in military cartography in the German states was still in its infancy, as, at that time, it was still common practice to draw by applying the principles of perspective. If the draughtsman was striving to be a painter, this meant he had to depict raised objects from one point of view and then apply *chiaroscuro*. The visual end effect for the eyes was quite attractive, but what soldiers actually needed was a horizontal projection. There was no need for the interplay of light and shadow. The terrain in question ought to be presented as if it was seen from the same height in mid-air (Lecoq 1798).

According to Lecoq, the foundations for this particular manner of drawing were established by Prussian engineer Major Petri in his maps made during the Seven Years' War. To be more specific, they were the situational maps, showing points A and B from the areas between the Elbe. This maintained their value, although they were not quite finished. Lecoq maintains, that Petri's method was applied by Captain Ludwig Müller (cf. the legend to symbols on Fig. 14) and above all by the Saxon Captain Franz Heinrich Backenberg. Backenberg was the author of an already cited manual for engineers. As Lecoq noted, its main advantage lay in the fact that Petri's method is a self evident method, and each military man – regardless of his nationality – is able to oversee the area for himself, without actually encountering it.

The details of the situation at the Viennese court are similarly unclear. From the end of the seventeenth century, attempts were made in Vienna to create a system of engineering education. Originally, they were backed by institutions and by individuals, who, while operating in Habsburg circles, did so without their rulers expressing an interest in such matters. In 1692, on the initiative of the Lower Austrian gentry, the Country Academy (*Landschaftliche Akademie*) was formed, but of primary importance for develop on engineers training in Vienna was the involvement of Prince Eugene of Savoy, an military man and statesman. He played an active role, with the Emperor's approval, in the establishment

of the *Ingenieur-Academia* in 1717 (Gatti 1901), which functioned from 1720. Here, the position of sub-director and a key figure for several years was Marinoni, court mathematician and astronomer, and the author among others of a map of Vienna, along with elaborate multi-segment maps of hunting lands owned by the Habsburgs. Marinoni was above all known as the organiser and author of the first cadastral maps which he made for the land of Lombardy, later taken over by the Habsburgs. Marinoni, in addition to knowledge on fortifications imparted to his cadets on academic courses, appreciated the role of *Feld-Messerey* and kept demanding to expand teaching in this area of engineering (Gatti 1901; Sofonea 1976). From letters he left, it is clear that Vauban was one of the authors whose significance for the development of military engineering at the academy was a major point of reference (cf. Chapter 3). All issues related to cartography in Vienna came in time into the hands of the *Generalquartiermeisterstab*. The Habsburgs were more concerned about formal regulations concerning the organisation of the cartographic service in their territories in Lombardy, Tuscany, and the Netherlands than they were for territories in Bohemia, Hungary and their native lands of Styria and Austria.

To see the bigger picture, one needs to note that thanks to a bequest by Prince Eugene of Savoy, in 1749, it was possible – following numerous attempts – to open the Knight Academy, also known as the *Emanuelina Academy*. Its founder was Princess Maria Theresia of Lichtenstein, wife of Prince Thomas Emmanuel of Savoy-Carignan, the nephew of Prince Eugene. It is certainly true that one can align the origins of Viennese cartography with the French academy *La Fère*, chiefly through the work of Jean-Baptiste Brequin (1712–1785). Brequin was an accomplished cartographer of cadastral maps, and a talented soldier.

The worth of the Military Academy was for years underestimated by the Habsburgs, despite Marinoni's efforts. Attempts made to reform the academy in 1743 failed; change came only with the reform initiated by Leopold Joseph von Daun, who, as Chief Director of Military Educational Institutions (*Ober Direktor der Militär-Bildungsanstalten*), had responsibility for engineering instruction for the general imperial army.

In 1747, he developed the *réglement* system regarding the training of officers, and two years later, in December 1749, was nominated director of the reformed *Militär Akademie*. Following the reforms, education at the academy took a minimum of three years, and teaching was complemented by regular fieldwork training (Gatti 1901). This allowed the education of groups of specialists who took up the challenge of elaborating maps for the Josephine survey (*Josephinische Lanesaufnahme*). Soon after, in 1753, taking the French system as a model, Brussels opened the *Academie Militaire di Genie*, and three years later, the Imperial and Royal Netherlandish National Field Ordnance Corps in Mechelen was established. Mechelen became the base headquarters for the survey of the Netherlands under the supervision of Joseph-Jean de Ferraris, begun in 1768 (De Coene et al. 2012).

Paper and the preparation of its surface

Drawing maps necessitated transferring the preliminary data that had been collected and recorded in the drafts onto a paper medium in preparation for production. Although the only material used at that time was paper, there were several methods in which topographical maps could be made, and each required a different procedure. Each had its drawbacks and limitations that made it complicated to achieve a quality result. Yet, at all times, the draughtsmen were required to be well prepared both in terms of knowledge of cartography and in control of the mastery of drawing techniques. Questions of aesthetics also played a major role. Some projects employed several draughtsmen at the same time, and it was common practice to employ many more people for the production of an entire map collection.

One of the key issues underlying the process of drawing of a map was its format. Although literature of the subject makes frequent reference to the multi-sheet map, actually the so-called map sheet did not always correspond to the size of the paper sheet used during production. Sometimes, the sheets were trimmed – at other times they were joined. There

were also instances where a selected type of paper sheet, once the ragged edges had been trimmed, served as a module for the person drawing the map.

Based on the analysis of the paper from maps studied in this book, one can formulate two basic observations. First, in the cases studied, European-type laid paper was used, an exception being the map of Kent, which was drawn on woven paper, which, from the 1780s, gained popularity across Britain. Second, the format was commonly called *Imperial,* or *Colombier*, and measured approximately 58 × 78 cm. There were exceptional cases where huge sheets were used in the *Grand Aigle* format, its close counterpart being the English *Atlas Imperial*. In some cases, it is possible to discern watermarks. References to the selection of paper were made by Gautier, Vauban, and Buchotte (cf. also Dinsdale 1748). The latter also dedicated a separate chapter to the ways of gluing pieces of paper into larger units, and their possible ungluing.

In the eighteenth century, the best paper was manufactured in France and the United Provinces: these two countries not only supplied the domestic market, but produced it for export. The German lands had their own paper mills. In Prussia manufactures were short of rags and glue, which explains the fact why an export ban was imposed on them and on raw materials for production of glue (i.e. hooves and skin). As far as the quality of paper is concerned, a major crisis was experienced by Italian paper mills. It turned out that transalpine paper, in its properly finished and smooth state, was better suited for paints diluted with water, and, therefore, for handwritten maps. From examination of the watermarks, French and Dutch paper was widely used in the Kingdom of Naples. Only after the outbreak of the French Revolution did the English manage to break into the market. Already by 1791 woven paper was in use as much better suited for drawing maps than laid paper (Valerio 1996). By the outset of the nineteenth century, Dutch paper was the most acclaimed, although – as Backenberg noted – we should not overlook the high quality of paper originating from England and Switzerland (Backenberg 1810).

Irrespective of its origin, several rules had to be observed with regard to the selection of paper. First, the bigger the format, the more durable

the paper should be. The most sought after paper was one that was properly smoothed and pressed. Colour of the paper was also important. For drawing, it was best to use white paper: the whiter the better, as this allowed one to make best use of the possibilities offered by paints, Indian ink and ink.

From an examination of the maps in this study, we may distinguish two major ways in which the so-called map plane was made. The first included one regular-measure sheet of paper and made up one segment. The second was the result of combining a few regular-measure sheets or pieces into one segment that constituted a part of the map (work), or by joining several sheets into one large segment, which constituted the entire work.

In the first case, when the sheet was made up of one segment, both the smaller and the biggest formats were selected (cf. the breakdown of the sizes of segments listed in the Table, pp. 96–97). As a rule, prior to beginning drawing, an internal modular frame was marked within which the proper segment of the cartographic content was to be made. Leaving a tiny free margin protected the plan against any possible damage of the information placed on the edge of the sheet of paper. This pattern was adopted by William Gardner in his execution of the map of Kent. It was also common to put additional information on the margins that made it easier to match a given segment with a neighbouring one; this meant providing the numbers of the neighbouring segments. This also made it possible to determine the points of the compass. These complementing items were added to make the grand map of the Josephine survey (*Josephinische Landesaufnahme*), the first military survey of the Habsburg Empire (Figs. 12 and 26). This solution was incorporated in Wrede's five-volume atlas of Silesia (Figs. 13 and 24). Here, ready-made sheets were bound *in folio* and individually stapled to form a coherent unit, each consisting of approximately 40 maps. An obvious advantage of the solution adopted in the *Kriegeskarte von Schlesien* was ease of storage; however, subdivision of the territory into small segments did not offer a single comprehensive view over the entire terrain. If the maps were left to be as separate sheets, their use was much less restricted as it was

possible to juxtapose them against one another. It should not surprise us to learn, then, that it is, in fact, the royal atlas copy that has survived to the present day, preserved in almost perfect condition, while the remaining loose-sheet copies have not survived. Both variants – i.e. loose sheets, and those bound to form one volume – were drawn in identical ways: the cover was made after the map's execution. This explains why it is appropriate to treat them as one separate group.

Loose sheets could be joined in ways to form a map of the entire territory, or – once accurately correlated – set against one another. This allowed them to be used conveniently when they covered a vast territory, even if this entailed joining the sheets of paper, or possibly pieces cut from them, into bigger units. Technically, there were two ways of joining that influenced the choice of drawing method: paper could be glued prior to commencing drawing; or after the cartographic content had been drawn.

Gluing prior to commencing the drawing process gave a coherent picture of the entire territory. The large maps that were thus created were meticulously elaborated upon in the places where they joined, and these spots were sometimes very skilfully hidden. One of the best examples of this is a map of Susa Valley, dating to 1764. The sheets, and even smaller pieces were glued together and placed in ways to form an extended rectangle measuring 254 × 106 cm (Figs. 14 and 27). In order to prepare this huge map, the 35 × 46 cm *Officio* format components were used, but once the map was completed, the whole work was complemented with a narrow five-centimetre band at the bottom, whose gluing had to be concealed under the frame coated with Indian ink. In this example, it is possible to see a few pieces superimposed on other parts to correct for errors.

A similar principle was observed throughout the preparation of the foundation for the segments of the map of the south-eastern Norway (Figs. 8 and 22). The starting point was the segment glued from a couple of sheets. Once the map was completed, and before the frame was added, additional bands were glued on the vertical margins, and the binding margins were concealed under the line of the ink. The binding was made with sheets of paper identical in size and quality. However, in the segment

from the area of Epinal marked on the map, the glued segments were not strictly correlated to one another; instead they overlapped, which means that each made up a distinct compositional whole (Fig. 9).

Draughtsmen needed a variety of skills to be able to prepare the fundamentals for mapping. Most importantly, the paper needed to rest on a large table that was accessible from all sides. Most probably, drawing begun from the middle parts and moved to the outside. Throughout the work, the risk of making a mistake was great and the process could take several days. If a mistake was made, the whole piece had to be discarded. The length of the map could conceivably have no limits, however, if breath exceeded 120 cm, a draughtsman had to lean forward over the table and cover parts of the map to prevent damage. When a draughtsman made a map using this method, he did not have to spend much time preparing the registration marks needed to correlate separate sheets. A well prepared and glued paper allowed him to add the line using graphite, or a pen, or possibly a small brush, even over the slightly thickened glued spots. Any minor ruptures, or possibly any weakened intensity of the applied colour that might occur, did not impact upon the full bond of the lines or the colour blots. One unquestionable advantage of this procedure was its final visual effect. The sheets thus drawn were also characterised by the fact that they featured additional information, and their distinctive nature was made more evident by their clear framing.

In a functional sense, for example, the grand map of the Hanoverian Electorate (Figs. 18 and 28) belongs to the first group, as the segment is relatively small, and the entire work is bordered by a thin frame with the cardinal directions. The segments were made by gluing two sheets in *Imperial* format. On the axis of the segment, below the town of Riesenlentz, it is possible to discern a loosening of the glue, which has uncovered a piece of the sheet's edge underneath it. There are no visible registration marks on it, or any other auxiliary markings used throughout the gluing, once the maps were brought to a completion.

The second technique required a completely different preparatory phase. Here, large sheets of paper were used, and the most frequent variant was made up of four sheets joined horizontally. In this case, it did not

Fig. 18 Sheet of map *Kurhannoversche Landesaufnahme*, 1764–1786, Original dimensions: 90 × 61 cm. Berlin, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. SBB IIIC Kart N 25564, Blatt 59.

matter whether the individual sheets were prepared by one draughtsman, or by a few who would work independently and, every now and then, would check the accuracy and correlation of their sheet with sheets made by someone else. This made the use of large sheets of paper very practical. First of all, on the sheet, one had to include all the relevant registration marks and other auxiliary lines, or, possibly, the grids that allowed for the transfer of information from the preliminary drafts onto the larger format. The sheets had to be matched in order to ensure that the lines that cross their edges, which would meet the lines from another sheet, were neatly and accurately joined. This was not always successful, even for professional draughtsmen. An example of this can be seen in the map of the Austrian Netherlands made by de Ferraris team (Fig. 19). The same map illustrates another major problem with this technique.

Fig. 19 Segment of a map stuck together with four paper sheets. *Carte de Ferraris*, *Carte de Cabinet des Pays-Bas autrichiens*, 1771–1777. The full dimensions of the original are: 141 × 91 cm. Brussels, Koninklijke Bibliotheek. 9 – Dixmude.

Perfect harmonisation of the tone and intensity of a given hue on all the sheets that were part of a glued segment was unattainable and posed a clear limitation on the colour in topographic maps. Sometimes, the difference in tones was easily discernible, as is clearly evident in the Austrian Netherlands, in which the same forest complex covering parts in the centre of the segment – that is, at the meeting point of four sheets – was drawn in different shades.

Another example is the map of northern Scotland (Fig. 25), which is a composite map made up of 28 extended different-sized sheets-bands, cut at a later stage from the earlier glued rolls of 38 segments. This map, like its other final variants, was transformed several times (Skelton 1967; Anderson 2009). In its current shape, the map reveals some serious defects located between the individual bordering sheets. There are also pieces where, once the sheets were joined and a unique Indian ink swoosh was made, it is clear to see that the neighbouring parts do make up a whole.

In addition to these identified groups, there remains the map of Sicily, executed under the supervision of Schmettau (Fig. 10). One key problem that makes its classification difficult results from the fact that this map has not been preserved in its original condition. It was most probably in sheets of *Imperial* format. But, it is plausible to assume that it was intended as a huge wall map and so should be classified as part of the second group.

A further separate group consists of those maps in which the sheet has been cut for practical reasons and glued onto the foundation, on canvas, or sometimes on paper. Without precise conservation and restoration research, it is impossible to determine whether the gluing was one of the stages of making the map, or whether it was done at a later stage, given any problems with storage, or use, for such a map. Based on a cursory look at the map and the foundation, it would appear that the division of the map into smaller segments was made later. Secondary cutting of a sheet is easily recognisable, mostly in places where any inscriptions were separated, particularly their tiny fragments. An example of a map whose part of the 270 individual sheets in *Grand Aigle* or *Olifant* format was cut into small sheets, once the map had been completed, and glued onto the canvas to store them folded in a box (travelling bags) is sheet 14 of the map of Prussia (Figs. 11 and 28).

Drawing and painting techniques

Drawing and painting techniques of water-soluble pigments (so-called water media) were highly valued given their ease of use. Their key advantage was that although the solvent was ordinary water, the dyes did not lose their properties with exposure. Until the eighteenth century, the most popular media were watercolour, gouache, and a variety of inks. Watercolours were transparent, whereas gouache was opaque, given its use as a supplement to white pigments. The technique itself had been known for sometime: it was used, along with gouache, in mediaeval illuminations (Meder 1923). Watercolour turned out to be irreplaceable

whenever one had to put something down swiftly. It was a perfect technique for travellers, botanical illustrators and landscape artists. Diluting the pigment could produce several differences in tone.

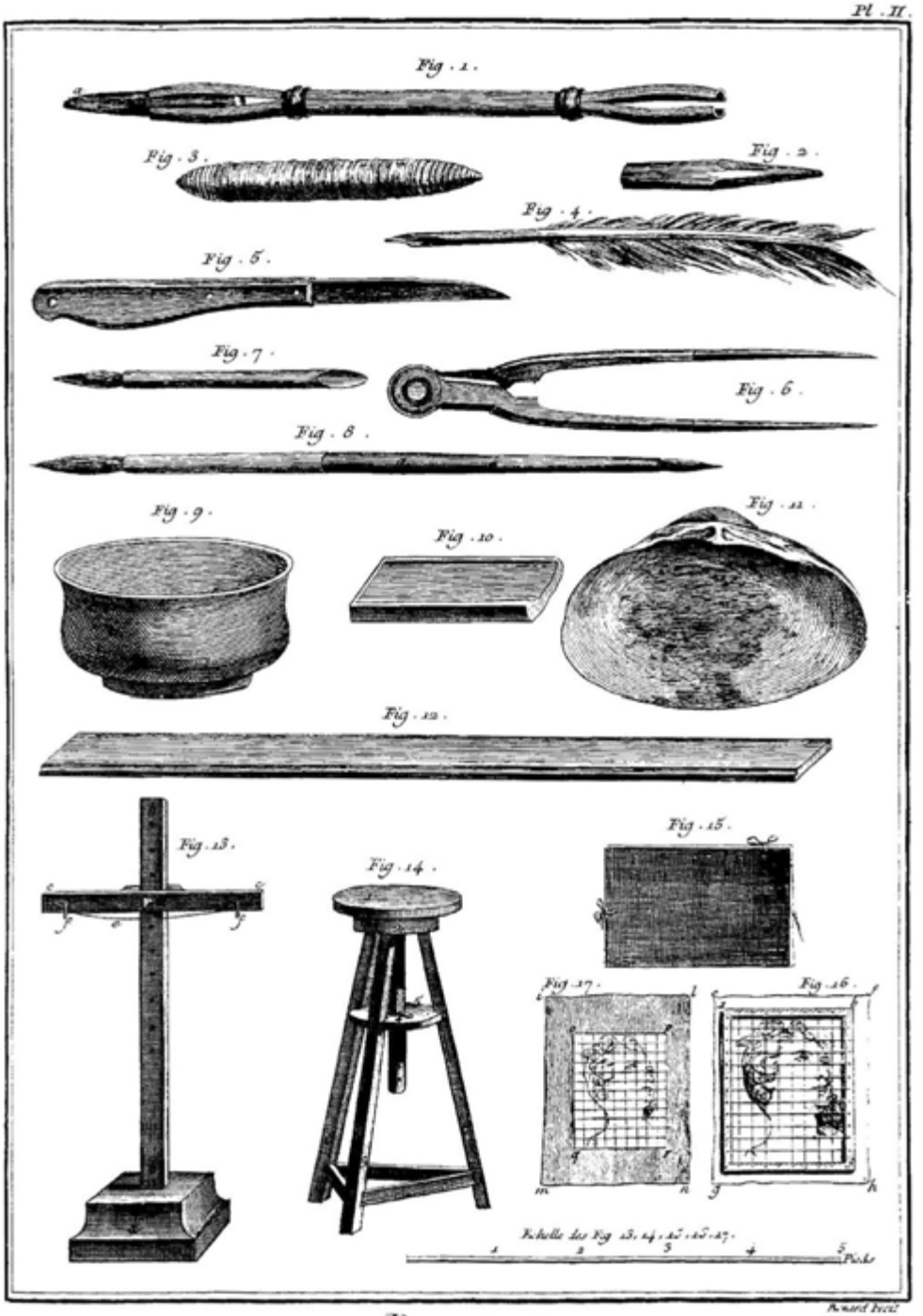
Of the inks applied, iron gall inks were the most common. Because they required special storing, artists would also apply waterproof carbon ink, and bistre. The former was similar to Indian ink, which was imported for some time from the Far East in the form of 'inksticks'. Bistre was used as a variant of watercolour paint, which was highly esteemed, because depending on whether water was added or not, a line was formed, or a splash ranging from black and brown to yellowish. Original Indian (or Chinese) ink was a lot more practical than the iron gall ink and European carbon ink; although European equivalents emerge (Baldinucci 1681). Even so, when further advancement in inks and improvements in paper quality began to appear by the late seventeenth century, and in parallel with new drawing techniques, it was Indian ink that was mostly widely used while Chinese ink was regarded as unrivalled. Buchotte (1754) notes that in the French market, Indian inks from Dutch Republic and France were available in two qualities, as was China ink. The best Chinese variety cost one and a half livres, as compared to one quarter of a livre for the cheapest Dutch or French product. The ink would be sold in sticks 5.5 cm long, 2.1 cm wide, and 0.9 cm thick. Indian inks were also manufactured in Germany. Indian inks differed in their properties. The Chinese ink tended to fade slightly into a brownish tinge, the French into a navy blue one, and German ink into a velvet black one (Backenberg 1810).

Once dry, the ink was waterproof. It did not fade away, and when it was not diluted, it gave an intensive black shade, which made it perfect for sketching lines, and marking pictograms, lines and dots with tiny lines. Similar effects could be achieved applying the European carbon ink, or, alternatively, sepia. The consistency of these inks allowed users to write with a pen and to draw wider lines with a brush. It also facilitated washing, and using a reed pen and a quill made line edges look smoother, whereas lines left by the brush were more diffuse (Meder 1923; Teissig 1983). Indian ink and sepia perfectly complemented

watercolour; similar types of binding medium were used in them, and it was possible to mix them.

The drawing tools used for mapping were illustrated by the French *Encyclopédie* (Fig. 20), in their entry on 'Drawing'. The key tools used for drawing were thick scribers made of graphite or black chalk which were processed to obtain a similar shape and fixed in a wooden stylus. Unnecessary lines or strokes made with graphite or chalk were removed with the help of a piece of chamois, as only in the nineteenth century rubber rags became popular. Ink lines were made with quills or reed pens: the former were cut differently when they were used for writing purposes. All water-based media could be applied or washed out with brushes of different thickness and shape. It was possible to change the intensity of colours by adding water in suitable vessels, and for this, the St. James's shells or scallops were most frequently used.

Apart from the black Indian ink, which was diluted to get a light-grey shade, coloured Indian inks were equally popular. The pigments were similar to those used in watercolours. The intense red colour known as carmine was attained by applying cochineal or red lead cinnabar (mercury sulphide), a practice known since antiquity. The latter, however, had a somewhat yellowish shade and was thus more subdued and brick-red. Hues in the Indian inks were obtained by adding iron oxyhydroxide, or arsenic trisulfide. The indigo retrieved from plants, the azurite [Basic copper(II)-carbonate], and the ultramarine (from lapis lazuli) gave a blue hue, whereas the pigment made from jadeite [copper(II)-acetoarsenite] was typically used to get the green hue. Green was also obtained from mineral clays (celadonite and glauconite) – so-called green earth. One of the most popular substances in watercolour painting was gamboge resin, which guaranteed an intense yellow colour, and it was commonly used instead of the zinc chromate, which was widely used in oil painting. To obtain brown colours, bistre and pigments based on ochre were used; after 1780, sepia was applied as well (Book of Drawing 1652; Gautier 1697; Buchotte 1754; Backenberg 1810; Ambers, Hook and Simpson 2009; Tallian 2009). Sample prices for the most of the above pigments that could be found in Paris in the mid-eighteenth century were reported by Buchotte (1754).



Dessein, Instrumens

We need to remember that in the eighteenth-century knowledge of the primary colours was different from what is commonly known today, which was based on the theory developed by Johann Wolfgang Goethe and Philipp Otto Runge in the early nineteenth century (Rzepińska 1983; Traeger 1975). Newton's discoveries regarding the issue of hues and his understanding of optics could not easily be translated into contemporaneous painting. To Gautier (1697), the basic colours in painting were black, white, violet, and yellow. All other hues, he claimed, could be obtained by mixing them up appropriately. For example, mixing yellow with black results in umber, i.e. different shades of brown, and mixing violet with white gives navy blue; by mixing yellow with violet you can get green. Gautier believed that violet always had an alkaline reaction, and once mixed with a little bit of vinegar (an acid reaction), it would give rise to red (Gautier 1697). This knowledge was subject to several alterations over the time. Still, one thing remained unchanged. A draughtsman had to get all his paints ready and store them in a proper place. It was important to make sure that various shades maintained their intensity on different maps. For watercolour, it was recommended to use twelve vessels for the colours and several other vessels for rinsing the brushes (Backenberg 1810).

Watercolour and Indian ink required the artist to apply and follow a precise process of drawing and to have a steady and even hand, as it was almost impossible to rectify anything once the layer has dried. When the drawing was sketched first to be followed by watercolour painting it was made with a black lead pencil (graphite), or black chalk (Tallian

Fig. 20 Drawing accessories: 1. Graphite or chalk holder; 2. Graphite or chalk; 3. A piece of threaden goat's chamois; 4. Feather quill drawing pen; 5. Penknife for sharpening the feather quill; 6. Compass; 7. Brush; 8. Brushes inserted in a wooden or bone tube; 9. Water container; 10. Slate to rub China ink; 11. Shell for the dilution ink or bistre; 12. Ruler; 13. Stand for drawings (a. base, b. height-adjustable post, c. cross-bar, d. screw, e. string; 14. height-adjustable stool (adjusted when use 1,2,3,4 and 5); 15. Drawing folder; 16. Frame used for drawing reduction. Taken from: *Encyclopédie, ou Dictionnaire raisonné des sciences, des arts et des métiers*, Planches, vol. 2b, Paris, 1762–1772.

2009). The former was a lot more frequently used, because once the paint was applied, it was possible to remove the graphite with a piece of bread, or chamois. To secure the durability of the hues, paper was sized and stretched prior to painting it with a weak solution of alum, or animal glue (Excellency 1668). Applied appropriately with accurately matched brushes, water paints allowed the artist to achieve a variety of effects depending on the width and softness of the brush. Paint applied on white paper produced the effect of a strong colour, but, when applied as wash, it would be less intense. Once it dried the artist could put on another coat of the same or different colour.

The use of water-based media required a fixed order of colour application. The first ones to be placed were dark pigments, or possibly those more saturated. For this purpose, thicker brushes were used. Painting with washes, in turn, required the application of the brightest shade, which was subsequently intensified to achieve a particular effect. Hence, sometimes, on the edges one can find a more intense shade of the same pigment. In nature drawings, the contours were marked with inks. Ink was also used to apply linear details onto the foundation prepared with water based paints (Teissig 1983). If the technique of wet–to–wet colouring was used, which in the case of maps was rare, the contours blurred, and the colours could easily mix. As a rule, when the maps were painted, it was common practice to wait until a given coat was dried before a new one was laid down. The stronger the finish of a given piece of paper – which made it smoother – the longer it could take for the ink or watercolour to dry.

5. *The choice of topographic works*

European archives store over thirty multi-segment and hand-coloured manuscript topographic maps developed in the eighteenth century. Some of them concern the same area, while others are products of separate or supplementary mapping. To execute them European rulers ordered that field surveys were undertaken for over 70 percent of the continent's territory (excluding Spain, Russia, Sweden, and the European part of the Ottoman Empire). Within a century, about three quarters of Europe underwent mapping procedures that resulted in new topographic information about the continent.

The maps share significant distinctive features, principally high quality in execution, possess artistic merit and, simultaneously, a uniform language in their representation. In other words, these maps offer a visually attractive, consistent and macro-scale image of European space and, at the same time, reveal an unprecedented attention to detail. Analysed collectively, they constitute on the one hand an excellent resource for studying the development of topographic visualization, and the artistic dimensions of cartographic works on the other. Of these thirty maps, eleven were most distinctive and significant as regards the above defined aspects and so were chosen for a thorough study (Table, see pp. 96–97). The selection criteria were:

- The **multi-colour technique:** this research focused upon manuscript maps drawn on paper with the use of watercolour techniques and at least four principal colours.
- An undertaken **field survey**: the analysed maps needed to be executed based on field mapping (field survey) employing at least the

basic instrumentation, i.e. plane tables (with compasses and astrolabes) that enabled cartographers to use triangulation and to produce field sketches, drawings and register the results in logbooks. By this benchmark, the maps were accepted even if particular field sketches were missing but the survey results could be found in other sources.

- **Professionalism**: the analysed topographic maps were created by specially educated military engineers who served European rulers. Their activity contributed to the development of the profession of military engineer and draughtsman (watercolourist). Professional map production took place in drawing rooms arranged for that purpose in the headquarters of topographic corps or their associated agencies.
- **Chronology**: the research concerned the maps created in the eighteenth century – to be exact, those resulting from mapping processes conducted after the treaties of Utrecht (the first signed in 1713) and until Napoleon's rise to power in France (1799). The criterion related to the field survey methods which were employed during the mapping processes. The eighteenth century witnessed an intense development of engineer corps within European courts and political structures. They played an important part in the evolution of manuscript topographic maps as a genre. The chronology was also significant because of the fact that the analysed maps were produced before the introduction of national norms for triangulation which, ostensibly, guaranteed better standards of measurement and accuracy and resulted in uniform instructions for topographic mapping.
- **Variety/diversity of graphic styles:** maps representing diverse (wide-ranging) drawing and watercolour techniques as well as allowing for the recognition of the eighteenth-century cartographic styles and schools were particularly important to the present research. Of the six maps created by Prussian cartographers only two were selected, i.e. those differing both physically and in terms of the use of linear and painterly graphical means of expression (i.e. hachuring and blotting respectively). For instance, out of two maps ordered by Frederick II, that is Wrede's map of Silesia and Balbi's map of the Brandenburg Margraviate (Kurmark Brandenburg), only the former was chosen

for analysis, although both represent a similar style of execution and constitute the best examples of the so-called *First Plankammer* style. Another Prussian topographic work selected for this study was the map of Prussia by Schmettau the Younger – an example of the second (chronologically-understood) style of Prussian manuscript map making. Of the three copies of de Ferraris's maps of the Austrian Netherlands in turn, the one stored in Brussels (sometimes considered as part of the Josephine survey) was chosen for analysis. It was treated as a unique work because of its significant colour compilation and way of shading.

- **Aesthetic completeness**: the maps had to be executed as finished fair drawings (fair copies). The drawings needed to be clean, in contrast to their state in rough-copy sketching, and their rendering had to reveal the diverse use of watercolour techniques, clean contours and lines, and precise washes. If particular, when field surveys led to the execution of only a few copies of maps, aesthetic factors were considered decisive. Thus, we were searching for those maps that seemed complete in every respect. They were usually produced for particular monarchs and functioned as informative and representative works rather than as material used either for training or tactical purposes.
- **Multiple segments or sheets/drawing surface**: only multi-segment topographic maps sized over 3 square metres (at least eight *Imperial* or similar-size paper sheets) were considered. Large map surfaces consisting of a number of paper sheets which – when combined – achieved the minimum size established by this criterion were also regarded as multi-segment. In addition, single large-surface cartographic works made of pieces of paper glued together or ones later cut into adjoining segments (composite maps) were also considered as potential objects of study. This criterion also included maps collected in atlases, whose segments amounted to the surfaces of over 3 square metres when put together.
- **Content**: measurable topographic objects that could be represented using cartographic signs or forms reflecting the shape of landform, e.g. gradual or steep hill slopes or land elevation, valleys or gorges.

Table: Eleven cartographic works selected for examination

Date	Territory (dynasty)	Original or catalogue name of the map	Scale
1704–1746	France (Bourbons of France)	*Minutes des Cartes des Naudin*	1:43,200
1720–1721 (1722)	Sicily (Habsburgs)	*Nova et accurata Siciliae Regionum* *Schmettausche Karte von Sizilien*	1:80,000
1747–1753	Silesia/Prussia (Hohenzollerns)	*Kriegskarte von Schlesien*	1:33,333
1747–1752	Scotland/ Great Britain (Hanoverians)	*Military Survey of Scotland* (Highlands)	1:36,000
1763–1785	Danubian Monarchy (Habsburgs)	*Josephinische Landesaufnahme*	1:28,800
1764	Piemont/ Kingdom of Sardinia (Savoys)	*Valle di Susa* *Carta topografica in misura, delle Valli di Cezana, e Bardoneche…*	1:19,000
1764–1786	Electorate of Hanover (Hanoverians)	*Kurhannoversche Landesaufnahme*	1:21,333
1767–1787	Prussia (Hohenzollerns)	*Schmettausches Kartenwerk* *Kabinettskarte*	1:50,000
1771–1777	Austrian Netherlands (Habsburgs)	*Carte de Ferraris* *Carte de Cabinet des Pays-Bas autrichiens*	1:11,520
1789–1799	England/ Great Britain (Hanoverians)	*Ordnance Survey Drawings*	1:10,560 1:21,120 1:31,680
1795–1797	Norway (Oldenburgs)	*Situations Cart over Smålene*	1:12,000

Number and size of sheets (cm)	Chef of survey, topographer, cartographer	Current institutional holder
47 segments different size	Jean-Baptiste Naudin Jacques Naudin Jacques Denis	Paris, Institut Géographique National
28 segments 360 × 285	Samuel Schmettau	Vienna, Österreichische Nationalbibliothek
195 folios 73 × 52 in 5 volumes atlas	Christian Friedrich Wrede Wilhelm Ludwig Oelsnitz	Berlin, Staatsbibliothek
28 strips different size	William Roy Paul Sandby	London, British Library
over 3000 segments 62 × 42	Engineers from Austrian General Staff	Vienna, Kriegsarchiv Wien
full sheet map 106 × 254	Giuseppe Avico Domenico Carello	Turin, Archivio di Stato
165 segments 90 × 61	Georg Josua du Plat Johann Ludewig Hogrewe	Berlin, Staatsbibliothek
270 segments 93 × 57	Friedrich Wilhelm Carl Schmettau	Berlin, Staatsbibliothek
275 segments 141 × 91	Joseph Johann Ferraris	Brussels, Koninklijke Bibliotheek
36 segments different size	William Gardner	London, British Library
11 big segments different size	Søren Hagerup Stabell	Copenhagen, Det Kongelige Bibliotek

- **Scale**: only maps of topographic scale ranging from 1:10,000 to 1:100,000 were selected. The scale denominator in particular topographic maps stemmed from the use of country-specific units of length. Since uniform or strictly determined length-unit systems were not a feature of the eighteenth century, the cartographic collection catalogues often employ the verbal (statement) or line scales. For example the maps of France produced in the *Dépôt de la Guerre* are described at a scale of 1:86,400. This indicates the use of the *ligne* unit (1 *Paris ligne* equalled 2.56 mm) on a map, which corresponded to 100 *toises* (ca. 1.95 m) in the field. The scale of 1:28,800 in turn suggested that the distance of 3 *lignes* on a map equalled 100 *toises* in the field. Such calculations offer only an approximate figure of the scale denominator, especially considering imprecise angle and distance measurement in the field at the time. All eighteenth-century maps are non-cartometric and betray highly irregular distortion figures within single segments. It is noteworthy that distance differences between any two points on such maps could amount to several percent of their actual length, similar to errors in particular azimuths (Medyńska-Gulij and Lorek 2008). This is why the scale figures relating to the eighteenth-century topographic maps here are often preceded by the word 'ca'.
- **Information adequacy**: settlements, villages and towns represented on maps function as area symbols, not as cartographic point signs.

Based on the above criteria, eleven maps – out of over thirty manuscript topographic works stored in various European institutions – were selected for thorough examination. They are here listed in a table offering information about their date of development, the territories concerned, the commissioning courts and monarchs, titles, scale, number and size of segments, names of military engineers in charge and the institutions which now house the maps.

After the initial or core selection, the researchers chose segments (graphic objects) representative for each map based on the following complementary criteria:

- **Quality of image preservation**: only the best preserved segments with clearly recognizable colours were selected. The segments of each map sometimes differ in terms of the quality of drawing as well as in purity and vividness of colours. Differences stemmed from the conditions of paper storage in archives, etc., or the durability of watercolours and Indian ink. The varied condition of particular segments also resulted from the interval between their execution within one topographic work (sometimes as many as 20 years) and from their creation by different authors.
- **Topographic comparability of works**: we have selected the segments representing areas which since the eighteenth century, have remained as unchanged as possible in terms of landscape. Minor landscape variations enabled the researchers to compare today's topographic practice in the field with the perception and visualization typical of eighteenth-century topographers. Such an attitude was vital for producing photographs and panoramas of the present landscape conditions – taken from the most probable observation posts that could be chosen by the topographers of the period (cf. Figs. 44–47). Selected fragments of these segments served as the basis for preparing 3D models which allowed for the examination of the individual three-dimensional landforms rendered by different draughtsmen and watercolourists (Figs. 33–43).
- **Use of the full range of graphical means of expression**: the selected segments were required to represent the employment of all the graphical means of expression included in each particular map to reflect its topographic content, cartographic symbols and the drawing of land morphology.

Figure 21 includes the information about the geographic scope of the eleven maps together with the locations of segments selected for further study. The fragments of these representative segments, according to their listing in the Table (pp. 96–97), are presented in Figures 22–32. We can safely assume that such a juxtaposition, even of the fragments of particular cartographic images, enables the viewer to grasp the general

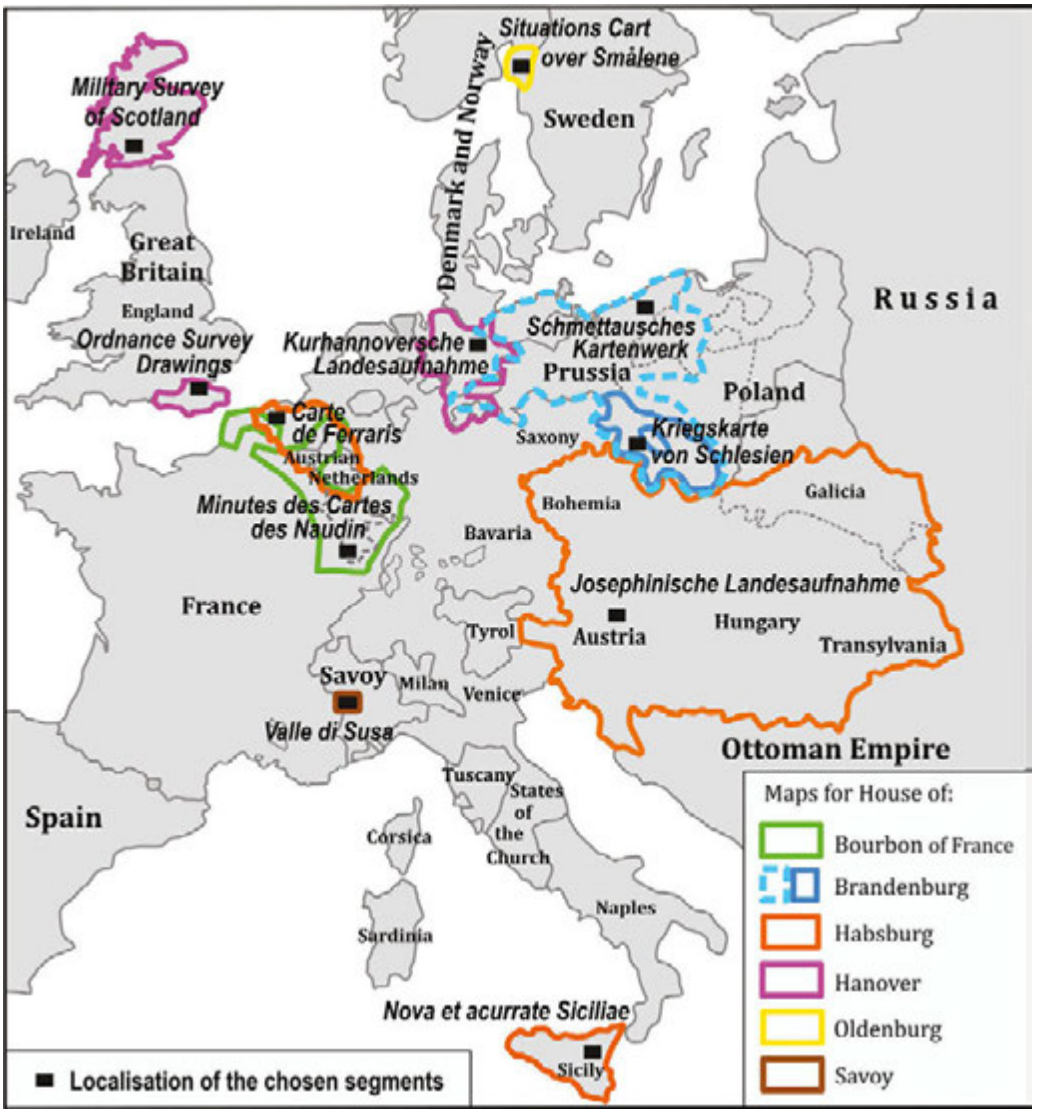


Fig. 21 The map of Europe with indicated borders of territories mapping on 11 selected works and the location of analysed segments, fragments of which are reproduced on Figures 22–32 (comp. by B. Medyńska-Gulij).

features of the drawings. According to gestalt theory, each image consists of single signs which together form – despite their distinctive character – a consistent ideological, informative, and visual whole (Arnheim 1965; Medyńska-Gulij 2013).

6. Eleven selected works of art: their origin and general characteristics

Minutes des cartes des Naudin (1704–1746)
Figures 8, 9 and 22

In the first half of the eighteenth century, French topographic cartography witnessed intense rivalry between two families of cartographers: the Cassini and the Naudin. The *Carte géométrique de la France*, a multi-sheet copperplate map made in 1744 at a scale of 1:86,000 by the Cassini, was by 1750 acknowledged as a pioneering achievement in the history of cartography, and a clear expression of the trends towards national self-realisation through mapping that would be a feature of the Enlightenment (Konvitz 1987; Godlewska 1999). This well-known cartographic copperplate, based on the first triangulation network, would face competition from hand-drawn pictures made by engineers-geographers from the Naudin family. In describing of the manuscript map *Minutes des cartes des Naudin,* created from 1704 to 1746 for the northern and north-eastern areas of France (with Lorraine), Huguenin (1957) stressed

Fig. 22 Fragment from *Minutes des cartes des Naudin*, 1704–1746, Paris, Collection cartothèque IGN, Institut Géographique National. LES NAUDIN: 48, Epinal. Reduction from the original by approximately 50%.


S. DIEY
la Houssiere
Courcreux
S. Leonard
Saulcy

Montagne
d'Ormont
Neymont
Colroy
Remomaix.
Combrimont.
Mines

the significance of topographic maps made irrespectively of commercial production by the *ingénieurs géographes des camps et armées du Roi* from the Naudin family.

Jean-Baptiste Naudin, as we have already noted, was the author of the first printed manual for land surveyors (Naudin 1695). In the twilight of his career, he was made chief of the Versaille-based *Dépôt des cartes et plans*. He is considered the founder of the 'Atelier Naudin', which operated at Versailles from 1726 and which he ran until 1733. His brother, Jacques Naudin (1673–1744) signed the maps he developed first as Naudin the Younger, then as Naudin the Cadet, and finally as Naudin the Father. He was in charge of land mapping on the French-Lorraine border and in Lorraine, work which he supervised in the years 1728–1739 together with his brother-in-law Jacques Denis (1686– after 1740), and, later, with his son Jean-Jacques Naudin (1714–1752). They documented all the land measurements at a scale of 1:21,600 (4 *lignes* = 100 *toise*); 1:28,800 (3 *lignes* = 100 *toises*). The colourful copies in reduced scales were made in the Versailles atelier. The map of the north-eastern border of France and Lorraine is a 47-segment work with segments of different sizes and orientation (Fig. 8). In the subject literature, it is typically known as the *Minute*, although it is actually an aesthetically exceptional image made with great care (Huguenin 1957). In this case, the term 'minute' is misleading, since it implies a draft, or a preliminary or preparatory map or a rough copy of an original document that had been elaborated with precision, sometimes imperfectly presented, which served as a basis for drawing an engraved map (Palsky 2018). Another version, also made by Naudin on 13 huge segments and showing north-eastern France, south Austrian Netherlands and Lorraine, can today be found in the collections of the Military Archive at Château de Vincennes, with a further copy in the Archive in Metz (Corvisier-de Villele and Ponnou 2002).

Although it was begun in 1704, the *Minutes* was in the making for several years afterwards. The individual segments were most probably executed in the 1720s and 1730s and based on earlier or repeated field mapping. That this was so is clear from the applied scale reduction

typical for maps originating at the *Dépôt de la Guerre,* scaled from 1:28,800 to approximately 1:43,200 (Huguenin 1957) (Fig. 8). This is a final draft (a *minute definitive*) with the same system of point signs: for example, the four symbols of the gallows served to mark the justice system (the legend to symbols was elaborated by Koerner 1997/1998); the brick-made bridges were marked with small red lines, and the wooden bridges with black Indian ink. This principle, set out by Buchotte (1754), was applied in other topographic works of the time (e.g. the war map of Silesia 1747–1753).

Each segment featured a meticulously drawn framing made up of a wide line drawn to act as the external frame (or middle frame), and two very thin lines for the internal frames. Some segments got an additional thin external frame. The *Minute* segments are also characterised by their wide extra-frame margins, and the setting of the various locations adjusted to the frame (Fig. 9). All this gives an impression of stability, and provides a proper overall finishing touch of the composition.

Nova et accurata Siciliae Regionum…; Schmettausche Karte von Sizilien (1720–1721, 1722)
Figure 23

The *Nova et accurata Siciliae Regionum* map was executed based on mapping procedures supervised by Samuel von Schmettau (1684–1751) by order of Emperor Charles VI in 1719. The immediate cause underlying the conception of this work was the occupation of the island of Sicily and the order given to promptly map the land, at a scale of 1:40,000, a task that was carried out remarkably quickly in the years 1720 and 1721.

Samuel von Schmettau, a representative of the Brandenburg nobility, and in the Habsburgs' service from 1717 (Hanke 1935), was a soldier and engineer in military campaigns, at one time assisting Prince Eugene of

Fig. 23 Fragment from *Nova et accurata Siciliae Regionum*, 1720–1721, Vienna, Österreichische Nationalbibliothek. ÖNB/KAR: AB141, E19.585-D. Reduction from the original by approximately 50%.

B O S C O
L
D
Capizzi
Cerami
TRAINA
NICOSIA
Spirlinga
Gagliano
S. FILIPPO
d'Argiro
Mte Campanito
Mte Casale
Ponte del Principe
Malo Fittano
Mte Nusuria
Li Sterri
Mte S.ta Agata


Marcello
Cesaro
Gallitino
Bronte
Aderno
Carcaci
Centorbi
Regalbuto
Mt. Carcaci

Savoy, one of the most famous European military commanders. Mapping Sicily became Schmettau's first great topographic task in his role as Quartermaster General, which was assigned to him in recognition of his experience as an artilleryman and fortress builder. Following the death of Emperor Charles VI in 1740, Schmettau began to serve in the Prussian diplomatic corps at the court of Frederick II, where he rose to the rank of field marshal. After seven years, he resigned his commission in order to dedicate himself exclusively to cartography and astronomy. His contemporaries looked upon him as an exceptional cartographer. In his Berlin palace, he gathered an impressive collection of maps (Hanke 1935). Schmettau was also the formal chief curator of the Berlin Academy of Sciences (Albrecht 2001).

Undertaken on the basis of field survey, the skeleton protraction at a scale of 1:40,000 was the basic source for making two copies at a scale of approximately 1:80,000 (Dufour 1995). The first final copy executed in 30 sheets was completed in 1722 and can currently be found in the collections of the *Kriegsarchiv Wien* (Österreichisches Staatsarchiv, Wien, B VII a 470). It was made with an orientation south-western, and it features cartouches dedicated to Charles VI. One of its characteristics is the hachuring technique of presenting the relief (Fig. 16). It is believed that Schmettau's skeleton protraction had a similar graphic style. This hypothesis has been indirectly corroborated by the fact that the *Atlas von Sizilien*, published by Schmettau the Younger in Berlin in 1800 on forty-two sheets based on his father's materials, is, in its nature, closer to the skeleton protraction. It has been also assumed, therefore, that the version accompanied by the graphically elaborated relief was begun as a foundation for a printed edition made from copperplate sheets (Dufour 1995).

The second final copy is currently stored at the Austrian National Library in Vienna (Fig. 23). It was most probably undertaken at the same time, and in the same place as the above map. One can assume that it was drawn in Vienna by someone from the Marinoni circle, the same person who, among others, authored the artfully illustrated cadastral and hunting maps. The map is in a north-north-eastern orientation. The

huge copy sized 360 × 285 cm was almost certainly destined for the emperor (Hühnel 1995). It is possible that it was used as a wall map, because the inscriptions written with large extended letters cover a few segments, and it is only possible to read the entire inscription from a distance. This assumption is also supported by the large decorative title cartouche dedicated to Charles VI, the external decorated frame that closes the entire composition, and the internal frame with a description of the longitudinal and latitudinal degrees. Today, it is a composite map with 28 secondarily-cut different-sized modules: the differences of the colours at the points of contact are visible on the example on Figure 10. This map, which features an outstandingly original painting of a layer of vegetation, stands out among others in the strikingly clear plasticity used in its depiction of relief by shading.

Kriegskarte von Schlesien (1747–1753)
Figures 13 and 24

Kriegskarte von Schlesien is a work of art whose military purpose is made clear by the popular name of the map. The origins of its title go back to the order given by Frederick II in Potsdam on 20th November 1746 to Major Christian Friedrich von Wrede (1702– after 1764), then commanding Glatz Fortress (now Kłodzko, cf. Hanke 1935). One of the immediate impulses that lay behind the order was a severe shortage of maps during Prussia's military campaigns in Silesia. The real significance of the map was further proved by the fact King Frederick II rigorously supervised and coordinated each stage of the work.

The royal order laid out the territorial range of mapping – a border zone measuring about 6 Prussian miles, i.e. 40 km – and it listed all the topographical facilities to be covered by the mapping process. Frederick II also established the time period over which the maps were to

Fig. 24 Fragment from *Kriegskarte von Schlesien*, 1747–1753, Berlin, Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. SBB IIIC Kart. N15060: Band 5, Blatt 18. Reduction from the original by approximately 50%.


Pissern
Lahse
Norigau
Pissorschine
Frösch
Rogen
Frösch
Gr: Wangern
Pfarregen
Kl: Wangern
Gräschine
Vorwindzig
WINTZIG
Klaschwitz
Hospital
Berg
Jachsdorf
Schlaupp
Insuldenort
Baschine


Plaskau
Hengwitz
Ostrowa
Camin
Wehlefrouke
Schipke
Leubel
Märsine
Wangleve
Kl: Paulow
Gr: Paulow
Packoswitz
Gr: Strien
Kl: Strien
Dittersbach
Neu-Teich
Mittel-Teich
Schäferey
Tschanline
Wirsebenn
Gross-Teich
Streu-Teich
Dietz-Teich
Stein-Teich
Alte Stein Mühle
Seyffrodau
Strenz
Chambowitz

be drawn. Wrede was given *carte blanche* in his selection of the team for the measurements. His cost estimate took into account the mapping of the territory of the area of Silesia and Glatz County that had been occupied, which roughly corresponds to today's territory of Lower Silesia, and was planned to take four months and involve a team of five engineers. After he had received this estimate, the king decided that the inner area would not be mapped, and consequently 80 square miles were disregarded (Hanke 1935). Wrede managed a team of several engineers on the site where designing draughtsmen (*Desinateur*) were present. As ordered, the areas exposed to the risk of military action were the first to be mapped, i.e. the southern part of Silesia; and eventually those that were considered secure, that is, lands neighbouring Saxony and Poland.

The copy of the war map of Silesia prepared especially for King Frederick II took the form of an atlas. Today, it is kept at the State Library in Berlin. It consists of five volumes bound in red leather, in *folio* format, where a sheet of paper is one-sidedly put together within the book. The individual sheets are at a scale of approximately 1:33,333, with an NNW orientation**.** The first volume (of 42 folios) was ready by August 1747, the second volume in 1748 (40 folios), the third one in 1750 (35 folios), the fourth in 1751 (36 folios), and the fifth in 1753 (42 folios) (Hanke 1935). Each section is based on a 51 × 73 cm format: the segment occupies two pre-arranged pages of a sheet, optically joined with frames that serve to stabilise and bring order to the entire composition (Fig. 13). The map segment is subdivided into regular rectangular parts: an area of cartographic content, an area of administrative names with a line scale, and an area of the cadastral register. The numbers of the neighbouring segments have been placed on four margins, which is a standard entry in contemporary topographic maps.

Wrede's holographic signature on the front page of the atlas volumes implied his supervision of the field measurements, and the undertaking of field sketches and the skeleton protraction at Glatz Fortress (now Kłodzko). The shaping of the graphical line for the Prussian fair copies, however, ought to be seen in relation to the organisation of works at the *Plankammer* in Potsdam, managed by Wilhelm Ludwig von Oelsnitz in

the period 1744–1756, and by Wilhelm von Anhalt from 1760.* As a rule, the surnames of the draughtsmen were not given on ready maps, and only in the fourth volume can one find the initials of the two engineers' last names: Marquart's and Schlott's. These two *Desinateurs* were employed by Wrede to make sure the drawing works would be brought to an end promptly (Hanke 1935).

Oelsnitz, the head of the *Plankammer,* not only supervised the works, but also personally made the fair copy for the monarch. His status was unique. This son of a Cade Corps commander in Berlin began his military career in 1741 as an *aide-de-camp* of the Prussian king, who entrusted him with the care of the Potsdam Drawing Room. In 1750, Oelsnitz became the adjutant of the quartermaster general Karl Christoph von Schmettau, Samuel's younger brother (Oelsnitz would die as an Austrian captive in 1757 as a result of wounds suffered during his reconnaissance while Prague was being besieged by the Prussian army). One of his duties as the head of the *Plankammer* was to manage and inform Frederick II about the teaching of cadets on such topics as drawing, measurements, and mapping (Seyfart 1786; Schneckenburg 1892; Łopatecki 2014). Even bearing in mind Frederick's final say, one can assume that the graphical style of the Prussian maps preserved in Wrede's works (Fig. 18), and Balbi's works at a later stage, ought to be credited to the commander of the *Plankammer* Oelsnitz and his draughtsmen who assisted the field documentation.

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* It comes as no surprise that the time when Wrede's and Schettau's maps were created is labelled as the pre-official period (German: *voramtliche*) of Prussian cartography. All the issues related to cartography were handled by the *Krieges und Domainen-Cammer*. The Maps Room (German: *Plankammer*) gained momentum only after the reform, from 1772, when Friedrich Wilhelm Ehrhard von Knobloch (1739–1817) was appointed its head. At the end of the century, Daniel Gottlob Reymann was in charge of the *Plankammer*. He was to became a key figure for the later development of cartography. He held the position of *Inspector der Plankammer und Ingenieur-Geograph* from 1788. In 1777, Berlin had as many as 29 active land surveyors, including George Christoph Berger, the land surveyor-elect at the War and Domains Chamber. (cf. Adreß-Kalender 1795).

Irrespective of the atlas, two additional copies of the maps were made, which, subsequently during the Seven Years' War, were themselves copied and sent to the commanding officers together with an instruction on how to use and store them (Hanke 1935). Following the capitulation of Glatz Fortress in 1760, whose commanding officer was Wrede, the copies of the maps of Silesia ended up with the Habsburgs and most probably served as a model for the development of the concept of the *Josephinische Aufnahme* (Lindner 1990). Because he surrendered the fortress, Wrede was sent to prison and consequently dismissed from the military service.

Military Survey of Scotland – Highlands (1747–1752)
Figures 4, 6 and 25

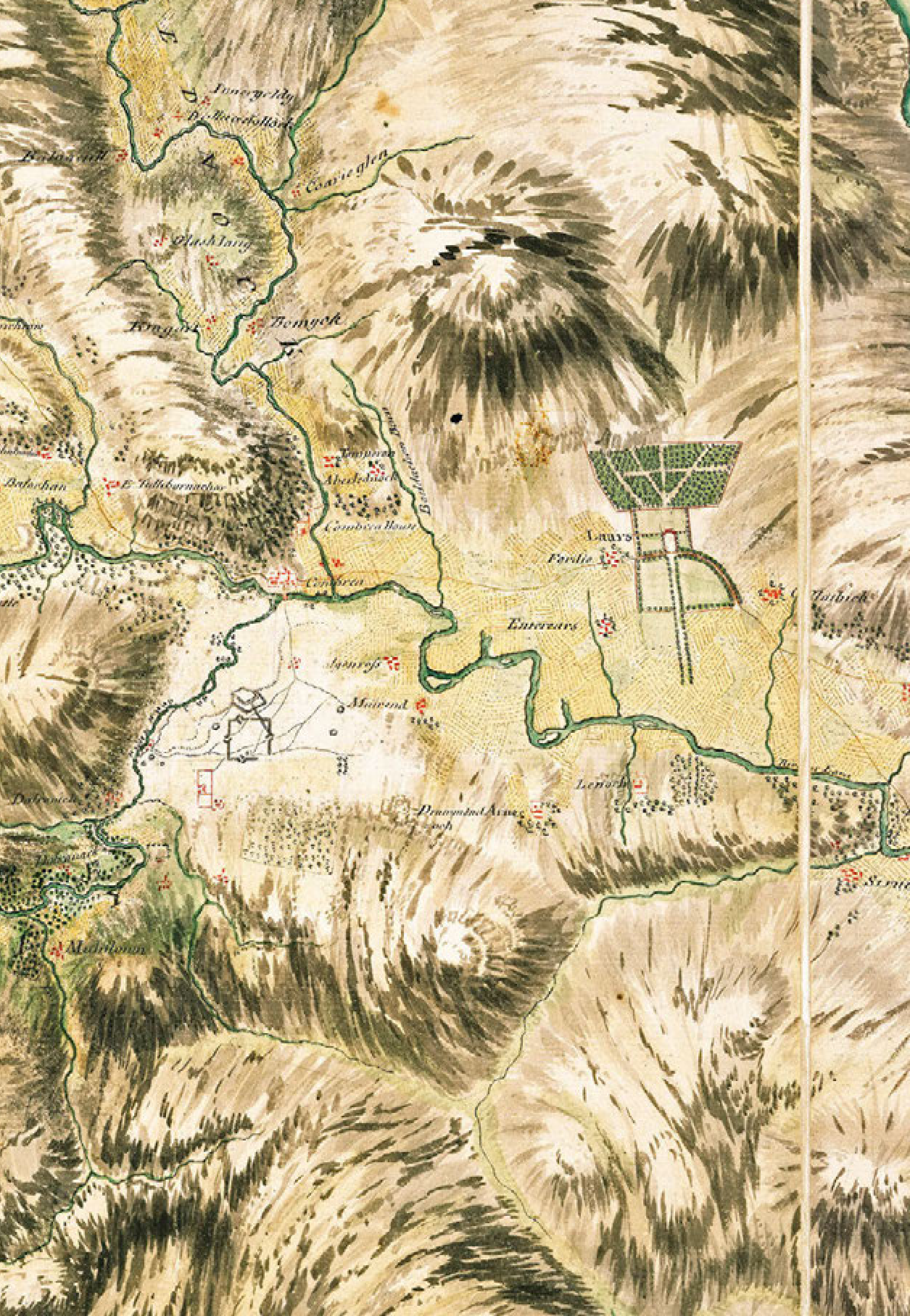
The reason why Britain's King George II ordered the drawing up of the *Military Survey of Scotland* was the severe deficiency of topographical maps for tactical activities during and following the Jacobite Rebellion of 1745–1746. *The Military Survey* was the first grand cartographical undertaking carried out by military engineers and draughtsmen of the *Board of Ordnance* and executed in order to pacify Scotland (Hodson 1991). The person placed in charge of the project was Major-General David Watson (1713?–1761), a royal engineer in the Hanoverian Army. Watson appointed a civilian draughtsman, William Roy (1726–1790), to serve as Assistant Quartermaster. Roy, with only limited experience at a post office in Edinburgh, was entrusted with managing the measurements without his having any military experience. Yet Watson made an excellent choice, as Roy was able to lead a team of soldiers-land surveyors effectively and in the years 1747–1755 successfully carried out the mapping of the mainland and a few islands to the west (Close 1969). Roy was promoted to the rank of Major-General in the engineers in 1781 and, in 1783, was appointed *Director of Engineers*. Given the works carried out by Roy on the techniques of precise triangulation measurements, he is commonly regarded as the father of the *Ordnance Survey*, which was officially established in 1791 (Oliver 2005; Hewitt 2010).

Mapping Scotland involved a few principal draughtsmen, of whom Roy made Paul Sandby his leading man (Fig. 4). At that time, Sandby (1731–1809) had just completed a period of training at the drawing office in the Tower of London, but what made him an exceptional choice was his passion for drawing, something his elder brother Thomas seems to have passed on to him. Throughout the mapping of Scotland, Paul made a number of watercolour paintings, and on one of them undertaken in 1749 with a watercolour brush pen and ink, he depicted his team while they were at work measuring (Fig. 4, O'Donoghue 1977).

Paul Sandby gave up his activity as a land surveyor once the Highlands had been mapped and, in 1751, returned to London, where, on the advice of his brother, he began an artistic career and, over time, became a major British watercolourist. Today, he is often termed the 'father' of English watercolour art (Bonehill and Stephen 2009). Sandby, served as the *Chief Draughtsman* of the fair plan, and, in 1768, was nominated *Chief Drawing Master* at the *Royal Military Academy* (Anderson 2009).

Based on the measurements supervised by William Roy, and the field drafts and drawings developed by three principal draughtsmen, two 'original protractions' at a scale of 1:36,000 (i.e. 1,000 yards to one inch) were made with a magnetic north declination. Both copies can be found at the British Library, and they are part of the famous Topographical Collection, begun by George II. One of these two, a rough copy called the *Original protraction*, or a *Drawing of the map of the Highland Survey* on 76 sheets, was compiled from observations recorded in the surveyors' field book and sketch book. In this copy, it is possible to discern a number of added vertical and horizontal lines for the purposes of copying or reducing the scale (British Library: Maps K.Top.25.1a., O'Donoghue 1977). The copy featuring the original protractions led to the creation of several copies of the *Great Map*, currently called The Roy Military Survey of

Fig. 25 Fragment from *Military Survey of Scotland – Highlands*, 1747–1752. London, British Library. K.Top: Maps. CC.5a441/16-3f BL. Reduction from the original by approximately 50%.



Invergeldy
Laurs
Fordie


GLEN SHAGIE
River Shagie
Callender
Monzie
Knock
Fernhall
CRIEFF
Lochland
Laggan
Mill Nab
Bridge
Dowell

Scotland. They each ended up in the possession of King George III after 1761 (Fleet and Kowal 2007).

Special importance must be attached to the fair copy that covers the northern part of Scotland (British Library: Maps K.Top.25.1b.), which is also the object of study here. It was made on 12 rolls, but at present it has been subdivided into 28 different-sized segments cut at a later stage that together give an area of over 36 square metres (Anderson 2009). Separate strips of the Roy Map do not have frames and are adjacent, and the large mountain ranges run smoothly together in painting with washes. This means that they were most probably painted by Sandby as an entire and physically coherent painting. In the original protraction, line techniques were applied, whereas the fair copy was undertaken with a larger palette of colours and water media (Fig. 6).

The partnership between the young officer-engineer William Roy and the even younger Paul Sandby, a civilian without a military education or experience but with a well-developed artistic sense, turned out to be highly effective during Scotland's mapping, and exceptionally creative in the execution of an original graphical expression for a topographical map (a fragment of the segment of the area of Crieff is shown in Figure 25). In the fair copy of the Highlands, one can see Sandby's characteristic shading technique, and details added by Roy (O'Donoghue 1977).

Josephinische Landesaufnahme (1763–1785)
Figures 12 and 26

The *First Military Survey of the Habsburg Empire* (1763–1787), commonly referred to as the *Josephinische Landesaufnahme*, was the biggest topographical work, and the largest cartographical undertaking of the age – both in terms of its area and its numbers, as it covered all the territories of the Habsburgs, sometimes dubbed the Danube areas. This led to the making of over three thousand segments in the first phase (Paldus 1919). This number grew after the Habsburg territories had been enlarged by the annexation of the First Polish Republic in the aftermath of the partitions. The measurement works and the performance of the first fair

copies by officers of the *Generalquartiermeisterstab*, commenced in 1763 from Austrian Silesia, a territory which had been under Habsburg control since the Seven Years' War. As already mentioned, the Austrian troops obtained copies of the war map of Silesia, kept in Glatz Fortress (Lindner 1990). This probably prompted the Habsburg cartographers to use an analogous composition of a segment with a frame and cadastral register. It could have also encouraged them to use some identical cartographical signs as those found on Wrede's map, e.g. a church tower placed on the right to mark an evangelical church, and a tower placed on the left to mark a catholic church.

Mapping with the use of the *a la vue* method was carried out under the supervision of Colonel von Fabris and Colonel-Lieutenant Gavaux in April 1764. The fair copy, also from 1764, is characterised by a novel graphical style typical for the graduates of the *Theresian Military Academy*, founded in 1751 (Lindner 1990). Given the vast area, the works were divided into 'lands' whose mapping was entrusted to seven commanding officers. Each of them was required to take care of logistics and observe principles of continuity in the overall production. From 1765, i.e. from the time of taking the Hungarian and Bohemia Crown, of which Silesia was officially part, the command was in the hands Maria Theresa's son and later Holy Roman Emperor, Joseph II (1741–1790), successor to the imperial throne. It is from his name that the map owes its popular name of the Josephine survey. He was also the person who accepted subsequent parts of the work at the court, made in accordance with all the lands.

One of the key commanders of the team of engineers was Ludwig Michael von Jeney (Mihály Lajos Jeney vel Louis Michael de Jeney, 1723–1797), born in Transylvania. He served in the army from the age of 14, being variously under Austrian, French and Prussian commands. He was, it may be said, typical of the Enlightenment: well-educated, receptive to new ideas and open to practical reasoning. During service with

Fig. 26 Fragment from *Josephinische Landesaufnahme*, 1763–1785, Vienna, Österreichisches Staatsarchiv: Kriegsarchiv. BIXa: 54. Section: 115–Stainz Widon. Reduction from the original by approximately 50%.


D. Oisnitz.
Spiegelberg
Glanitz
Glaserberg
Fuchsberg
D. Wetzelsdorf
D. Möllersdorf
Zu Möllersdorf
D. Wiselsdorf
Dobis.
Schloss Hornec
Steinitz Bach


D. Fordern
D. Forst
D. Dillersdorf
D. Forst
D. Zwaring
D. Freindorf
D. Beydendorf
Kainach Bach

the French army (1754–1758), where he served as a cartographer, he wrote a manual featuring his own hand-made maps, entitled *The Partisan, or the Art of Making War in Detachment*. This was published in French in 1759 and in English in 1760. This manual later translated into three languages, was a significant point of reference during the revolutionary wars in North America against Great Britain in 1776 (Hofstätter 1989). From 1758 to 1763, i.e. during the Seven Years' War, Jeney was a captain-engineer in the Prussian army, and, in 1787, was promoted the rank of major-general of the Austrian troops. He began working on the Josephine survey in 1775 and would continue for nine years, mapping five lands in the meantime (cf. Chapter 2). Jeney's work rested on field surveys of over 450 segments.

One fragment of the representative sheet (segment) of mapping of central Austria can be found in Figure 23, a view of the entire sheet is shown in Figure 10 (B IX a 54, Innerösterreich: 1784–1785). Segments sized 62 × 41.5 cm follow the denominated scaling technique used for marking distance based on the conversion of the Habsburg units: *Zoll-Klafter* and the target scale of 1:28,000 (Dörflinger 2004). Each segment had a stable composition thanks to the application of the frames, and the subdivision into rectangular fields (Fig. 12).

Valle di Susa; Carta topografica in misura, delle Valli di Cezana, e Bardoneche… (1764)
Figures 14 and 27

The Turin-based corps mapped its own and neighbouring lands, chiefly as a result of the changes of the Savoyard State borders following several peace treaties (Sereno 2002). The result is an impressive number of maps made by the Topographical Office (*Ufficio Topografico*) (Masabò Ricci and Carassi 1987; Storrs 2013), which can now be found at the Turin National Archives (*Archivio di Stato di Torino*). At the Office, topographical maps of the Savoy were developed in manuscript at three scales, and the consecutive final copies were called reductions of the field surveys. These are the *Catasto della Savoia* 1:12,000 (77 segments) – the first

reduction; *Carta della Savoia* 1:48,000 (36 segments) – the second reduction; and two full sheet maps in the third reduction, entitled *Savoye* (1737, 1:96,000) and *Carta topografica del Piemonte* (1762, 1:96,000). The scale of all maps was a consequence of applying the then unit of length used across Piedmont and Savoy: 1 Piedmont *trabucco* = 3.082 metres.

In 1764, a fair copy was made for the entire Susa Valley (called as the *Susa 3*) at a very large scale of 1:9,600 on nine huge segments with the biggest of which was 490 cm (*Carte topografiche e disegni, Carte topografiche per A e B, Susa 3*). The team responsible for detailed mapping of the whole valley consisted of four topographers: Giovanni Giuseppe Avico, Giuseppe A. Boveri, Domenico Carello, and Antonio Durieu (Garis 2006; Savigliono 2006). Since the *Susa 7* map, used the scale of approximately 1:19,000, covered only the western part of the valley, its elaboration required use of the same skeleton drawing as for the *Susa 3* map.

The highest level of graphical execution and originality of style can be discerned on this map of the western part of the Susa Valley, (we show the whole map in Figure 14, a fragment in Figure 27). To follow its catalogue description, this map has a scale of 1:18,792, and has the size of a segment of 106 × 254 cm for the part of the Susa Valley that includes the areas of Cesana and Bardonecchia. A detailed inscription explains why the map was created. It was conceived to delimit the borders established under the 1718 treaty, but only ratified in 1761. It was drawn by the king's topographers in 1764. The map has a south-west orientation, adjusted to the horizontal distribution of the area, which made it more practical to over-see (Fig. 14).

The surnames of the cartographers – Carello and Avico – are placed next to the scale and the wind directions. Their handwritten signatures are to be found in the bottom right corner of the segment: *Dom[eni]co Carello*, and *Giuseppe Avico* below: a novel feature of this type of map. Domenico Carello had worked at the corps from 1739, whereas

Fig. 27 Fragment from *The Susa Valley* (*Carta topografica in misura, delle Valli di Cezana, e Bardoneche, …*), 1764. Turin, Archivio di Stato di Torino. Susa 7. Reduction from the original by approximately 50%.


Pointe des Maines
Clot Chavas
Bois de la Plaine
Sartana
Bois Quersut
Mal Atraj
Lo Rous
Deserte
Côte Lanolle
Bois de la Crosa
Balbiere
Serre de la Draja
Ventet ou Pint
Lo Planeou
Près de la grange
Chaumena
Lozet
Les Autagnes
Serre de la Sômette
Croix del Cambovie
La Ribiere
Chapelle de Côte roÿe
Combal
La Replate
Soubras
Foutaine de la Sagne
S.t Barnabé
Le Grand Bois
Oratoire de Rocharle
Serre de Rocharle
Prés des Sappes
Fontaine de Rocharle
Vazon
Clot de la Chaume
Les Fossieres
CEZANNE
VALLÉE
Roche majou
Fontaine du Bonvit
Serre de Poet
Serre Garsin
Villards
La Luberne
Pierre menau
Pellossiere
Grange de Jean veu
La Bru
Côte rouge
Doire
Riviere
Les Signols
Oratoire de S.t Maurice
Croix du Serre
Oratoire de S.t Antoine
Chatellard
Serre du Gué
Les Ullés
La Pellossiere
La Praz
La Portette
Fontaine de la Portette
S.t Marc
Les Isles
Combe


BARDONNECHE
DE
Dora R.
Beaullard
Chateau Beaullard
Puis de Beaullard
Clot de la Miande
La Grangiassa
Mollinet
Notre Dame
Pranou
En Peadra
Oratoire de N. D. des Carmes
Oratoire de la Repose
La Salude
Refour damont
Refour daval
Oratoire de la Crus
Aux Isards
Serre du Bars
Lo Serre
Corbiera
Moulin de l'Envers
Moulin de l'Adroit
Pont de Beaullard
Bologna
Rochere
Barcellon
Chesalal
Villard
La Roise
Pura
Supra
Croix de Collin
Le Plainet
Pra du Bou
Sellette
Pra Clau
Le Fort
Praz du Blanc
Les Constans
Mejer
Savuolx
Oratoire de Champlas
Montagnes de Foin
Bois de Foin
Serre de Zolvant
Combe des Constans
Croix de Pierre rouse
Roche daval
Roche damont
Imberts daval
Imbert damont
Lo Serre
Près des Granges
Paturage de la plana
Lo Gautier
Pinson damont
Pinson daval
Bletonet
Les Moines
Serre de Gumagnan
Pellcal Daval
Perlcal Damont
Montagnes de la Combe
Serre de l'Aiuara

Giovanni Giuseppe Avico had been working there for 10 years, having begun his career as a topographer's assistant. In 1761, he was upgraded to a position of topographical engineer and, in 1779, became director of the Topographical Office (Masabò Ricci and Carasi 1987; Storrs 2013).

Kurhannoversche Landesaufnahme (1764–1786)
Figures 18 and 28

Constant growth in the number of Hanoverian Electorate citizens had contributed to the need to extend the cultivable areas, including drainage of wetland areas, from the end of the seventeenth century. The need to cultivate moors and drain other extensive wastelands of Lower Saxony prompted moves to make detailed maps (Bauer 1993). Thus, in 1765, the Elector of Hanover, George III (Britain's George III) issued a decree in which he ordered field mapping to drain wetlands and to prepare them for cultivation. The size of a segment was defined in a decree in a practical manner: four table cards 43.7 × 43.7 cm were suited to a single sheet 87.4 × 58 cm (Fig. 18) (Bauer 1993).

According to the elector's wish, the following types of land use and administrative properties were to be depicted on the map by means of lining and colours: peatbogs (light brown), pastures and meadows (green), buildings (red), waters (blue), roads (brown, sometimes yellow) and administrative borders in grey (Brauer 1993). This emphasis on marking specific types of land was because topographic maps were supposed to be used mainly for planned canal and road construction in order to make bogs and wetlands fit for settlement. Appropriate measurements were made by officers of the engineer corps in Hanover between 1764 and 1786. The work was produced in 165 segments at a scale of 1:21,333 (18 inch = 1 German mile: Torge 2003) What draws one's attention most in the examined fragment (Fig. 28) is its picturesque character and the multiple additional textual entries defining the names and character of lands, especially wetlands.

Captain William Georg Josua du Plat, working under orders from Georg III, was the formal leader of the *Kurhannoverian Survey*. However,

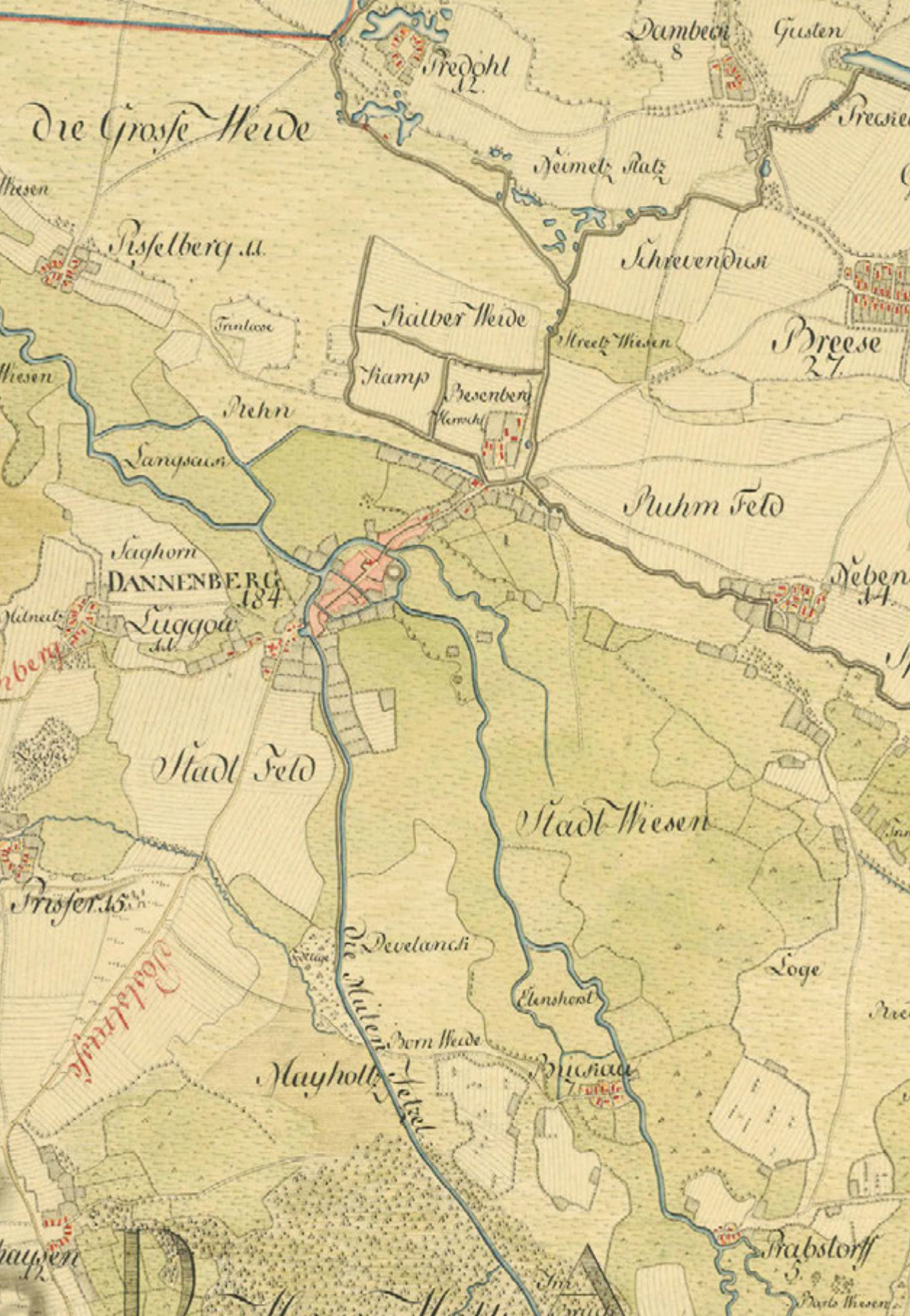
extensive topographic field works were overseen by Johann Ludewig Hogrewe (Hogreve, Hogrefe 1737–1814) from Hanover. Hogrewe planned the course of the field survey and its division into segments. He also supervised the production of final copies. Hogrewe began his service in the engineer corps in 1764. Between 1767 and 1769 he was sent by George III to England, Netherlands, Lorraine and Upper Rhineland to gain experience in canal and fortress construction. Hogrewe was the author of numerous works on engineering and drew upon his practical measuring experience, will additional tips on map drawing, in his 1773 handbook (*Praktische Anweisung zur topographischen Vermessung eines ganzen Landes*) and in his 1785 *Theoretische und praktische Anweisung zur militairischen Aufnahme oder Vermessung im Feld* (see Fig. 3). It is likely that his first handbook contributed to him receiving the position as a teacher of George III's children (*Prinzenlehrer*) which he held between 1780 and 1784. His expertise was later recognised by his admission to the Göttingen Academy of Sciences.

Schmettausches Kartenwerk; Kabinettskarte (1767–1787) Figures 7, 11 and 29

The genesis of the first map of Prussia, made in 270 segments, is connected with a private undertaking by Friedrich Wilhelm Carl von Schmettau (1742–1815). It makes one wonder, however, how it was possible that the king could allow the creation of a topographic map as a matter of private initiative and without the participation of his engineer corps, given that cartographic restrictions were in force in Prussia in Frederick II's times. The answer lies in the private connections of the author with the Prussian court and in his individual persistence. A famous cartographer and Prussian field marshal, Schmettau the Elder supervised the creation of the map of Sicily as noted above and

Fig. 28 Fragment from *Kurhannoversche Landesaufnahme*, 1764–1786, Berlin, Staatsbibliothek – Preußischer Kulturbesitz. SBB IIIC Kart N25564/59. Reduction from the original by approximately 50%.

Kahmen
8
Kahmer Feld
Heid Berg
Stretze
15
Moor
nach
Dannenberg
Lüneberg
Las Berg
Krugerskule
Loge Feld
Falsch Feld
Dobre
Maujahns Feld
Lentzen
Schmarsau
nach
Labins Heide
Labins Feld
Bohn Berg
Matz Berg


Die Grosse Weide
Fredohl
12
Dambeck
8
Gusten
Neimetz Platz
Schreventhin
Kalber Weide
Kamp
Besenberg
Herrschft
Streetz Wiesen
Breese
27
Prehn
Langsaun
Ruhm Feld
Saghorn
DANNENBERG
184
Luggow
Stadt Feld
Stadt Wiesen
Loge
Die Develandt
Elenshorst
Born Weide
Mayholtz Jetzel
Grabstorff
5


Dam̃garten
Zwilipp
Semmerow
Seefeld
Mottow


Heide
Peterfitz
Mohr
COERLIN

was honoured by Friedrich as a prominent cartographer. As father to Schmettau the Younger, he guaranteed his son an excellent start, and, godson of a royal brother, Prince Ferdinand Hohenzollern, Schmettau the Younger enjoyed special favours on the Prussian court, which resulted in a military upbringing in ways similar to that of the children of the royal family (Hanke 1935).

Schmettau the Younger began his career in the army aged 13 in the Knight Academy in Brandenburg. In addition to the support of his father and godfather, he received patronage from Friedrich Wilhelm von Schulenburg-Kehnert (1742–1815), the Prussian minister of finances and home affairs. Despite the urging of his godfather, Frederick denied the younger Schmettau the promotion he desired and as a consequence Schmettau joined the Bavarian army, resulting in a breach with the Prussian king and the loss of funds for the project, even though the first segments had been completed. Despite his dismissal in 1778, Schmettau the Younger continued his work, probably under the auspices of Prince Ferdinand. Only after the death of Frederick II (1786) did his successor King Frederick Wilhelm reinstate Schmettau and promote him as a major-general – and purchase the *Karte von Preussen* in 1787.

During that period of 'soft ostracism', Schmettau made 270 segments of a map of 97 × 64 cm at a scale of 1:50,000 (Troschel 1925). He additionally prepared a colourful tableau with section numbers and coloured regions of Prussia, facilitating the easy assemblage of segments (Fig. 7). The map of Schmettau the Younger was referred to as a cabinet map (*Kabinettkarte*) as it was supposed to serve administrative purposes for the Prussian cabinet, the supreme state office (Hanke 1935). Schmettau's work was created over 20 years, in nine years of which he had no state funding. It is known that in his search for funding he spared no effort to obtain a contract from the Polish King Stanisław II August in order to create a similar map of Poland (Buczek 1932).

Fig. 29 Fragment from *Schmettausches Kartenwerk* (1767–1787), Berlin, Staatsbibliothek. SBB IIIC Kart L5420/14. . Reduction from the original by approximately 50%.

During his work on the map of Prussia, Schmettau the Younger introduced some significant innovations. Schmettau's mapping ideas were ahead of common practice on manuscript maps in that period. First and foremost, he introduced a rounded denominator of a 50,000 scale suited to 6 German miles and 2000 rods (*Ruthen*). Only narrow margins were retained on the segments, as the result of which the topographic content of a single segment could be easily matched to an adjacent segment. Such practice made it possible to arrange the segments next to one another (Fig. 11). Schmettau the Younger also preserved the old Prussian mapping principle of depicting forests in grey and waters in sky-blue, working out a perfect shading of the surface of lakes and rivers. The introduction of green for marking arable land and pink for moors and other types of wasteland was, however, a novelty (Fig. 29). Schmettau limited all colourful areas with a contour which allowed him to achieve a contrast between the elements of a map and easy recognition of arable land types. He also enriched blue dash patterns to denote wetland areas (Fig. 11).

Carte de Ferraris, Carte de Cabinet des Pays-Bas autrichiens (1771–1777)
Figures 19 and 30

The *Carte de Ferraris* (*Carte de Cabinet*) was created out of the initiative of Prince Charles of Lorraine (1712–1780), who, between 1748 and 1780 (with a short break), held the office of governor of the Austrian Netherlands on behalf of his sister-in-law Maria Theresa. Since 1763 the *Josephinische Landesaufnahme* prepared for the Habsburg lands, had been so prepared according to the principles and style suggested by the general corps in Vienna (see above). For the Austrian Netherlands, however, Charles of Lorraine was granted a right to proceed differently and the cabinet map – a map used for administrative purposes of the supreme

Fig. 30 Fragment from *Carte de Ferraris*, 1771–1777, Brussels, Koninklijke Bibliotheek; *Carte de Cabinet des Pays-Bas autrichiens*. 9 – Dixmude. Reduction from the original by approximately 50%.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office (like the Prussian map described above) at a precise scale and including cadastral information – was created.

Prince Charles initiated two map projects. According to the first, undertaken by French engineer Jean de Bon, the map was to be created by French mappers at a 1:14,000 scale. It was, however, rejected by Charles of Lorraine for financial and security reasons. Since the time of Louis XIV, South Netherlands had been area of French aggression. The second project was presented by Joseph Johann de Ferraris (1726–1814). It was his own conception, according to which two separate maps for entirely different purposes were to be created. The first of these, a manuscript map based on measurements at a scale of 1:11,500, was supposed to be classified as a confidential *Carte de Cabinet*. The other, the *Carte Marchande*, based on the same measurements and after appropriate reduction and selection at a scale of 1:86,400 and imprinted on copper plates, was supposed to partially fund the enterprise based, it was hoped, upon its public sale (De Coene et al. 2012). Charles of Lorraine selected the project by Ferraris, principally because he trusted Ferraris who had been commander in his regiment during the Seven Years' War. Ferraris, it was hoped, would guarantee success for the enterprise: he had received a thorough education in the Vienna court and, he had good relationships with the imperial family. The decision to choose Ferraris offered an opportunity for him to create his own graphic line, less dependent on the one that dominated in the region. Charles of Lorraine nominated Ferraris for the leader of the artillery corps of the Austrian Netherlands in Malines, the basis for the team that would be responsible for mapping, and together they selected engineers for the enterprise (Coene 2001).

The impact of the French and Austrian styles on Ferraris' map has already been highlighted (Lemoine-Isabeau 1983). Recent work of the first key of the map has also commented upon the map's rich content (De Coene et al. 2012). The influence of the French on the cartographers in Ferraris team was unavoidable as mapping referred to the measurement systems of the Cassini. It is also possible that French cartographers, or cartographers educated at French schools, were in the team. It is no coincidence, then, that the map of the Austrian Netherlands, printed in

25 sheets, was based on the same scale as the famous map of France by Cassini (1:86,400). Further, elements of graphic similarity to the atlas of French roads, *Les atlas des route de France*, undertaken between 1745 and 1780, whose production was supervised by civil engineer Daniel-Charles Trudaine, also suggests that Ferraris employed civil engineers-draughtsmen for making fair copies.* The system of topographic signs, as mentioned above, was based on suggestions by Buchotte (De Coene et al. 2012).

The *Carte de Cabinet* was made in three manuscript copies at a 1:11,500 scale: the first one for Empress Maria Theresa, the second for the State Chancellor at the Vienna court of Prince von Kaunitz and the third, the most original and aesthetically pleasing of the three, for Charles of Lorraine (now in Brussels, in the Koninklijke Bibliotheek van België). The copy for Charles of Lorraine with 275 segments of 90 × 140 cm had a total area of approximately 340 square metres (Coene 2001). It is this map, made on separate sheets and glued together in 275 segments, that is an object of research here (Fig. 19). A fragment of the selected segment (Fig. 30) is noteworthy for its shades of green and pink that fill in those regular boxes into which arable land was divided.

Ordnance Survey Drawings (1789–1799)
Figure 31

In 1763 and 1766 Major-General William Roy, the man responsible for the 'Military Survey of Scotland' (see above), prepared a draft of the official topographic survey of Britain for King George III. This turned out to be too expensive a proposition (Harley 1980). The idea re-appeared in 1791 when *Ordnance Survey,* a new state institution, was established according to Roy's technical and scientific conceptions, and effectively the replacing *Board of Ordnance* (Oliver 2005). The reason for changes in policy regarding mapping lay in attitudes towards Revolutionary France. To prepare Britain for, as it was considered, the inevitability of

* Website of the French National Archives, 2018: www.archives.developpement-durable.gouv.fr/atlas-des-routes-de-france-dits-atlas-de-trudaine-a34781.html.


LUDDENHAM
Stone
OSPRINGE
Ospringe Church


ORE.
Ham Farm
FAVERSHAM
PRESTON
Perry
Macknade

a French-led invasion, *Board of Ordnance* ordered the creation of maps for military purposes and began mapping from coastal areas, those most exposed to threat. That is how the first state topographic survey of Great Britain, commonly known as *Ordnance Survey Drawings*, was carried out. The survey was conducted between 1791 and 1842. As a result, 449 manuscript segments, now kept in the British Library, were made with the use of the following ratio: two, three and six inches to one mile, making scales of respectively 1:31,680, 1:21,120 and 1:10,560. The first few dozen sheets made before about 1799 were characterised by a specific graphic style (Fig. 31).

Before that, in 1778, Thomas Yeakell, with the help of a young engineer William Gardner (1739–1800), completed the mapping of the county of Sussex at a 1: 31,680 scale with characteristic and realistic field boundaries (Hewitt 2010). After the death of Thomas Yaekell in 1787, the position of Chief Draughtsman was entrusted to Gardner. He maintained and developed the drawing manner of his predecessor.

The creation of *Ordnance Survey Drawings* began from mapping of the counties of Kent and Sussex – as noted, areas most exposed to French invasion. A survey was conducted under the guidance of Gardner in 1795, who was himself responsible for drawing the final versions. The fair drawing was made between 1797 and 1799 at the scale of the field survey enclosed by a black rectangular frame: 75 × 132 cm (Hodson 1989). Gardner's drawing style allowed the easy interpretation of cartographic data concerning terrain characteristics (Fig. 31) and was highly appreciated by the army. As a result, this suggestive manner of depicting land – 'the William Gardner's style' – was recommended by *Ordnance Survey Drawing* as the basis to its field sketches and for drawing maps (Kingsley 1982).

In mid 1799, William Mudge, a new director, decided to discontinue measuring and drawing field boundaries despite their unquestioned

Fig. 31 Fragment from *Ordnance Survey Drawings*, 1789–1799, London, British Library. OSD-112 27B 1797, Faversham, Kent. Reduction from the original by approximately 50%.

value and usefulness. He did so because such an undertaking was highly time consuming and very expensive. The reduced risk of the French invasion was another important factor. Only minor segments from that time are preserved in a good condition. The best segment (Faversham from 1797, scale ratio: 2' : 1 Mile; 1:31,680), in which realistic field boundaries and dominating colours (blue-green for waters and green for arable land) are visible, was selected for analysis here (Fig. 31).

Situations Cart over Smålene (1795–1797) Figures 15 and 32

Threats of a Swedish invasion of Norway were the reason why Heinrich Wilhelm von Huth (1712–1806), an experienced artificer and fortress builder, was conscripted into the Norwegian corps between 1772 and 1773. Born in Germany, von Huth was an officer of high social status, who had studied mathematics in Leipzig, and who had been a leader of a corps of engineers in Hanover. From 1771, he had served the king of Denmark and of Norway. Apart from overseeing the modernisation of Norwegian fortresses close to the Danish border, he became leader of the first topographic mapping scheme in Norway. As a result of the survey, 210 square sheets, the *Kvadratmilkart*, at a scale of 1:10,000 were created between 1774 and 1808. In 1774, when Huth was called to Copenhagen (Harsson and Aanrud 2016) to become the head of the government, he entrusted mapping and drawing maps to his fellow German, Carl Alexander von Stricker (1731–1820), who he had brought to Norway a year before. Stricker had served in the engineer corps for ten years, and had worked for Schmettau the Younger (Stricker 1804). At the same time, reform of units of measurement took place as a result of which the Norwegian mile equaled 18,000 Norwegian ells (*alen*), i.e. 11.295 km.

Fig. 32 Fragment from *Situations Cart over Smålenene* (1795–1797), Copenhagen, Det Kongelige Bibliotek. KBK III2.127-0-1795-8. Reduction from the original by approximately 50%.


Dejgnes=
Rachestads=


Erte
Stomperuud
Kiern
Store Hejer
Lysebraaten
Lund
lille Tilleruud
Oroe
Store Skarpsholdt
lille Skarpsholdt
Gammelsruud
Tilleruud
Aasen
Haug
Lunde
Lundehytte
Helle
lille Hejer
Moosen
Lannum
Stenrud
Braaten
Lannumhytte
Valved
Store Valved
Tilsruud
Kollen
Stryker
Strykerhytta

A few dozen earlier sheets, created in 1773–1778, are characterised by a prominent black hachuring and grey wash. Blue is also noticeable and brown, used to colour the line of roads, is the third, albeit most faint, colour. Unlike other multi-segment military works, there is a signature of the draughtsman in Norwegian or French below the frame on almost each segment. Stricker is one of the most frequently occurring names, which shows that he was not only a commander of the corps but also an excellent cartographer. His views were probably crucial in designing the original style for depicting hills and hill ranges. His choice of multi-coloured technology for use in publication was decisive in the later work of the Norwegian corps.

Twenty years later Huth, then the Prime Minister (*Statsminister*) but still supervising mapping undertaken by the Danish and Norwegian corps (which he did until 1805) ordered a new survey to be undertaken of the area of Norway bordering on Sweden. According to his mathematical approach, maps were north-oriented just as in the original mapping, which was distinctive when compared to topographic maps in other countries. On the basis of such mapping, officer-engineers from the Norwegian corps of riflemen (*Norske Jæger Corps*) produced the *Situations Cart over Smålenene* (Østfold) between 1795 and 1797. The work was supervised by Bernhard Ditlef von Staffeldt (1752–1818), head of the corps from 1789. Under his supervision, a dozen large island maps were made at a scale of 1:12,000, with an over-sized arrow showing geographical north (Fig. 15). Each map has a title cartouche with the name of the commanding officer, Staffeldt and other cartographers, who took part in the survey (Butenschøn, Krebs, Meyer, Stabell). Thanks to this information included in the cartouches, the names of those officers who carried this mapping under Staffeldt's supervision as well as of those who made fair copies from sketches, are known (those were: Birkebek, Enger, Hansen, Hennum, Joensen, Michelsen, Stabell and Ulven). The cartouches inform us that they were making a reduced drawing at a new official scale. Profiles of almost all the engineers were included in a biographical work on Danish and Norwegian officers (Hirsch 1888–1907). Among them, Søren Hagerup Stabell (1770–1840), a Norwegian cartographer, is

a key figure. Despite his young age he made the most maps. He began his service in the corps of riflemen aged only 18, and was educated at the military school in Christiania (now Oslo). He was promoted to the rank of lieutenant-general in 1835. The Segment no 8, mapped and drawn by Stabell (as the inscription in the cartouche notes) was included in the present analysis out of the twelve well preserved sheets with unique circular brushing of elevations and ranges of hills (Figs. 15 and 32).

7. Stages in development of the topographic images

In order to get an insight into typical cartographic procedures it is instructive to reconstruct the order in which the significant features were added to a topographic image. We will first consider the Epinal segment (Fig. 22) from the ***Minutes des cartes des Naudin***. When a new copy or a reduced version was being made, the first thing the cartographer did was to redraw the system of roads and rivers by using chalk or graphite: this constituted the basis for other topographic features. Simultaneously, the most significant point-based objects were copied, together with their accurate location, as specified during the field survey. Roads and rivers were initially marked with a quill pen and grey Indian ink, then watercolours were applied: light brown inside the boundary lines of the roads and dark brown to the right or below from this line (occasionally it was drawn above the line of road). The same Indian ink used for rivers and roads was applied by the draughtsman to delineate the boundary lines of meadows and arable land as well as the boundary lines of land developments in towns, villages and detached houses. It was also used to draw lines for inscriptions. Arable land, woodland and meadows were highlighted by lines in watered-down red. The boundary lines of fields were marked with an extra green line, leaving spaces for rivers and roads. Fields were then marked with parallel yellow, sometimes relatively diluted red or even green lines in order to differentiate them. Next, fields were

filled in with light green, the colour of meadows, and fields in woodland were painted in yellow. Border lines of houses and villages were marked with little Indian ink points, and the borders of cities with fortification lines (if there was a fortification) in red lines for urban development. Inside settled areas the layout of houses was drawn, with, sometimes, the outline of streets and roads.

Marking land relief was the next stage in the map's creation. The draughtsman used a soft brush, highlighting areas of upland in brown mixed with grey changing into red and pink, toning down the wash according to the principle that the more elevated the land, the more intense the colour.

Geographical names were brownish-yellow in dark brown hues, and these were written between ruled lines in order to differentiate the size of inscriptions and ensure that they were written horizontally. Names were applied with great precision to avoid letters touching the topographical features and were made visually consistent with the landscape depicted. Even today positioning of geographical names constitutes a great challenge for cartographers: in this respect, the high professionalism of many eighteenth-century cartographers, particularly observable in their layout of names that were long or which consisted of two or three words, is remarkable. The name of a town would conclude with a full stop. This manner of indicating the end of the name with a dot or moving a part of the name with a colon, had been used on copperplate maps since the sixteenth century (Medyńska-Gulij 2011).

Patterns of trees in woodland were applied in the final stages of the work to entirely fill in woodland areas. The miniature trees were not applied to spaces where roads went through woods, or where rivers and geographical names had been already drawn. With such a large drawing area and the necessity to divide drawing into stages, making breaks for specific layers to dry out, and working in separate stages contouring, applying washes and providing descriptions – required a division of labour between draughtsmen and calligraphers.

Those draughtsmen who copied measurements made by Schmettau the Elder's team (***Nova et accurata Siciliae Regionum)***, firstly drew the

shore line of the island and then, using a thin ultramarine line, marked the course of the river (Fig. 23). Next to the ultramarine line the draughtsman applied another quite diluted line by means of a thin brush. That line was frequently uneven and inconsistent, so much so that the brush stroke would not contain the pen line. A characteristic wavy line was typical in depicting meandering rivers. It was supposed to reflect irregular water flow, and not depict real river banks (Medyńska-Gulij 2011). The thin lines for the road network were added only after the rivers and streams were drawn. Roads constituted a basis for elements of land development which were usually drawn as little rectangles in two shades of carmine – light and dark, juxtaposed so as to give an impression of their three-dimensionality. The effect is particularly noticeable in urban settlements.

Drawing roads and rivers on sheets led to the way of depicting the land relief. Draughtsmen, using a brush with ink like a stamp, would create a diverse grey stain. More intense and frequent brushes were used to depict uplands: as a result, the highest parts of slopes are the most clearly shown. Stamped parts denoting mountains were slightly blurred, with the result that the greyness lost its intensity on edges. Stamping in three variants of green – green with the addition of carmine, green with chrome yellow (giving olive green as a result), and emerald green used to mark fresh plants – was considered highly sophisticated. Finally, a wash with grey Indian ink was added with various levels of tonal depth according to the principal light coming aslant from the north-west. That principle allowed the map users to interpret elevations and the land morphology. Adding geographical names was the last stage in the process of map creation. There were several reference lines, usually four or more, if the letters were large and, initially, names were written in graphite.

Different techniques were used to depict unusual features, for example an active Mount Etna. The volcano is marked as two small round 'stains'. Initially, two thin circles were made with bistre, then the draughtsman used carmine to fill them in, accentuating the middle with white, and, finally, he added chrome yellow on the edges to signal on intense orange associated with fire.

The ***Kriegskarte von Schlesien*** was meticulously finished. In the final maps, the main reference lines were removed and they are almost invisible in the finished work, see for example sheet no 18 from volume 5 also (Fig. 24) but we can learn a little more about the drawing process by studying the unfinished sheet no 32 from volume 5. To begin with, draughtsmen divided their cartographic content box, with graphite lines, into a graticule of 1.8 cm-sided squares. Horizontal lines were drawn first and then vertical lines were added where necessary. The sheet analysed below was probably prepared in the same way.

This graticule was then covered with roads, territorial boundaries and river courses, with crucial parts highlighted with graphite. Lines were drawn with a quill pen, with bistre used for roads, and, depending on hierarchy, one solid line was drawn and a parallel dashed line drawn next to it. Borders were drawn with the same bistre shade, marked by a thick dashed line. When drawing, the draughtsman followed earlier graphite hints. The shore lines of rivers, ponds and lakes were drawn, either in Prussian blue or in ultramarine. A brown brush stripe was added to the road line to make it more distinct. Rivers and lakes were shaded in a similar way, using a blue wash in the space between boundaries lines.

Having such a basis, the draughtsman would move to drawing other elements of the map, including settlements, the wild habitat and woodlands, leaving arable land areas in the natural paper colour. Any previously marked with graphite urban and rural land development or even individual houses were drawn in red. Boundaries of households, woodland areas and wasteland areas were marked with a thin grey-green line. Features of urban land development element were similar drawn with the use of carmine.

The last key element in the process of map creation was to mark the relief. The draughtsman used a small brush to produce hatched, brushing lines along a slope. He began hatching with higher areas and marked a slope with strokes of a brush, taking the brush away in places that were supposed to depict an area of lower elevation. As a result, lines were hachured around the slope like rays. Sometimes, when a mountain peak was depicted, hachuring had a shape of a fish back (Fig. 24).

The next stage of map creation was to add geographical names and signs (windmills, mills etc.). Three guiding lines were drawn to position the names precisely however signs were put without any lines. After names were written, woodland areas, roads and areas in river valleys were completed. Symbols, looking like semi-open circles denoting trees or bushes, were drawn. If capital letters were situated in woodland areas, tree pictograms were not drawn there and such areas were left covered in a greenish-grey hue.

Sandby and Roy (***Military Survey of Scotland*** **– Highlands**) began working on properly glued together segments with drawing reference lines and reference divisions in graphite (Fig. 25). Lines of construction were drawn obliquely, with the deviation of 65° from the vertical axis. Additionally, rectangles of many sizes were drawn, usually not larger than 0.9 cm-sided squares. As an example, one can observe them on the segment between Laars Mathik and Fernhall (Fig. 25). Such a constructed system, probably a copy of the divisions used in measurement sketches, was used by draughtsmen for proper land development plan. Oblique lines, remnants of observation point marking, can also be observed on the scrutinised segment.

Apart from a rough plan for land development, the layout of rivers was also an auxiliary element of the map's creation. The draughtsman marked the course of the river, drawing two parallel lines next to each other, with empty spaces for bridges to be added. The space between the lines was coarsely filled in with green turning sky-blue. Mountain streams were shown by a double line that turned into a single line in upper river courses, sometimes becoming exceptionally thin and vanishing.

The communication systems and human habitat were also placed on the map. Roads were drawn in thin, single, sometimes double lines, in brown. Features of land development was drawn in subdued red. Boundaries of rural land development were marked by inked tree miniatures arranged in lines, each resembling a question mark standing horizontally. The draughtsman attempted to reflect the view of the buildings in perspective as seen in the example of the manor at Laars. Such building plans, including gardens, were drawn with great attention to accuracy.

When a specific graticule of reference points was ready, mountains and arable land were marked on the segment. Mountains were drawn in an Indian ink of different shades of green, arable land was yellow and specific fields are marked with a light-brown dashed line that made a collection of irregular tetragons. In both cases Sandby used the paper white background, leaving parts of the land's development intact or marking only mountain peaks on the white background. Mountains were drawn with short strokes of a small brush, in light colours, through grey turning green to black.

For each segment of the Josephine survey (***Josephinische Landesaufnahme)*** a frame with topographic content was divided with a graphite graticule of 1.31 cm-sided squares. Occasionally, an extra division of squares was introduced, divided vertically into smaller rectangles in the ratio of 1:3 to 2:3. In some places, intersection spots were additionally circled. Such features allowed map makers to put individual elements of cartographic content on the map (Fig. 26). Lines denoting roads and rivers were first lines made by the draughtsman. It is difficult to specify which were drawn first as lines cross, overlap and intersect, even where bridges are marked. Roads were differentiated in many ways, although all were drawn in brown. They were marked with double parallel lines, by a thin line with parallel stippling and a single line. Paths were marked with stippling. Such roads were highlighted, brushing brown between the lines or between a line and stippling. If there was a single line, a brown line was brushed on the darker line of the already marked road.

The course of streams and rivers was similarly differentiated. Rivers were drawn by pen with Indian ink, as thin wavy lines in Prussian blue. Larger rivers were marked with two parallel dark lines, the space between them given a brushing of diluted blue. The same shade of blue was used for water bodies, with the colour wash applied more lightly in the centre of the water body. Rural settlement features were depicted in red rectangles of a similar size: the lower half of the rectangle or its right half was brushed in a red of greater intensity along the longer edge. Two shades of red, diluted and light, and more intense for boundaries were used to mark urban settlements.

The riparian forests and meadows were marked with larger colour blots of olive green, a mixture of Prussian blue and chrome yellow. Grey-green was used to mark woodland areas: the draughtsmen tried not to cover existing roads, but frequently failed.

At this point the draughtsman put hachuring, as typified on the Josephine map, on the map to depict the morphology of the landscape. Minor strokes of a thin brush dipped in grey Indian ink, following the shape of an arch, marked the lines of hachuring, which, in upland parts intersected, so making the feature look more intense.

Inscriptions and symbols were put on the map at a final stage. Draughtsmen used Indian ink and a quill pen, trying to lay out names so as to forestall any difficulties of interpretation. Hachuring was followed by writing; most texts had three graphite lines. When the text was copied on the map, tree symbols were drawn on woodland areas by the use of a thin quill pen. Dark green was used for the addition of names, e.g. at the top left corner, above the village of Stainz. Here the names of rivers Lemsitz Bach and Tratten Bach were added through the meadow. Framing segments and various descriptors to the table beyond the map completed the process of map creation. The segment was framed with the lines as recommended by Buchotte.

Avico and Carello made the ***Valle di Susa*** with diligence and artistic sensitivity (Fig. 27). One segment, consisting of separate pieces and paper slips, was covered in an oblique graticule of 2.93 cm-sided squares, onto which measurements made during the survey were copied. Draughtsmen who created that map, like other maps made by *Ufficio Topografico* in Turin, used the scheme of the island map (Fig. 14).

First and foremost, draughtsmen added the network of roads, rivers and borders to the graticule. All those elements were drawn with a quill pen without any reference lines. Streets were marked with red Indian ink. Roads in built-up areas were drawn in the same colour as areas of urban layout and settlement development, buildings being marked in red, and breaks between houses left uncoloured. The outline of rivers were marked with black Indian ink with their course painted in blue. Boundaries were stippled with black Indian ink. Main roads beyond

towns were marked with two parallel stipplings and filled in with pink with the use of a brush. Paths were marked with a single dotted line and repainted brown.

Finally, the draughtsman, with the use of bistre in different shades, marked the relief. When using a brush, care was taken not to cover the brown line of rivers. After the paper dried, the next and darker layer was applied. As a result, the morphology of the land is vividly and linear portrayed. The draughtsman created the effect of strong illumination of the uneven area with the light of the sunset. The ridges and area towards the west mountain are depicted in light brown, properly differentiated: those to the east seem hidden in shadow. Such technique allowed the draughtsman to differentiate light and dark shades of brown, making the colour palette include the whole variety of colours from the neutral colour of the paper to brownish black. The brush strokes are sure and give an impression of three-dimensionality, perhaps from the 'fluffiness' of the brush.

Inscribing names on the map was the last stage of map creation. In this aspect, the calligraphy was firm and effective. Just a single lower reference line of meticulously calculated length was drawn for names: occasionally they were written precisely without any helping lines. The same draughtsman drew cross patterns in appropriate places on the map and elaborate tree miniatures in woodland areas thus giving the impression that they cast a shadow towards the east. The precision of these tiny signs is enhanced by the fact that trees, shown as approximately 2.5 cm high, are elaborately finished with green blots.

As its first stage, the draughtsman of the ***Kurhannoversche Landesaufnahme*** copied the main elements of the initial map, making lines of roads, rivers and boundaries of farmsteads, cities, and woods in graphite (Fig. 28). Not all the graphite marks have been completely erased: a canal in the north-east drawn in graphite and not erased is connected with a canal to the south of the village of Prabsdorf near the Pülmeitz Foven farmestead (seven households marked). A mark after his drawing a road with graphite can be observed at the crossroads to the east from Prabsdorf. Forest boundary lines drawn in graphite are clearly visible

in the eastern part of Gravenhorst, in the Kleine Lucie forest south of the main canal (Land-Graben). The draughtsman used graphite also to mark the relief, hachuring in places that were rendered with washes and toned down, e.g. to the left from the calligraphed 'M' and below, in the word 'AM', in the centre of the analysed segment (Fig. 28). Most map elements are linear and in black Indian ink (additions in red ink were added later). The use of other colours is limited. The drawing is clear and specific elements are meticulously drawn.

The drawing process was generally based on a horizontal view but the draughtsmen were not consistent. The way, in which forests ways, alleys and paths in garden areas are drawn creates a clear spatiality effect by the fact that trees, in the form of semi-ovals open at the bottom and with a dot on the right, were marked near main roads and paths in parks.

Marking boundary lines of settlements was the next stage. The boundaries of villages near roads were marked with minor oblique hachuring in Indian ink. A dash-dot pattern was diligently used to depict boundaries between particular homesteads, and arable land areas were marked with field stones. Fields were marked with dilute Indian ink. Houses were shown differently depending on the construction materials. Brick or stone buildings were marked in red, wooden buildings in chrome yellow. To reflect the diversity of the land surface, the draughtsman used shades of light green with the addition of chrome yellow, which made the black Indian ink lose its intensity. The draughtsman tried to prevent the indigo river from crossing the line of the road if there was a bridge over the river. Rivers on the map meander in a picturesque, almost unnatural way.

When the linear stage was complete, the draughtsman marked the land relief with tone washes, highlighting slopes of hills with a dark shade. Then arable land, wetland and woodland areas were coloured in. Inscribing names on the map was the last stage of the work. Inscriptions were prepared with diligence, guide lines drawn before writing (usually three horizontal lines per name). Both letters and symbols illustrate the author's competence. After the names were ready, the same calligrapher or draughtsman drew tree symbols on the fields, similar to those previously drawn by the roads, and skilfully laid them out between letters.

From the segment of ***Schmettausches Kartenwerk*** (no 14) considered here, one can conclude that the highly accurate graticule (consisting of 0.8 cm-sided squares; Fig. 29) was a starting point for the final copy. Cartographic content was based on it. As on Wrede's Map, arable land was left in the natural colour of the paper. Draughtsmen began by drawing boundaries of villages and towns which were then connected by the road system. Roads were marked by a single line that in the areas of rural or urban development changed into frontages. Roads with beaten surface were marked with two parallel lines and shaded with brown. Villages were painted in lighter green to distinguish them from the surrounding fields (drawn in darker green) and specific households were filled in with very thin hachuring in which lines are arranged in different directions. River banks were drawn in two dark blue parallel lines, with the area between filled in with a lightly-shaded blue-grey. Streams and minor watercourses were drawn as single lines. Bodies of water were marked in the same way as rivers. However, the shading was stronger and blue lighter.

Draughtsmen then marked riparian forests, meadows, forests and bogs. Each was highlighted with a boundary line which emphasises their separation. Riparian forests and meadows were drawn in light green, and wetland areas were blue highlighted with horizontal zigzag hatching. Woodland areas were marked in greenish-grey. Miniature bushes drawn with a thin pen with black Indian ink were added to bogs.

This method of uniform colour was used to mark wastelands and moors. Diluted carmine was used here making parts of the map a pale pink. Having finished that stage, Schmettau the Younger's team began to depict the configuration of land with slight single strokes of hachuring made with a thin brush. Here black Indian ink was used as well as grey, which sometimes turned into green. The strength of the hachuring and variations in the length of hachure strokes was used to illustrate diversity in upland topography. Slight brush strokes started in higher places and ended at the bottom of hills. When short strokes were added to the highland area they made the slopes seem much steeper. The last stage of the work was to put names on the map and mark trees and miniature

bushes on meadow areas. Indian ink was used for both. A wide external frame made in ink was created after a cut segment had been glued to the canvas.

The ***Carte de Ferraris*** (Fig. 30) was made on over 1,000 separate sheets glued to 270 segments. Draughtsmen had to very accurately unify not only the system of classification and the signs used but also the systems of line, point and blotting. The use of blotting and wash were the greatest challenge for draughtsmen as it was difficult to achieve identical shades when applying the watercolours or when laying down the colour with a brush to different sheets at different times.

Draughtsmen firstly drew a shared graticule for all segments planned to be glued together. Such a graticule allowed then to easily copy measurements from the sketches onto specific squares. The graphite lines that we can reconstruct from several of the preserved fragments, were drawn obliquely. The arrangement of the graticule is best observable in the top part of the sheet to the east from De Wynendale Capelle. An entire system based on 1.8 cm-sided squares was created, with inaccuracies resulting from the fact that the lines were not parallel: it was not always possible for the draughtsman to draw a straight line through the entire segment in a single hand movement. After that, the layout of fields, as well as the areas for towns, villages and single farmsteads, were determined. The map, highly accurate and detailed, includes divisions into arable land, meadows and woodland areas and shows the boundaries of fields and meadows. The impression of perspective was achieved by adding shadow to the majority of the cartographic signs (point, line and area).

Woodland areas were marked with Indian ink. Numerous parts of the map were made in a landscape convention, particularly orchards. The tree symbols arranged in border lines make a complex system. Lines of trees are highlighted with a stripe of grey ink to suggest the casting of shadow. Trees by canals and roads were also depicted in perspective. Trees by wide roads were depicted as casting shadows from north-west to south-east. Built-up areas of brick and stone were highlighted with red small rectangles for civilian architecture and with church miniatures for

sacred architecture. Wooden buildings were marked in the same way but in yellow.

Having finished these graphic tasks, the draughtsmen turned to colouring the land, using different colours to differentiate land use functions. Polder areas were covered in unified green and arable land with two types of hachuring to suggest furrows: light red, and light green. The draughtsman took care to draw lines along the longer side of the field. Canals crossing the polder were initially painted in the same colour as the polders. The draughtsman then added some chrome yellow to a still-wet green but the effect of such admixture is in many places almost unnoticeable. The same rule for depicting water in canals was applied to the depiction of ponds, but their surface was shaded and the colour used produced a more emerald green. To highlight the different ownership of individual meadows, short horizontal wavy lines of several millimetres were drawn on a wet surface, which has resulted in a slightly blurry effect. The draughtsman then depicted the relief structure and suggested hills in brushed blots of brown and red (Fig. 30). Putting names and signs on the map was the last stage in the map creation. Homesteads were numbered without reference lines, as were crosses (denoting cemeteries and churches) and windmills (divided into wooden mills, painted brown with ink, and brick mills, drawn with ink and coloured red). Three guides lines were drawn to help position the names precisely. Names were calligraphically rendered with black Indian ink in order to prevent the letters covering significant elements of the map.

The map of the Kent county, ***Ordnance Survey Drawings*** (Fig. 31) is elegant and minimalist in its artistic expression. The draughtsman made it in black Indian ink, marking with a slightly muted green areas of meadows, woods, rivers and water bodies. Buildings such as small farms, villages and towns were painted red. In this study, we consider the segment around the neighbourhood of Faversham (Fig. 31). The map gives the impression of being unfinished. The middle channel of the Wantsum canal is additionally highlighted with parallel lines to emphasise that the fact that it was navigable. The navigable area, in the form of a line drawn at a distance from the shore and parallel to it, was consistently marked

in the mouth of the canal, according to the same principle. Because the watercolourist left these places without colour, there is an impression of his having left the work incomplete.

In a few places on the segment altitudes are visible: spot heights noted in red-ink and remnants of auxiliary lines made with graphite between fixed triangulation points. They usually intersect at the node points for those who made the measurement – that is, high buildings (towers), and hill tops. One can presume that the London Road, an oblique line that goes down from near the midpoint on the segment's left edge to the bottom right, is one of the significant lines organising the map. Other roads, the course of the Wantsum river and field boundaries are marked with graphite and highlighted in Indian ink. Several elements, mostly roads, were drawn simply with graphite, such as the road that leads to Luddenham (Fig. 30).

Buildings were worked out in a similar manner, i.e. they are presented in two shades of red, suggestively presenting the three-dimensionality of buildings. Stonework buildings or structures are drawn in red Indian ink, wooden structures or buildings in black or sepia Indian ink. The Faversham buildings are depicted in detail, including the street system and land parcels along with it neighbouring land. Boundaries of meadows and orchards are drawn and coloured green.

The boundaries of fields, meadows and forests are shown with a thin line and meadows, forests and waters are coloured with different shades of green. Arable land is shown in muddy brown or left as the natural tone of the paper. Wetland areas were covered in green streaks painted with a small brush between which 'windows' of white paper are visible. Meadows and woodland areas are highlighted with an evenly-applied emerald green: rivers, canals, tributaries and water bodies are coloured green with the addition of sky-blue.

In making the map more graphically informative, the draughtsman used a small bristle brush to leave characteristic marks in the form of thin lines between which various shades of grey were applied. These parts resemble hachuring made with a hard graphite. The woodland area of hills is highlighted by stamping with a firm brush dipped in chrome

yellow. Drawing miniature tree to stand for forests and orchards, and inscribing names of towns, finalized the work. The draughtsman completed his composition with a rectangle frame drawn in black Indian ink.

The map produced by Stabell and his team (segment 8 from ***Situations Cart over Smålene***) was drawn in large segments of sheets in different sizes (Fig. 32). Such a format must have been problematic to work with. There are several places in which lines were aligned to points of contact, although these points are sometimes inaccurate.

The very process of drawing the map is schematic and drawing the road system was the basis for further work. Marking the water system was the first step. Roads were drawn in a thin bistre line and a light shadow in the same shade was added on the right. Winter roads were marked by two parallel sequences of points. The course of the river was marked by two meandering parallel blue-grey lines, more intensely drawn on one side than the other. The bed of the river is drawn lightly in a dilute shade of the same tinge of blue. Boundaries of private land property were marked in the same colour as roads. The last step was to denote homesteads in red Indian ink and triangles denoting stone hovels.

The use of hachuring appears on two areas of the map. Areas of peatbogs were hachured with green, slightly-arched, lines and the slopes of hills and river beds were marked with an oblique grey shading and miniature rocks denoted a stony ground. That was probably the near final stage of work. Text was applied in Indian ink. Places with water wheels and the boundaries of communities were marked. The inscription cartouche was drawn in the top left corner. Landforms, distinct and unreal, were shown in grey ink wash but without tone variation.

Based on these detailed descriptions of the maps, it is possible to discern their general formal characteristics and, from that to outline preliminary conclusions about their authors' cartographic concerns and drawing styles. This is helpful, too, in moving from the maps' two-dimensional representational forms to their 3D form (Figs. 33–43).

Fig. 33 3D Model of detail from Fig. 22, *Minutes des cartes des Naudin* (elab. by B. Medyńska-Gulij).

In the *Minute*, considered above, the most striking feature is the drawing of farmland of rectangles and squares filled with parallel narrow three-colour stripes: yellow, green, and red (pink). Such a subtle, but also incredibly precise, wash, combined with a selection of colours, makes the map (Fig. 22) one of the most dazzling of the eleven studied in this work, with its saturated colours and warm tones. The three-dimensionality inherent in the representation of topography, achieved by adding brown shading, is especially clear when we compare a topographic picture with one based on a three-dimensional model (Figs. 22 and 33). The cartographers of the Naudin family paved the way for the shaping of the graphic line in French manuscript topographical maps, which, in part, was the result of the high-level position held by the eldest of the Naudin family. This style had already been evolving from the time when it was first used in the 1720s. Based on further later segments, one can

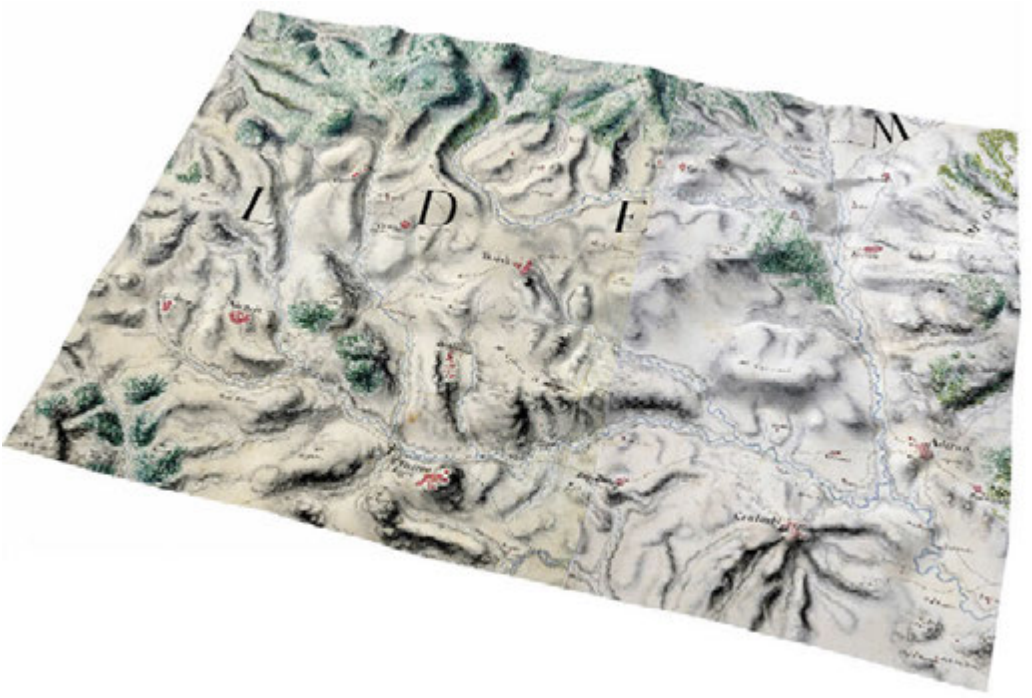


Fig. 34 3D Model of detail from Fig. 23, *Nova et accurata Siciliae Regionum* (elab. by B. Medyńska-Gulij).

clearly see the process which underlay that convention of using colours for the individual cartographic content: brown for colouring roads, red for buildings.

The other manuscript version of the map of Sicily is epitomised by an original watercolour depiction of woodland in graduated varieties of green, and a perfectly toned grey to render the morphology (Figs. 23 and 34). Based on inspection of the decorated cartouche and the different ways of rendering space, it is possible to suggest that the drawings were made by a talented cartographer who however lacked an artistic and/or professional education. It was typical, even idiomatic, to apply tone using the technique of stamping with a small brush. Comparison of the colours used on one sheet (Fig. 34) and in the photograph (Fig. 44) leaves one with impression of the painterly techniques used in depicting a landscape and doing so perfectly in line with natural colours.

Fig. 35 3D Model of detail from Fig. 24, *Kriegskarte von Schlesien* (elab. by B. Medyńska-Gulij).

The map commonly referred to as Wrede's military map is a milestone in Prussian cartography (Figs. 24 and 35). It owes its existence to the draughtsmen of the Potsdam Map Room (*Plankammer*). Here, under the supervision of Oelsnitz, the head of the Room, the first style of Prussian cartographic maps was developed. The map stands out in its similarity to field sketches, and to two ways of rendering the land relief by hachuring, black strokes and grey shades. As far as the selection of colours is concerned, it is typical to apply Prussian blue to mark waters, red for buildings, and brown for roads. Presenting a woodland in dark grey usually signified an obstacle and, even, a feature's impenetrability for military purposes (Fig. 35). When comparing the view of a forest from distance with that shown in a photograph, we can consider that the colour impressions has been retained (Fig. 45).

In Roy and Sandby's map, the principle of applying primary colours as a rule coincides with those used in other topographic works of the period [red for buildings, blue-green for water, green for woodlands, yellow for cultivated ground, and yellow-brown (buff or gamboge) for

Fig. 36 3D Model of detail from Fig. 25, *Military Survey of Scotland* – Highlands (elab. by B. Medyńska-Gulij).

moorland]. This map is above all distinguished by its depiction of diversely landforms, primarily by the dominant mountains and valleys, effected through use of a grey-brown shading (Fig. 23). This combination of colours gives the map its particular receptive qualities: the way in which Sandby has mixed shades renders the natural features and colours of the landscape very real, as is clear from photographs and 3D models (cf. Figs. 23, 36 and 46).

In the Josephine survey, whose execution as we have seen took many years, one can discern the search for an individual graphical style. The three different copies of the of the borderline segment Jägerndorf (Kriegs Archive: BIXasect.21) illustrate this finding. One copy is clearly in the style of early Prussian maps: the others are characterised by the hachuring of slopes in ways typical for the other Habsburg maps. The grey lines of different thickness and length that cross one another at various angles and overlap have become an original way in the Josephine survey

Fig. 37 3D Model of detail from Fig. 26, *Josephinische Landesaufnahme* (elab. by B. Medyńska-Gulij).

of presenting relief for subsequent segments (Fig. 26). For military actions, this was indeed an unambiguous way of reading the directions in which the slopes slanted. Putting a number of grey lines (thin stripes made with diluted black Indian ink) was supposed to render the inaccessible mountainous areas in a more distinctive way than for those areas that were available without obscuring them with numerous strokes or lines. While the hachuring applied on the map of Silesia is not given a three-dimensional expression (Fig. 35), the cross-hatching applied on the map of Austria provides a visually appealing way of showing the land's morphology (Fig. 37).

In their work the Savoyard cartographers Carello and Avico applied a unique style of rendering the topographical relief which differed from other maps produced by the Turin Office. Even though they were using the same skeleton drawings as in their other maps, this particular work is truly unique (Fig. 38). Direct observations and intimate knowledge of the land combined to give a colour-based comprehensive representation

Fig. 38 3D Model of detail from Fig. 27, *The Susa Valley* (elab. by B. Medyńska-Gulij).

of the landscape. The fluidity of the morphological forms in their approach is clear from the 3D model (Fig. 38). The multi-tonal shading of mountain valleys is similar to Sandby's depictive style, although the selection of colours, and their ways of washing and bleeding tones is a distinctive feature of these Turin-based cartographers.

The Hogrewe map (Fig. 28) stands out for its highly sketchy use of cartographic signs: the boundaries lines that mark areas of farmland and vegetation are similar to the graphite-made field sketches. The fact that the work has a neatly arranged graphical expression and that each part is highlighted with a symbolic pattern makes it easy to comprehend visually. Of all the maps studied here, the Hogrewe map has been most thoroughly described. Many accounts refer to the land not under cultivation. This focus reflects the original purpose of the map. It was to serve as a guide to the development of what had formerly been wastelands, including the drainage and improvement of boggy land. On this map, attention should be paid to the specific, sketchy presentation of the stone borders between households and arable land. Similar markings

Fig. 39 3D Model of detail from Fig. 28, *Kurhannoversche Landesaufnahme* (elab. by B. Medyńska-Gulij).

were made by Yeakell and Gardner on their map of Sussex completed in 1778, as well as on several *Ordnance Survey Drawings*. The subtle greyish shading that reflected the suggestive shapes of the passages, little valleys, hills and land elevations can be appreciated in comparing the map (Fig. 28) with the 3D model (Fig. 39).

The map made by Schmettau the Younger is distinguished by its even distribution of colour blots closed by the boundary lines (Fig. 29). The tone is kept exceptionally consistent for the grey of the woodland, the green of the meadows, in the Prussian blue for the lakes with its enhanced boundary lines for the shores, and the pink – or dilute red – for moors and wastelands. The draughtsmen working for Schmettau easily handled the ways in which one shade of a colour was maintained on large surfaces of paper: in the case of watercolour, this is not easy. His team used blue Indian ink to draw small rivers and streams, which makes the map different from the others, because as a rule, black or grey secondary lines would be coloured together with blue lines. This graphical style is

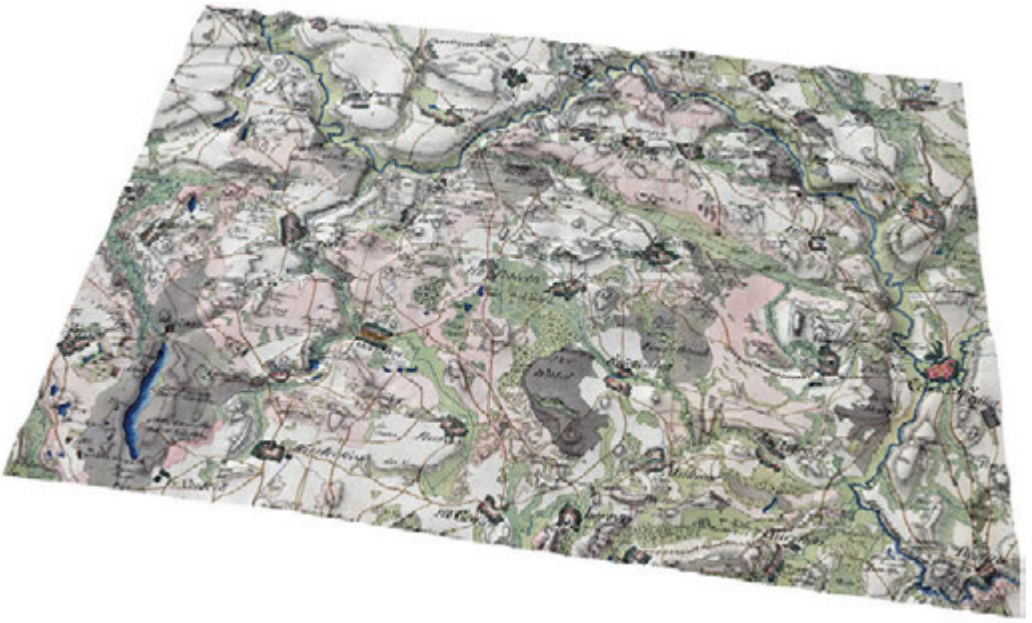


Fig. 40 3D Model of detail from Fig. 29, *Schmettausches Kartenwerk* (elab. by B. Medyńska-Gulij).

typical of those maps that were created at the *Plankammer* in the 'Second Prussian Style'. It is a distinguishing feature of this second style in comparison to the first, as evident on Wrede's and Balbi's maps (Fig. 24).

A important conclusion to be drawn from analysis of the fragment of segment 9 of Dixmude (Fig. 30) is that the colours typical for the map produced by de Ferraris are closer to French maps made in the workshop of the Naudins (Fig. 22) than in the contemporaneous Josephine survey (Fig. 26). The cadastral subdivision into individual arable fields was rendered through use of analogous symbols in terms of the structure and colours as was Naudin's *Minute*. Both cases demonstrate the same style of shading for the slopes. From all this, we may assume that to execute the finished de Ferraris map, French draughtsmen were employed and given the skeleton protraction by engineers from Mechelen.

The Faversham segment of *Ordnance Survey Drawings* (Fig. 31) is a good example of the principles applied throughout mapping. Relief was rendered with ink hachures. Red was used for buildings in contrast to

Fig. 41 3D Model of detail from Fig. 30, *Carte de Ferraris* (elab. by B. Medyńska-Gulij).

various shades of brownish green for several types of vegetation, and blue and green for waters. The field boundaries are realistically marked, rather than being given a simple schematic outline. For this reason the early *Ordnance Survey Drawings* segments can be compared with satellite imagery of the same areas. The Survey segments excel in faithfully rendering colours of the English landscape. The combinations of green flat areas and blue-green water areas, and the thin lines that give a shading effect consistent with the principle of vertical lighting, add immeasurably to its visual appeal (Figs. 31 and 42). The associations of the colours are similar to natural tonal variations, and the colour contrast, which is kept relatively low for the surface, is heightened thanks to the boundary lines of the fields being drawn in black Indian ink (Medyńska-Gulij 2017).

For the maps produced under the supervision of Staffeldt, one's general impression is dominated by their varieties of grey, black contours, and signs (Fig. 32). What stands out is his way of drawing with Indian

Fig. 42 3D Model of detail from Fig. 31, *Ordnance Survey Drawings* (elab. by B. Medyńska-Gulij).

ink, and the characteristic laying of concentric trails or bands washed in various shades of grey. In those ways, they distinguish the style of the Norwegian mapping corps from other topographical maps in eighteenth-century Europe. On the map of Norway selected for analysis, an intense red colour was applied for cartographic signs to mark buildings, which, in the case of the wooden houses painted in red, was both visually evocative and actually symbolic. The way in which hills and slopes are drawn provides insight into the methods applied in the first topographical maps of Norway. Stabell's draughtsmen used concentric hachuring to slow the concentration of elliptic shapes. This graphic picture was laden with a multitude of grey concentric fragmented graphical forms. Such use by Staffeldt of this graphical expression was perhaps a convergence of the principles of representation of altitude set out by Rawert in his 1793 manual (Rawert 1793). One is inclined to draw such conclusions when looking at the 3D model, which illustrates the graphic potential

Fig. 43 3D Model of detail from Fig. 32, *Situations Cart over Smålenene* (elab. by B. Medyńska-Gulij).

and the perspective of the map under analysis (Fig. 43). In the photograph, however (Fig. 47) doubts are raised in comparing it with the map since these convex forms as symbolic elements have little in common with the actual terrain.

Fig. 44 North view from the Agira Castle (Castello di Agira, formerly Castello San Filippo D' Argiriò) in Sicily; see Figs. 23 and 34 (photo by B. Medyńska-Gulij).

Fig. 45 North-west view from the way leading to east from Baszyn village (formerly Baschine) in Silesia (Poland); see Fig. 29 (photo by B. Medyńska-Gulij).

Fig. 46 North view from Knock Height, near Crieff town in Scotland – see Fig. 25 (photo by B. Medyńska-Gulij).

Fig. 47 North view from Etre Lake (Etrevannet) in Norway – see Fig. 32 (photo by B. Medyńska-Gulij).

8. Graphical means of expression

The tools used for drawing could prove to be important to specific techniques and their effects. For topographic maps, draughtsmen employed pencils (black lead, black chalk), pens (reed pen, quills), and brushes (Fig. 20). Quill drawing produced a graphical effect similar to that obtained with graphite during field survey sketching. The final fair copies of maps required an initial drawing or line work in graphite that was later erased (despite attempts at its removal, graphite left traces that on occasion are still visible in close view). Pens or quills made thin strokes, dashes or dots, whereas brushes were used to make broad strokes as well as spots or patches of colour. Reed pens or quills were the most appropriate tools used to achieve a uniform intensity in the ink traces on paper, although density of colour depended on the strength of the aqueous solution. Brushes were employed to paint with inks and watercolours, and, exceptionally, with gouache. Since all the employed media were water soluble, they could be mixed or superimposed using different techniques. When drawing and painting maps, cartographers had at their disposal five groups of drawing techniques, from graphical to painterly: pencil (graphite) drawing, reed pen or quill drawing, pen or quill Indian-ink drawing with washes, brush drawing with Indian ink or watercolours, brush drawing with Indian ink or watercolour washes. Map draughtsmen used four types of tools: black lead pencils, reed pens, quills, and brushes, and five watermedia techniques: ink and bistre for

quills; watercolour, Indian ink, bistre, wash, and gouache for brushes; and ink, Indian ink and bistre for reed pens.

In order to determine as precisely as possible the features in the manuscript map created by use of these several techniques as the graphical means of expression, those elementary components of graphical procedure to present geographical features used by cartographers, need to be carefully itemised (Medyńska-Gulij 2013). The compilation in Figure 48, which aims to systematize cartographers' activity identifies ten means of graphical expression and five stages of drawing techniques – from graphic linework to painterly expression. They are significant for analysing the content of the topographic maps. The columns of the set include chronological examples of the graphical means (see Table, pp. 96–97). If the maps include multiple techniques, the set presents their sequence from the top, that is, the final, layer.

This description is supplemented with reference to the most frequently used colours, tools and techniques, as well as examples of topographic objects represented by use of the chosen means of expression (Fig. 48):

- **Lines, dashes and dots:** black, grey, brown, red, pink (roads, borders, relief, churches, chapels, roadside crosses, gallows, bridges, watermills, windmills); black lead pencil, graphite, reed pen, and quill: ink, bistre, Indian ink;
- **Broad strokes:** blue, red, brown – drawn as thinner lines and dashed and dotted lines, black, grey (roads, streams, rivulets); quill: ink, bistre;
- **Single-colour bands (broad strokes) with contour (border line)**: black-blue, grey-brown, black-red, black-brown (roads, rivers, administrative borders); brush: watercolour, Indian ink, bistre; reed pen: ink, Indian ink, bistre;
- **Small, oblong or rectangular single colour spots**: red (buildings); reed pen: ink; brush: watercolour, ink;
- **Single-colour blots with or without contour (border line),** dotted or hatched, or without contour, dotting or hatching (settlements, woods, farmland, meadows); brush: watercolour, coloured ink, gouache; reed pen: ink, Indian ink;

- **Areas closed by graduating boundary lines** (lakes) **or bands limited by one-sided graduating contour or two-sided graduating contours** (rivers); brush: watercolour, ink; reed pen: ink;
- **Banding, parallel single-colour dotted line spotting** (farmland); brush: watercolour, bistre, ink, and wash; reed pen: ink;
- **Single-colour spots with black contour on lighter single-colour blots** (pattern of trees in woods); reed pen and quill: ink; brush: watercolour, ink, gouache;
- **Stippling, spotting or blotting in grey** (relief grading); brush: Indian ink and wash;
- **Blotting, banding with multi-colour and multi-shade spotting** (landform hatching, land-relief shading on woods or on fields; varying use landform); brush: watercolours, Indian ink, bistre, and wash.

The above compilation of the different graphical means of expression allowed us to determine the structural features of the maps analysed, in relation to the principles of cartographic design, and based on their evident similarities and differences, to establish degrees of affinity between the different maps. Initial analysis showed that all the maps studied were developed using the first four graphical means of expression listed above:

- Lines, dashes and dots directly transmitted from field sketches that, at the same time, constituted the only graphical means of expression employed in copperplate-engraved maps (Medyńska-Gulij 2013);
- Broad single-colour strokes with one- or two-sided contours (boundary lines) representing roads, rivers and administrative borders. Here, the lines in this form strengthened the contrast between colours and features. This improved the readability of river or road features. This method for rendering roads and rivers was used in accordance with the above for colouring copperplate-etched maps;
- Regular rectangle shapes marked red (or pink, or combining the two colours) indicated the presence of brick- or stone-build settlements;
- Bounding the area of the blue (or blue-green) feature that denotes a water reservoir body or a large river.

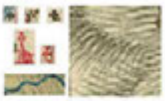
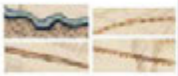
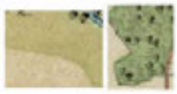
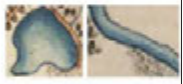
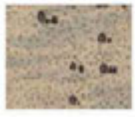
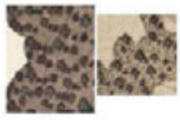
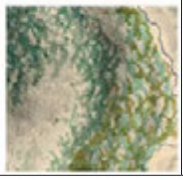
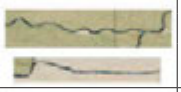
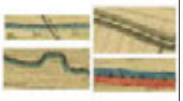
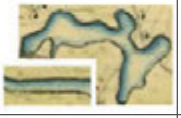
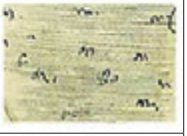
	1704–1746 France	1720–1721 Sicily	1747–1753 Silesia	1747–1752 Scotland	1763–1785 Danubian Monarchy
Lines, dashes and dots; black lead pencil, graphite, reed pen, and quill: ink, bistre, Indian ink					
Broad strokes; quill: ink, bistre					
Single-colour bands (broad strokes) with contour; brush: watercolour, Indian ink, bistre; reed pen: ink, Indian ink, bistre					
Small, oblong or rectangular single colour spots; reed pen: ink; brush: watercolour, ink					
Single-colour blots with or without contour; brush: watercolour, coloured ink, gouache; reed pen: ink, Indian ink					
Areas closed by graduating boundary lines or bands limited by one-sided graduating contour; brush: watercolour, ink; reed pen: ink					
Banding, parallel single-colour dotted line spotting; brush: watercolour, bistre, ink, and wash; reed pen: ink					
Single-colour spots with black contour on lighter single-colour blots; reed pen and quill: ink; brush: watercolour, ink, gouache					
Stippling, spotting or blotting in grey; brush: Indian ink and wash					
Blotting, banding with multi-colour and multi-shade spotting; brush: watercolours, Indian ink, bistre, and wash					

Fig. 48 Graphical means of expression (**in black**) and drawing techniques

1764 Piemont-Susa	1764–1786 Electorate of Hanover	1767–1787 Prussia	1771–1777 Austrian Netherlands	1789–1799 England	1795–1797 Norway
					
					
					
					
					
					
					
					
					
					

(**in blue**) used in the eleven analysed works (comp. by B. Medyńska-Gulij).

Each of the maps involved employed at least six other means of expression. The least commonly represented included stippling, spotting or blotting in grey – present in five maps only – and blotting and banding with multi-colour and multi-shade spotting – evident in six maps. The latter contributed to the painterly effect of maps and was the result of the individual approach and aesthetic tastes of different map makers.

The most prominent features in cartographic design included those developed during the production of monochrome maps and were based on solid black lines, dashes and dots as used in copperplate-engraved maps (Medyńska-Gulij 2013). These eighteenth-century map draughtsmen continued to employ them without introducing major adjustments to them: point signs and hachuring for land relief as well as coloured banding on dotted or dashed lines to increase the visibility of roads, rivers, borders, and so on. The use of graduated contour (boundary lines) – from dark blue (or navy) at a lake shoreline to lighter blue centrally – is something of an idiomatic expression in these manuscript maps. These maps display several innovative solutions which, over time, became common in printed topographic maps and even remain mandatory to this day. These include:

- Single-coloured area symbols with or without contours (boundary/borders) to represent the use of land; present in seven maps;
- Stippling, spotting or blotting in grey for relief grading; present in five maps;
- Single-colour light blue bands (broad strokes) with intense dark blue contour to represent large rivers; present in eight maps;
- Single-colour spots with contour (border); similar to the methods of rendering patterns in field sketches.

It is noteworthy that the use of colour increased the information content of mapped areas. Multi-layer graphic messages transmitted through watercolour techniques, area symbols and descriptors (geographical names) do not interfere with the visual attractiveness of the maps. Maps' visual harmony stemmed from the fact that fair-copy draughtsmen adhered to painterly rules of colour contrast and complementarity. The

multi-segment form of many maps in turn allowed for their wider reception as individual pieces or as component parts of the whole.

Questions may also be asked of these map' representativeness in terms of the categories of 'emulating nature' and 'mimesis'. It is justifiable to ask those questions in relation to the forms of graphical expression (Fig. 48) and in particular map segments (Figs. 22–32). As we have noted, many map makers recorded information about particular areas using pigments that were intended to imitate natural colours in ways similar to the practice of watercolour landscape painters. Sandby's distribution of colour in his work for Roy's maps resembled the tones employed in his watercolour landscapes. Close approximation to colours in nature could be evident at a glance: the artist achieved this by employing not only appropriate shades but also by blotting and banding with multi-colour and multi-shade spotting to indicate natural textures. Map draughtsmen intensified their use of colour by including hachuring to emphasize varying land relief and by use of patterns or washes. This complementarity of drawing and painterly techniques makes the maps aesthetically pleasing and visually harmonious.

The maps studied here situate themselves on two extremes of the dominance of either drawing or painterly techniques and effects. Interestingly, this polarizing attitude reflects the aesthetic dispute between proponents of line or colour in the seventeenth and eighteenth centuries (Rzepińska 1983). The dominance of line and dash, especially with the use of reedpen or quill, is recognizable in Ferraris's map of the Austrian Netherlands and in Schmettau the Younger's map of Prussia. Painterly means of expression with blots of colour and brushstrokes prevail in Roy and Sandby's maps of Scotland and in Avico and Carelli's map of the Susa Valley.

The three-dimensionality of landforms was rendered most realistically in the maps of Sicily, Piedmont (the Susa Valley), Scotland, and England. In these maps, the landscape effect was achieved by employing subtle painterly techniques, predominantly washes and moderate use of contour/ boundary lines. These maps, despite the richness of pigments, seem considerably toned and muted, in contrast to maps of Silesia,

Prussia, France (Lorraine), Austria, the Austrian Netherlands, and Norway. In these examples, the map makers emphasized their readability and opted for linear forms of graphical expression. The colours are more intense for point or line signs and less vivid for area signs to make the smaller topographic symbols more distinct. Greys or blacks were meant to strengthen the contrast. Maps thus varied from seeming, to be more practical, that is, with distinctive and contrasting graphical elements and colours, to more aesthetic in a 'nature imitating' style achieved by feathering and the use of patches of colour.

A comparison of two British maps (the map of Scotland – Highlands and the map of England – Kent) with the map of the Electorate of Hanover – as all three were prepared on the instructions of rulers of the same Hanoverian dynasty – is illuminating in this respect. The two British maps, despite forty years between them, reveal their makers' preference for painterly means of expression and for colours imitating natural landscape. The draughtsmen employed the most appropriate means of expression and extensive single-colour blots, i.e. natural greens, to render the forest areas. The draughtsmen working for the Elector of Hanover in turn chose – according to the ruler's instructions – the graphic style with the dominance of graphical means of expression, although with an inclination to differentiate land relief with greys in painterly fashion. The reedpen or quill stroke distribution and its relation to the painted map sections is also worthy of attention. For instance, the Prussian draughtsmen strengthened the shades on the hill- and mountainslopes with hachuring, whereas the authors of maps produced for the Danubian Monarchy preferred cross-hatching for the purpose. The painterly rendered hills of Lower Saxony betray wet feathering, whereas Roy and Sandby's map of Scotland and Avico and Carello's map of Piedmont reflect the hills with distinct, one-direction, brushstrokes made with slightly watered Indian ink. Sandby's brush was round, whereas Avico and Carello chose tuft brushes, which are similar to today's filbert brushes (Fig. 27). Sandby used the same means of expression and the same sets of colours to represent landform in his field-survey watercolours (Fig. 4) and in the rendering of hills and mountains (Fig. 25). The comparison of two works

by Sandby reveals the extent of his imitation of nature (Fig. 36). Sandby paid special attention to what we might term area analyses, including the investigation of the local geology as it influenced the relief.

By thus laying out the different forms of graphical means of expression (Fig. 48), researchers can more grasp the distinctive effects. The use of graduating areas closed by contours (boundary lines) was typical for representation of rivers and lakes, but in two maps they mark rural and urban housing areas: in the map of Prussia (Fig. 29) they are shown in green to reflect the density of village settlements, and in red in the map of the Austrian Netherlands (Fig. 30).

We must allow that distinctive styles of graphical expression – those that, effectively, constituted their authors' unique signatures – could also be important in determining the unique features of specific maps, in searching for further works executed by given map makers or teams of specialists, in recognizing connections between works, and – finally – in examining the degree to which map makers adhered to the instructions they received. The map of Norway studied here is a noteworthy case because of its original stylistic solutions, including hachuring with black Indian ink, was additionally emphasized with grey spots or broad brushstrokes.

We may conclude from analysis of the maps of Scotland, England and the Electorate of Hanover (Figs. 25, 31, and 28), that the leaders of the mapping groups played a key role in influencing the final results and give the work an individual feature even when the instructions were similar.

9. Conclusion

It is arguable that professional topographical mapping began in the Enlightenment, certainly towards the end of the eighteenth century. The development of professional topographical mapping in the Enlightenment was manifestly connected with the recognition of the authority of maps in the (re)presentation of space and their unique combination of the rational language of mathematics with the aesthetics of artistic production. The maps presented here offer a rare opportunity to analyse the ways in which Europe and its topography was visualised and perceived by cartographers, map commissioners, and map users. It has become apparent that maps should be placed in wider cultural process of change in Europe, as acts of 'improvement'. Improvements concerned in part the exchanges of knowledge, which included the field surveys and map drawing. The maps we analysed here provide an insight into the eighteenth century understanding of geographical space and the modes and motifs of its visualization.

This work has focused on a hitherto-unexamined set of multi-segment maps. The conclusions offered here speak especially to this unique set of maps. The research presented here does not attempt to address the correlation of manuscript maps with the later mass-produced printed topographic maps. Nor does it examine the development and standardisation of topographic symbols specific for countries or in different publishing contexts.

Our attempts to systematize the chosen manuscript maps and certain graphic objects led us to propose a classification based on two essential criteria: normative and idiomatic. The former relates to shared and complementary features, those that provided insight into the graphical means of expression used to visualize topographic space in eighteenth-century Europe and the principles of their use. The second criterion emphasized the unique characteristics of the works themselves which were an outcome of the specific identifying features of given draughtsmen or schools. In exceptional cases, we have been able to attribute maps to specific authors, to distinctive personalities involved in developing maps and we were even able to identify an individual's drawing language. At the same time, we have tried to bring together the sometimes disparate methodologies of the history of cartography, political studies and art history. It has been necessary to do this in order to understand fully the close connections between politics, art and cartography.

One key question concerned the influence of drawing techniques on the utilitarian competence and the aesthetic appeal of eighteenth-century topographic maps. Notions of utility and attractiveness are, of course, highly subjective. Our procedures here adopted in analysing the graphical means of expression in maps – though emphasizing objectivity – should not be treated as a working model. Rather, they should be regarded as methodological guidance.

The foundation for this research lies in the thorough description of specific cartographic works, the selection of which was restricted – for practical reasons – to single segments representing the maps as a whole. Based on research methods that have combined the methodological repertoires of a cartographer and an art historian, the main formal features of eleven eighteenth-century manuscript topographic maps have been systematically determined. The maps are, in various ways, representative of European cartography in the period and were produced in one or other of the six most important courts of Europe. The cartographic criterion of our research concerned the accurate representation of the mapped topography, situation, and its achievement through different artistic expressions, namely drawing or watercolour painting. This enabled

us to approach the study of maps by looking at the use of drawing techniques and at methods employed in artistic work. One decisive moment of the research was the division of map styles into linear (drawing) and painterly (watercolour) expression, and their combined effects.

As a result, three essential manner or approaches were specified, each embracing a range of more individual styles:

- A drawing manner which employed the simplest graphical means of expression. It was adequate in terms of topographic information and preserved a high contrast between specific elements of the map content, e.g., the early (first) Prussian style (map of Silesia); the second Prussian style (map of Prussia); the Hanoverian map of the Electorate of Hanover; and the late Habsburg style (the map of the Habsburg Dominion);
- A combined drawing and painting manner, e.g., the French style (Map of NE France with Lorraine), its derivative Malines style (map of Austrian Netherlands), the late British style (map of England), and the Norwegian style (map of SE Norway);
- A painterly and drawing manner, which employed sophisticated means of graphic expression, with harmonious colours and imitation of natural features, e.g., the early Habsburgian style (map of Sicily), the early British style (map of Scotland), and the Savoy style (map of Susa Valley).

The first styles proved to be the most practical and useful for establishing normalized system of symbols. This in turn inspired the development of sign and colour systems employed in topographic maps published later in lithographic techniques. The emphasis on lines, dashes and dots would result in the widespread production of exclusively black and white maps in the nineteenth century – and was related to the growing publication of maps in newspapers. The styles of the third manner were often neglected by cartographers in later periods because of the difficulties in establishing normalized cartographic systems.

In the case of the painterly styles, the final visual effect was determined by author's individual predispositions. With the use of water

media and related drawing techniques, maps represented topographic information about specific areas (both military and administrative) in the form of a consistent visual message that, in many instances, could be associated with landscape painting. This was because, the professional affinity of the map draughtsmen to the landscape painters was on occasion especially close (see Figs. 4, 25, 36, 46, as well as the 3D model and photographic material). The comparison of maps with the actual topographic situation in the countryside, also made us realize that the perception and cartographic work of various groups of map-making officers in similar cultural and surveying conditions, but in different topographic situations, might be interpreted as elements in a broader phenomenon of the understanding of space in the Enlightenment.

We have shown that the term 'authors' of maps should extend to the organizers of mapping processes and to the originators of particular mapping systems. Further, map authorship (and the resulting customary map titles) was often attributed to the commander or leader of a field survey (cf. Table, pp. 96–97). Cartographic historians have traditionally paid less attention to the ordinary map draughtsmen, who have remained anonymous as result. Yet it was they (as authors of fair copies) who often determined the final form of maps and their aesthetic worth. These unique manuscript maps represent exceptional examples of applied-arts objects, ones that increased their aesthetic value together with their role in indicating new possibilities for the geography of Europe (Pomian 1990).

Producing a map depended to a great extent upon existing logistical conditions. We have identified, five types of design authorship (cf. Fig. 48):

- Hierarchical authorship. This authorship indicates the work of several people: Wrede's map of Silesia was developed under Frederick II's supervision, who was himself theoretically and practically competent in map making. The mapping and the resulting protraction copy were made by Wrede and his team, but the draughtsmen were probably coordinated by Oelsnitz, head of the Potsdam drawing room (*Plankammer*). Such a hierarchical production structure, might also

be recognized in the map of Norway developed by order of Huth – the Staatsminister and mathematician – who delegated the coordination of surveying and drawing activities to Staffeldt. In fact, the men responsible for the original map were cartographer Stabell and other engineers. A similar solution would explain the map of the Electorate of Hanover, produced by Hogrewe and his subordinate engineers, formally supervised by du Plat, but with the personal involvement of George III in the decisions over segment division and cartographic content.

- Institutional authorship, or maps produced by the head of a specific drawing room and his subordinate draughtsmen. The map of England, attributed to Gardner and the personnel of the Tower of London drawing room, was developed according to this system.
- Authorship in tandem: those engineers who performed field surveys and sketches, and later produced fair copies (e.g. Roy and Sandby's map of Scotland) – the former drew topographic objects and the latter was the sole author of landform painting; Avico and Carello (map of Susa Valley) – both put their ink signatures on the map, independent of the cartouche content.
- Collective authorship where the maps were produced by draughtsmen associated with particular drawing rooms or employed to draw maps according to the protracted copies supplied. The former included, for instance, the case of the map of NE France with Lorraine (from Naudin's atelier) or the over 3,000 map segments (map of the Habsburg Dominion) developed by officers in Vienna. A further example would be the map of Austrian Netherlands, most probably involving draughtsmen educated in France.
- Individual authorship, i.e. a single map maker. In this category would be included a draughtsman of the map of Sicily (Fig. 23). Although he did not leave his name, his drawing style is distinct and different from Schmettau the Elder's work or any other work. The draughtsman probably came from the Viennese military engineers' circles, possibly Marinoni's.

Whereas map conventions concerning corps organization and military tactics, are easy to identify with particular armies, it is not always so with the graphic 'manners' of individual cartographic engineers. Here, an important clue is the distinct and unique use of liquid media in individual drawing rooms. It is also important to look at personalities and their working practices. In the period 1773–1805, all the field surveys related to mapping in Norway were supervised by Huth who did not speak either Danish or Norwegian (he was the German speaker and probably knew French), but was appointed as German officer in command of the engineer corps in Christiania (now Oslo). As a result, all the Norwegian mapping instructions were in German and the Norwegian engineer corps functioned through German. This, however, was not reflected in the means of graphic expression used in Norway or in the style of Norwegian maps: the present research concerning Norwegian maps established major differences in graphic style between these maps, possibly influenced by Rawert, and German (Hanoverian and Prussian) maps.

The use of water-based media allowed for the representation of lands throughout Europe. No other technique offered map makers and artists an opportunity to reflect landscape so realistically. It is, no wonder, then, that it strongly affected the development of modern principles for cartographic design, even being translated through into the engraving and lithographic world of print. The map-making initiatives conducted in the Enlightenment were distinctive, helping define an age and a new emerging Europe. In these manuscript maps, we can see how eighteenth-century European contemporaries helped develop conventions – in the use of line, colour, perspective, tone and topographic form – that shaped how their world was seen: on maps, in art, in the political imagination.

List of Figures

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Name Index

Abbreviations

a – after
A – Austrian
ar. – architect
astr. – astronomer
b – before
b. – brother
b.i.l. – brother in law
c – circa
C. – century
cart. – cartographer
c.d.r. – chief of drawing room
c.e.c. – chief of engineer corps
col. – colonel
c. sur. – chief of survey
d. – daughter
Dan. – Danish
dr. – drawing
drm. – draughtsman
En. – English
eng. – engineer
f. – father
fl. – flourished
Fr. – French
gen – general
Ger. – German
gf. – grandfather
gs. – grandson
h. – husband
H. – Half
Han. – Hanoverian
HRE – Holy Roman Emperor or Holy Roman Empress
It. – Italian
lt – lieutenant
mar – marshal
math. – mathematician
mil. – military
n. – nephew
Nor. – Norway or Norwegian
of. – officer
Pr. – Prussian
qm – quartermaster
s. – son
Sav. – Savoyard
Sax. – Saxon,
ser. – service
sur. – surveyor
t. – teacher
top. – topographer
Ven. – Venetian
w. – wife