R

Reilly, Franz Johann Joseph von. The Austrian cartographer, editor, and writer Franz Johann Joseph von Reilly was born in Vienna on 18 August 1766, a descendant of a prosperous family originally from Scotland or Ireland. He died in Vienna on 6 July 1820. After a brief unsuccessful career in the civil service and perhaps inspired by the continuing success of Franz Anton Schrämbl's *Allgemeiner Grosser Atlass* ([1786]–1800), he used an inheritance from his father for the publication of his own atlas, the *Schauplatz der fünf Theile der Welt* (Dörflinger 1984, 208–30; 2004, 87; Dörflinger and Hühnel 1995, 1:83–102). This atlas was produced over a period of seventeen years from 1789 to 1806, with a break during the Napoleonic occupation in 1802–3. Reilly released a map a week, for a total of 830 maps, a tremendous work rate aided by the generally small size of the maps and their simple style as reductions from previously printed models. Due to their great commercial success (123,000 copies of the first 90 maps were sold within nine months after issue; Dörflinger 1981, 67), Reilly was able to establish a publishing house in 1791–92, the Reilly'sches Landkarten und Kunstwerke Verschleiss Komptoir (or Reilly'sches geographischen Verschleiss Komptoir).

Reilly reused the maps from the *Schauplatz* with little or no variation in several regional atlases such as the *Atlas von dem Königreiche Ungarn* (1796) and the *Atlass von Deutschland* (1803). The Komptoir's other atlases included the *Schul Atlas / Atlas Scholasticus* (1791–92); the *Diplomatischer Atlas* (1791–98), recording the political changes in Europe from 1790 to 1798; the *Grosser deutscher Atlas* (1794–96) in large folio format; a regional atlas of Silesia, *Atlas von den an Böhmen und Mähren gränzden fürstenthümern Schlesiens* (1796); and the *Atlas universae rei veredariae bilinguis . . . Allgemeiner Post Atlas von der ganzen Welt* (1799), showing the regular mail service routes in Europe and western Siberia (see fig. 785) (Dörflinger 1984, 250–60; a full list and contents of all Reilly's atlases is in Dörflinger and Hühnel 1995, 1:83–116). Reilly also published a number of single map sheets and several geographical handbooks (Dörflinger 1984, 206). By 1802 he began to turn to noncartographic prints and literary-historical works. His *Atlas von der moralischen Welt* (1802) contained ten satirical-allegorical maps, mixing cartography and literature.

As the success of his early maps waned, he stopped the production of cartography completely in 1806. Nonetheless, the impact of his prodigious output, combined with that of Schrämbl, ensured that Vienna would become a center of commercial cartographic production in the German-speaking world.

GERHARD HOLZER

SEE ALSO: Austrian Monarchy

BIBLIOGRAPHY

Dörflinger, Johannes. 1981. "The First Austrian World Atlases: Schrämbl and Reilly." *Imago Mundi* 33:65–71.

———. 1984. *Österreichische Karten des 18. Jahrhunderts*. Vol. 1 of *Die österreichische Kartographie im 18. und zu Beginn des 19. Jahrhunderts: Unter besonderer Berücksichtigung der Privatkartographie zwischen 1780 und 1820*. Vienna: Österreichische Akademie der Wissenschaften.

———. 2004. "Vom Aufstieg der Militärkartographie bis zum Wiener Kongress (1684 bis 1815)." In *Österreichische Kartographie: Von den Anfängen im 15. Jahrhundert bis zum 21. Jahrhundert*, by Ingrid Kretschmer, Johannes Dörflinger, and Franz Wawrik, ed. Ingrid Kretschmer and Karel Kriz, 75–167. Vienna: Institut für Geographie und Regionalforschung der Universität Wien.

Dörflinger, Johannes, and Helga Hühnel. 1995. *Atlantes Austriaci: Österreichische Atlanten, 1561–1918*. 2 vols. Vienna: Böhlau; Weimar: Köln.

Wawrik, Franz. 1982. *Berühmte Atlanten: Kartographische Kunst aus fünf Jahrhunderten*. Dortmund: Harenberg Kommunikation.

Relief Depiction. See Heights and Depths, Mapping of: Relief Depiction

Religion and Cartography. The common misunderstanding of the Enlightenment as *the* era of cartographic reform has gone hand in hand with the equally common misunderstanding of the Enlightenment as an era of secularization. On the one hand, since the eighteenth century itself, the Enlightenment has been defined as both an intellectual-cultural movement and as a normative concept by its opposition to, if not outright denunciation of, religion. The Enlightenment has been synonymous with secularization, as a period when critical reason banished traditional beliefs, superstition, and blind adherence to religious authority. On the other, the map has served as a potent symbol of the Enlightenment: measured, universal, and true to empirical fact, the scientific map is seen to have accurately represented a natural space without taint of cosmology or metaphysics. David Harvey (1989, 249) could thus argue, for example, that by the end of the eighteenth century maps had been "stripped of all elements of fantasy and religious belief"; they "had become abstract and strictly functional systems for the factual ordering of phenomena in space."

The apparent irreligiousness of the Enlightenment stands in marked contrast to conditions in the Renaissance. Volume 3 of *The History of Cartography*, reflecting the historiographic interpretations that have emerged since 1980, is permeated by cartography's many interrelations with religion. Renaissance cartography remained a discipline and a practice inextricably tied to religion as an institution and as a set of beliefs. Religious views and concerns informed, if not dictated, much cartography in the Renaissance, well into the seventeenth century. That there is a need to explore the subsequent unfolding of this complex relationship during the period 1650–1800 is evident from the way that nuanced studies have in recent decades pointed out the inadequacies of preconceived notions. Map historians have explored the conceptual and ideological character of Enlightenment mapping (e.g., Godlewska 1995; Edney 1999, 167–70). At the same time, historians have revealed both the perseverance of religion throughout the intellectual history of the eighteenth century and the constantly evolving nature of both religion and reason. For example, Enlightenment ideas were embraced and developed within certain church circles, such as the Edinburgh Moderates. Moreover, recent scholarship on the Enlightenment has also deemphasized the radicalness of the French *philosophes*. When studied from a pan-European perspective, religion and belief were still dominant in the republic of letters and among the public as a whole (Sheehan 2003).

This entry begins to fill in this historiographical gap by tracing the major traditions and developments that characterized religion and cartography in the European Enlightenment. It distinguishes between interrelated and overlapping themes: the religious context of cartography and the mapping of religious topics. The religious context entailed the institutional patronage of intellectual and mapping projects, the making of maps by churchmen or theologians, and the infusion of religious themes in works by lay mapmakers. Conversely, the mapping of religious topics comprised both the well-developed tradition of *geographia sacra* (the historical mapping of biblical places and events) and ecclesiastical mapping (the mapping of religious houses and the organization of provinces, dioceses, etc.).

The religious context for mapping activities was much less pronounced after 1650 than before. As individuals, most cartographers probably were religious, but they did not conceive of their work as necessarily related to their beliefs or religious affiliations and did not seek to reflect them in their maps. The high-ranking Franciscan and prolific cartographer and globemaker Vincenzo Coronelli was an exception to the rule. Yet even Coronelli, while employing a cosmographic imagery inherited from papal Rome, was commissioned for his major works by secular patrons (Cosgrove 1999). Another intriguing example is William Gerard De Brahm, a surveyor for the British in colonial America, who understood his geographical knowledge as being intimately linked to his alchemical and mystical beliefs (Paulett 2009). One of the more overt instances of cartographic religiosity, which followed earlier Renaissance models, was Vicente de Memije's 1761 allegorical merging of the Virgin Mary with the Spanish world (fig. 703), a map that accompanied a more conventional world map (Padrón 2011). Eighteenth-century emblem books, again following an earlier tradition, made meaningful use of cartographic images (globes, maps, instruments), often as symbols of religious faith (fig. 704). Moreover, geography was a field of study that since antiquity had stood as a central pillar in the moral education of elites. It is not unreasonable that together with the bourgeoning

(*facing page*)
FIG. 703. VICENTE DE MEMIJE'S *ASPECTO SYMBOLICO DEL MUNDO HISPANICO*. Intended to accompany his *Theses mathematicas de cosmographia, geographia, y hydrographia* (Manila: Imprenta de la Compañia de Iesvs, por D. Nicolas de la Cruz Bagay, 1761). This allegorical figure of the Virgin Mary, who had recently been adopted as the patron saint of their Most Catholic Majesties, extends across the Spanish world, her feet resting on the Philippines, Memije's home, her head and crown pillowed by the Iberian Peninsula. The royal arms of Spain fly from her cross-tipped staff. Heinrich Scherer had included similar iconography in the margins of his world map, centered on the Pacific, included in his *Atlas Marianus* (1702). Copper engraving on two sheets.
Size of the original: 99 × 63 cm. © The British Library Board, London (Cartographic Items Maps K.Top.118.19).


AFRICA
AMERICA SEPTENTRIONAL
AMERICA MERIDIONAL
SENO MEXICANO
ISLA DE SANTIAGO
NEVA TRA
REYNO DE EL AUSTRO
Tierra interior incognita
Mar de Fodoro
Mar Oriental
IESO
PLVS ULTRA
PLVS ULTRA
ASPECTO SYMBOLICO DEL MUNDO HISPANICO,
PUNTUALMENTE ARREGLADO AL GEOGRAFICO.
QUE A SU GLORIOSO CATHOLICO REY D. CARLOS TERCERO EL MAGNANIMO
DEDICA, Y CONSAGRA D. VICENTE DE MEMIJE, CON IX. THESES, Y XC. PROPOSICIONES, QUE ACERCA DE EL DEFIENDE:
PRESIDIENDO EL R.P. PASQUAL FERNANDEZ PUBLICO PROFESSOR DE MATHEMATICAS
EN LA UNIVERSIDAD DE MANILA DE LA COMPAÑIA DE IESUS AÑO DE


122 LEERZAAME

Het XXIX^ste ZINNEBEELD.

Zo gaat men veilig.

Neemt myn jok op u, en leert van my, dat ik zachtmoedig en nederig van herte ben: en gy zult rust vinden voor uwe ziel. Matth. XI. 29.

Ik ben het licht der waereld: die my volgt, zal in de duisternis niet wandelen, maar het licht des levens hebben. Joan. VIII. 12.

Jezus zeide tot hem; Ik ben de weg, de waarheid, en het leven. Niemand komt tot den Vader, dan door my. Joan. XIV. 6.

Op

FIG. 704. CONSUMPTION OF GEOGRAPHICAL MAPS AS A METAPHOR FOR RELIGIOUS FAITH. This emblematic image by Vincent Laurensz. van der Vinne, titled *Zo gaat men veilig* (thus men go safely), illustrated three verses from the New Testament—Matthew 11.29 ("Take my yoke upon you, and learn of me; for I am meek and lowly in heart: and ye shall find rest unto your souls"); John 8.12 ("Then spake Jesus again unto them, saying, 'I am the light of the world: he that followeth me shall not walk in darkness, but shall have the light of life'"); and John 14.6 ("Jesus saith unto him, 'I am the way, the truth, and the life: no man cometh unto the Father, but by me'")—suggesting that Jesus is not just the path to eternal salvation, he was the route map. From Adianne Spinniker, *Leerzaame Zinnebeelden* ('te Haarlem: Izaak van der Vinne, 1714), 122.
Size of the original: 11.6 × 9.0 cm. Image courtesy of the PJ Mode Collection of Persuasive Cartography, Cornell University Library, Ithaca (1016.01).

ethnographic and travel literature of the time, maps were being used as aids to moral and religious reflection, promoting a greater appreciation of God's creation (Godlewska 1999, 29). Most mapmakers and maps, however, were not as committed to holistic, theologically informed cosmographic schemes as their Renaissance predecessors had been.

The cartouches of some maps, often related to war or overseas expansion, featured religious elements: a sword-bearing lion of St. Mark, representing a Christian Venice, commands a group of defeated Muslim Ottomans on a map of the Peloponnese by Matthäus Seutter (*Peloponnesus, hodie Morea*, in *Atlas novus*, 1727), who followed earlier versions by Cornelis Danckerts and Frederick de Wit (Brummett 2015, 216, 221 [fig. 5.17]); Europe as a Christian queen is situated next to a Muslim ruler and savage personifications of Africa and America in Gerard van Keulen's world map (*Nieuwe . . . paskaart vertoonende alle bekende zeekusten en landen op den geheelen aard boodem of werelt*, in the *Zee-fakkel*, 1728; see fig. 643); illustrated quotations from Genesis and Job appear on Seutter's celestial planisphere (*Planisphaerium coeleste*, in *Atlas novus*, 1730). However, these and similar elements represent a continuation of iconographic conventions and do not necessarily demonstrate a strong link between the maps' content and religious conviction.

Institutionally, after 1650, Europe's burgeoning states and commercial marketplace took increasingly significant roles in promoting and sponsoring cartography. Yet certain ecclesiastical institutions did continue to engage in otherwise secular cartographic projects. Notably, Jesuit missionaries made many surveys, in Europe, China, and elsewhere, with long-term missionary aims in mind (Harris 2005), while the popes mapped their territories in central Italy. The comparative decline in religious mapping is reflected in the entry on geography in Denis Diderot and Jean Le Rond d'Alembert's *Encyclopédie*; it divided the discipline into six branches, four secular—natural, historical, political, and physical—and only two religious: "géographie sacrée" or *geographia sacra* (sacred geography), and "géographie ecclésiastique" (ecclesiastical geography) (Robert de Vaugondy 1757, 613). The mapping of religious topics had thus developed into particular and circumscribed types of activity.

Geographia sacra had been practiced continually from its origins in late antiquity, most notably in the topographical works of Eusebius and Jerome, as a fundamental component of biblical scholarship and exegesis. The reconstruction of biblical geography in textual commentaries, lists of toponyms, and maps had attained new status during the Reformation, when Catholics and Protestants alike held that correct biblical interpretation had to be grounded in correct geography. By 1650, this well-developed scholarly tradition was becoming a subject less for polemic and more for popular interest. As the Huguenot scholar Samuel Bochart observed in his unfinished treatise "De loco Paradisi terrestris" (ca. 1640), "knowing where the Terrestrial Paradise was located, was not necessary for salvation. It is better to aim for the celestial, where we are called, than to look for the terrestrial" (quoted by Shalev 2012, 170). Even so, reconstruction of biblical geography and events remained a necessary exercise for understanding Scripture. Indeed, in the first decade of the eighteenth century, scholars such as the Protestant Jean Le Clerc and the Benedictine monk Augustin Calmet reprinted and collected major works in the genre and thus helped create a stable lineage of authorities. In this manner, *geographia sacra* flourished throughout the Enlightenment as a field of popular as well as scholarly interest (Shalev 2012, 259–70).

Maps of biblical geography adhered to the period's graphic conventions and were hardly distinguishable from general regional maps. They had north at the top and generally used meridians, parallels, and scale bars. Overall, measurement and precision were essential tools for approaching and explaining Scripture and were certainly not in tension with piety and belief. Methods used for the creation of religious maps were also not that far removed from the compilatory and humanistic-erudite descriptive procedures used by eighteenth-century geographers as a whole (Godlewska 1999, 37). However, given their special embeddedness in textual and historical traditions, practitioners of *geographia sacra* normally used whatever contemporary geographical data was available onto which they added text-based details.

The primary mapping activity of *geographia sacra* was the production of maps, whether in separate sheets or bound in books, that described the geography of biblical lands (primarily the Holy Land) and situated scriptural events. Such maps appeared in Bibles, such as Brian Walton's *Biblia sacra polyglotta* (1657); those in Dutch Bibles derived mostly from older models (Poortman and Augusteijn 1995, 141–267). They also appeared in many exegetical works, such as John Pearson's *Critici sacri* (1660); historical atlases, such as Claude Buy de Mornas's *Atlas méthodique et élémentaire de géographie et d'histoire* (1761–62); and in general atlases too, such as Didier Robert de Vaugondy's *Nouvel atlas portatif* (1762). However, despite this large and varied output, during our period and later into the nineteenth century, this cartographic body remained quite conservative in terms of methods used and cartographic content. More often than not, cartographers simply copied or redesigned earlier maps without any significant updates. Although generally common among geographers, this replicating tendency was perhaps accentuated among biblical mapmakers by their fundamental commitment to a canonical text. Nonetheless, some scholars grappled with the foundations of sacred geography. Two were notable.

In the early eighteenth century, the Dutch Orientalist Adriaan Reelant produced one of the most influential works on the topography of Palestine: *Palaestina ex monumentis veteribus illustrata* (1714). This work would become a major resource for pioneer archaeologists in the region after 1800. Reelant's chief aim was to clear the ground of the many unfounded traditions that had sprung up within the geography of Palestine. Rather than argue over specific locations with medieval and Renaissance authors, he chose to assemble the texts and maps afresh, based solely on ancient sources such as Eusebius, Josephus, the Talmud, classical geographers, and Arabic writers. The main part of Reelant's work is an alphabetical list of biblical place-names, a sort of updated and expanded version of Eusebius's *Onomasticon*. Reelant's eleven maps certainly look clean and free of unnecessary detail: adhering to his own criticism of earlier maps, Reelant avoided the usual random scattering of mountains and rivers and he omitted settlements whose locations could not be verified. Reelant's "clean" style might be said to evoke the ideals of the early Enlightenment; however, it may also point to his Protestant approach, which sought an authentic ancient landscape behind spurious traditions. Moreover, his mapping relied on ancient texts and therefore its claim to accuracy and critical erudition drew upon a long-existing and rich textual tradition.

William Whiston combined, from an early stage in his scholarly career, an interest in natural philosophy and theology, as shown in his *New Theory of the Earth* (1696). One of his most successful publications was a translation into English of the works of Josephus (1737), which included a carefully crafted map of Palestine as well as a set of illustrations of sacred architecture (fig. 705). Whiston's map acknowledges his sources—both Reelant's *Palaestina* and Christophorus Cellarius's two-volume *Notitia orbis antiqvi* (1701–6)—while at the same time including considerable textual arguments concerning their geographical inadequacies. Whiston calculated the land's area in acres, making it much larger than had previous geographers. He also returned to a controversial point of exegesis by arguing that the Holy Land could indeed have sustained its population, considering its now recalculated extent and famed fertility, and the support of divine providence (Shalev 2015, 200–208). The map includes a gazetteer-like list of place-names and their coordinates. Uniquely, it calculated longitudes from a local zero meridian through Jerusalem; this was a telling move by Whiston, who also devoted considerable effort to solving the problem of longitude. Thus, Whiston's map of Palestine, in the context of his larger theological-scientific projects, provides an important example of the various ways in which religion and maps were blended.

In a few cases, scholars extended their biblical mapping beyond the Holy Land to encompass the whole world, or at least those parts that Scripture described. In part, the wider scope was necessitated by the need to show the itineraries of the Apostles (e.g., Török 2005, no. 42). A more profound enlargement was achieved by Bochart in his authoritative and massively erudite

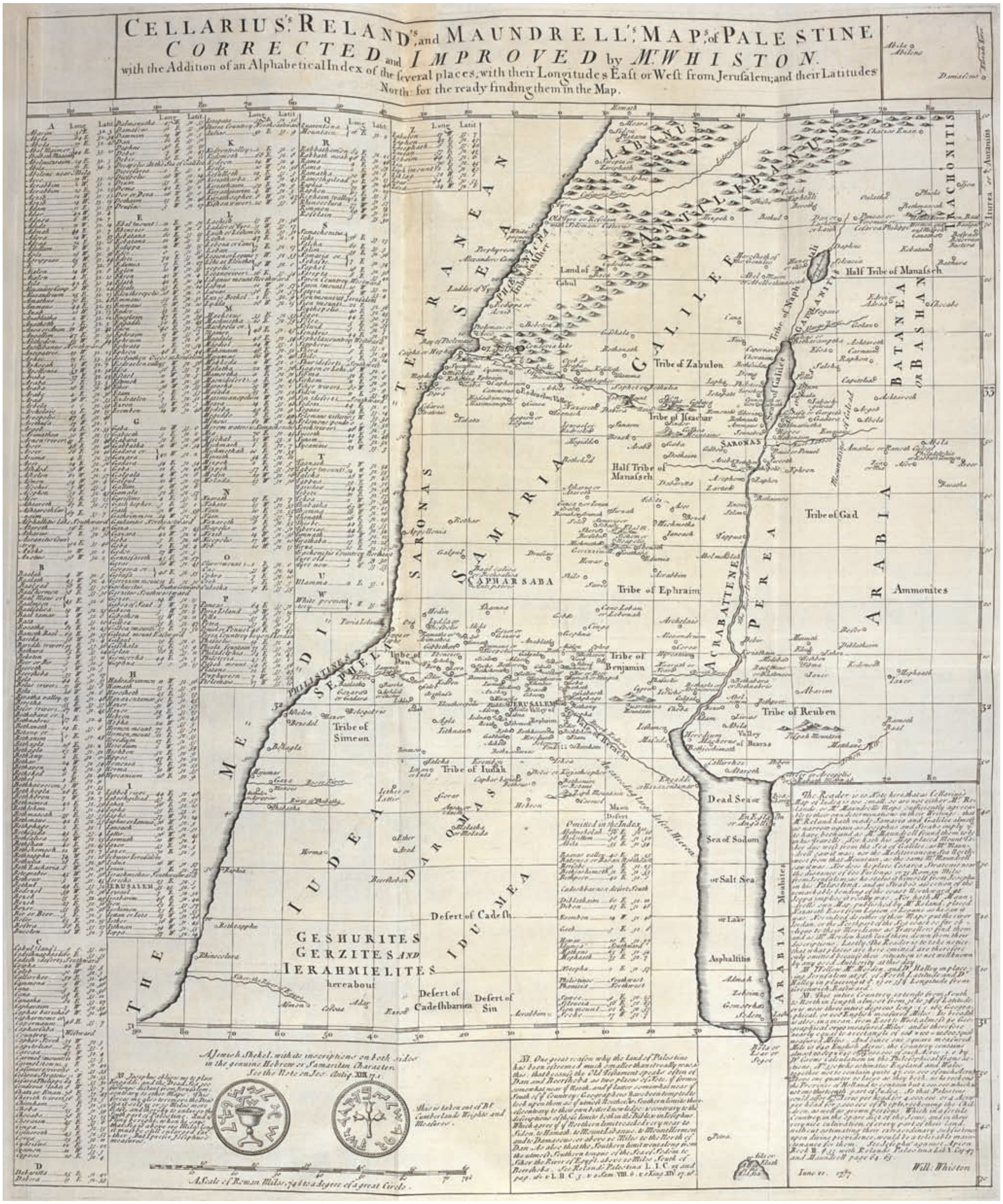

FIG. 705. WILLIAM WHISTON, *CELLARIUS'S, RELAND'S, & MAUNDRELL'S MAPS OF PALESTINE CORRECTED AND IMPROVED*. From Whiston's *The Genuine Works of Flavius Josephus, The Jewish Historian*, 2 vols. (London: Printed by W. Bowyer for the Author, 1737), vol. 1, facing 6. The map employs the "clean" style of Reelant (Reland), eschewing any uncertain topographical information, but adds a longitude and latitude grid, which also functions as the location grid for the place-names listed on the left.

Geographia sacra (1646). Bochart reconstructed the whole of ancient geography from Scripture, complemented by complex etymological explorations in other ancient languages. His special topics were the geographical distribution of Noah's descendants and the reach of Phoenician navigators (Shalev 2012, 141–203). Eighteenth-century scholars still considered Bochart's enterprise worthy of reediting and revising. Reelant was one, Johann David Michaelis another. In his *Spicilegivm geographiae Hebraeorum exterae post Bochartvm* (1769), Michaelis reworked Bochart's *Geographia sacra* using the findings of Carsten Niebuhr from the Danish expedition to Arabia (1761–67) that Michaelis had initiated (see fig. 608) (Sheehan 2005, 203–4).

In addition to general maps of biblical geography, Enlightenment scholars also mapped specific places of scriptural significance. Topographical maps of Jerusalem and early Christian Rome, together with architectural renditions of relevant buildings, especially the Temple, provided a constant theme. Most were published from earlier models, although some new maps were created (e.g., Rubin 2006). A topic of continuing discussion and geographical analysis remained the location of Eden and the terrestrial paradise. Scholars continued to advance alternative positions. Most sought to locate Eden as the source either of four rivers or, as Calvin had maintained, just one, but others sought to circumvent the need for such exegesis. In particular, some eighteenth-century scholars resurrected an earlier argument that Eden could never be located on modern maps because the earth's surface had been so completely changed by the Flood. They accordingly placed Eden in the Holy Land. Eventually, the multiple locations for Eden contributed to the late Enlightenment shift to see the biblical story of Creation in metaphorical terms (Scafi 2006, 303–45).

English Puritans further extended *geographia sacra* to New England, which they held to be the new Israel. The minister William Hubbard perpetuated the older, exegetical tradition when in his *Narrative of the Troubles with the Indians* (1677) he mapped New England as the site of God's traumatic testing of the Puritans' faith during King Philip's War (1675–76) (Edney and Cimburek 2004). Cotton Mather subsequently included an "ecclesiastical map" in his history of Puritan New England. This map comprised a hierarchical list of the colonies, counties, and congregations in the region, which he called "Hecatompolis: Or, A Field which the Lord hath Blessed" (Mather 1702, titlepage, 27–29).

Whereas *geographia sacra* was pursued by Protestants and Catholics alike, from the early seventeenth century the study of ecclesiastical geography—i.e., the spatial organization of the church—was a predominantly Catholic phenomenon. The origins of such work lie in the Catholic Church's own attempts to understand the extent of its provinces and dioceses: in 1627 Pope Urban VIII directed that questionnaires be sent to each diocese asking, among other things, about the geography; subsequent popes followed suit. Such information fed an array of published works and maps, such as Aubert Le Mire's *Geographia ecclesiastica* (1620), which presented a catalog of historical and present-day dioceses; Wilhelm Gumppenberg's *Atlas Marianvs* (1657), an illustrated global guide to apparitions of the Virgin Mary; and atlases of monasteries prepared by Jesuits, Augustinians, and Capuchins. All presented a Catholic, ancient, well-ordered, necessarily universal, and even timeless sacred space. Augustin Lubin (1678, 88–89) argued that it was best for modern geographers to follow stable ecclesiastical province boundaries rather than try to map unstable political divisions. Ecclesiastical geography thus joined the better-known works of ecclesiastical scholarship and often shared their polemical character (Shalev 2012, 205–57, esp. 233 on Lubin).

The complex work of ecclesiastical mapping continued after 1650, often as direct continuations of earlier initiatives. For example, throughout the seventeenth and eighteenth centuries, members of the Sainte-Marthe family and later the Maurists continued Claude Robert's ambitious *Gallia Christiana* (1626), an ecclesiastical historical geography of France. A large number of individual as well as general French diocesan maps appeared during the period, beginning with Nicolas Sanson's *La France et les environs, jusques a l'estendüe de l'ancien[ne] Gaule, divisée en ses primatiats, provin[ces] ecclesiast[ques], et diœceses des archeveschés, et eveschés* (1651) (Dainville 1956). Heinrich Scherer, SJ, issued a new *Atlas Marianus* (1702) as well as *Geographia hierarchica* (1703), a twenty-map atlas of the Catholic Church, complete with a thematic map showing the distribution of the different Christian professions in Europe (Török 2005, nos. 24 and 34).

Monastic maps, whether of provinces or particular abbeys, were also popular. In 1700 Nicolas de Fer reissued Alexis-Hubert Jaillot's map of Christian Egypt, depicting the lives of the saints of the desert, and matched it with a topographical map that celebrated the location and lives of the noteworthy founders of the "new Thébaïde," La Trappe Abbey in Perche (Orme, Normandy) (fig. 706). After 1698, a series of maps and views of the monastic complex on Mount Athos were produced as part of handbooks for Orthodox, rather than Catholic, pilgrims (Della Dora 2011, 90–97). In the 1730s, the Homann Heirs in Nuremberg published a series of maps depicting abbeys belonging to the Benedictines (Török 2005, no. 28); that of *Gallia Benedictina* (1738) featured an elaborate cartouche in which a Benedictine

LA NOUVELLE THEBAIDE, OU la Carte tres particuliere et exacte de L'ABBAYE DE LA MAISON DIEU, NOSTRE DAME DE LA TRAPPE. de l'Estroite Observance de Citeaux, Située dans la province du Perche, Diocesse de Sées

Dressée Sur les lieux par Monsieur de la Salle
Et mis au jour par N. de fer, Geographe de Monseig.r
Avec Privilege du Roy 1700.

FIG. 707. GIAMBATTISTA DI SANT'ALESSIO, VIEW OF CARMELITE SITES ON THE CARMEL PROMONTORY. *Compendium historicum de statu antiquo et moderno Sancti Montis Carmeli* (Augsburg, 1772), 84. The textual key to the sites (not shown here) is on the same page.
Size of the original: ca. 7 × 11 cm. Image courtesy of the Bayerische Staatsbibliothek, Munich (ESlg/4 H.mon. 302-1).

of the congregation of St. Maur paid homage to the king. In 1765, to give a later example, Giambattista di Sant'Alessio, a Carmelite lay brother, arrived in Mount Carmel to supervise the construction of a new building for the Carmelite community. He documented his work in *Compendium historicum de statu antiquo et moderno Sancti Montis Carmeli* (1772 Latin, 1780 Italian). The book offered a history of the Carmelites as well as a geographical and historical survey of the sacred mountain. Giambattista recounted the traditional narrative of prophetic-monastic continuity on the mount since the days of Elijah and presented pilgrimage routes among the various Carmel holy sites. Maps, views (fig. 707), and architectural plans feature prominently in the *Compendium*. Giambattista included maps of the Haifa bay, several bird's-eye views of the Carmel, and plans of ruined, existing, and proposed structures. Finally, curiosity about the process of papal elections produced a particular genre of printed images of the conclaves, which combined architectural plans of the Vatican, vignettes of the ceremonies, and landscape views (Lincoln 2012). Overall, the vitality of ecclesiastical mapping throughout the

(*facing page*)
FIG. 706. FR. L. DE LA SALLE, *LA NOUVELLE THEBAIDE, OU LA CARTE TRES PARTICULIERE ET EXACTE DE L'ABBAYE DE LA MAISON DIEU, NOSTRE DAME DE LA TRAPPE. DE L'ESTROITE OBSERVANCE DE CITEAUX* ([PARIS]: DE FER, 1700). This map accompanied de Fer's reissue of Jaillot's *L'Ancienne Thébaïde*. A *thébaïde* is a place of solitary retreat, appropriate for this Cistercian monastery, surrounded by ponds and forests, founded to observe the rule of St. Benedict (top right) and strictly reformed in the seventeenth century by Armand-Jean Le Bouthillier de Rancé (top left).
Size of the original: ca. 46.5 × 35.5 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge DD 2987 [1060]).

eighteenth century demonstrates that the authors and surely some audiences thought such maps useful as devotional, administrative, and display pieces.

In the absence of a fuller treatment of religion and cartography during the European Enlightenment, this brief survey suggests a few initial ideas. The modern historiographical tradition that has elevated the idea of the map as an emblem of a secular, measured, and rational era, and in parallel, a tradition that interpreted the cartography of the period in the sole context of secularization, is not very useful for our understanding of the varieties of religion and cartography. Between 1650 and 1800, a demonstrable secularization is evident in the sense that religion, in the domain of cartography, became a particular genre within an increasingly diversified cultural realm, and it lost some of the universality it had enjoyed during the Renaissance. This relative decentering, however, teaches us little about the religiosity of mapmakers and map readers at the time. Within its newly delimited sphere, the tradition of religious mapping continued to thrive as a respectable and important field of knowledge and practice and as an indispensable aspect of education, erudition, and devotion in the European Enlightenment.

ZUR SHALEV

SEE ALSO: Atlas: Historical Atlas; Enlightenment, Cartography and the; Geographical Mapping: Enlightenment; History and Cartography; Metaphor, Map as; Society of Jesus (Rome); Thematic Mapping: Enlightenment

BIBLIOGRAPHY

Brummett, Palmira. 2015. *Mapping the Ottomans: Sovereignty, Territory, and Identity in the Early Modern Mediterranean*. New York: Cambridge University Press.

Cosgrove, Denis E. 1999. "Global Illumination and Enlightenment in the Geographies of Vincenzo Coronelli and Athanasius Kircher." In *Geography and Enlightenment*, ed. David N. Livingstone and Charles W. J. Withers, 33–66. Chicago: University of Chicago Press.

Dainville, François de. 1956. *Cartes anciennes de l'Église de France: Historique, répertoire, guide d'usage*. Paris: J. Vrin.

Della Dora, Veronica. 2011. *Imagining Mount Athos: Visions of a Holy Place from Homer to World War II*. Charlottesville: University of Virginia Press.

Edney, Matthew H. 1999. "Reconsidering Enlightenment Geography and Map Making: Reconnaissance, Mapping, Archive." In *Geography and Enlightenment*, ed. David N. Livingstone and Charles W. J. Withers, 165–98. Chicago: University of Chicago Press.

Edney, Matthew H., and Susan Cimburek. 2004. "Telling the Traumatic Truth: William Hubbard's *Narrative* of King Philip's War and His 'Map of New-England.'" *William and Mary Quarterly*, 3d ser., 61:317–48.

Godlewska, Anne. 1995. "Map, Text and Image, the Mentality of Enlightened Conquerors: A New Look at the 'Description de l'Égypte.'" *Transactions of the Institute of British Geographers*, n.s. 20:5–28.

———. 1999. *Geography Unbound: French Geographic Science from Cassini to Humboldt*. Chicago: University of Chicago Press.

Harris, Steven J. 2005. "Jesuit Scientific Activity in the Overseas Missions, 1540–1773." *Isis* 96:71–79.

Harvey, David. 1989. *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change*. Oxford: Blackwell.

Lincoln, Evelyn. 2012. "Publishing, Secrecy and Curiosity in German Conclave Print." *Art in Print* 2, no. 4:3–8.

Lubin, Augustin. 1678. *Mercure geographique, ou le guide du curieux des cartes geographiques*. Paris: Christophle Remy.

Mather, Cotton. 1702. *Magnalia Christi Americana: Or, the Ecclesiastical History of New-England, from Its First Planting in the Year 1620. unto the Year of Our Lord, 1698*. 7 books. Book 1, *Antiquities: The First Book of the New-English History*. London: Printed for Thomas Parkhurst.

Padrón, Ricardo. 2011. "From Abstraction to Allegory: The Imperial Cartography of Vicente de Memije." In *Early American Cartographies*, ed. Martin Brückner, 35–66. Chapel Hill: For the Omohundro Institute of Early American History and Culture by University of North Carolina Press.

Paulett, Robert E. 2009. "The Bewildering World of William De Brahm: An Eighteenth-Century Map Maker Surveys the End of Time." *Eighteenth-Century Studies* 42:481–99.

Poortman, Wilco C., and Joost Augusteijn. 1995. *Kaarten in Bijbels (16e–18e eeuw)*. Zoetermeer: Boekencentrum.

Robert de Vaugondy, Didier. 1757. "Géographie." In *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, ed. Denis Diderot and Jean Le Rond d'Alembert, 17 text vols. and 11 plate vols., 7:608–13. Paris: Briasson, David, Le Breton, Duran.

Rubin, Rehav. 2006. "One City, Different Views: A Comparative Study of Three Pilgrimage Maps of Jerusalem." *Journal of Historical Geography* 32:267–90.

Scafi, Alessandro. 2006. *Mapping Paradise: A History of Heaven on Earth*. Chicago: University of Chicago Press.

Shalev, Zur. 2012. *Sacred Words and Worlds: Geography, Religion, and Scholarship, 1550–1700*. Leiden: Brill.

———. 2015. "Early Modern *Geographia Sacra* in the Context of Early Modern Scholarship." In *The Oxford Handbook of the Bible in Early Modern England, c. 1530–1700*, ed. Kevin Killeen, Helen Smith, and Rachel Willie, 196–208. Oxford: Oxford University Press.

Sheehan, Jonathan. 2003. "Enlightenment, Religion, and the Enigma of Secularization: A Review Essay." *American Historical Review* 108:1061–80.

———. 2005. *The Enlightenment Bible: Translation, Scholarship, Culture*. Princeton: Princeton University Press.

Török, Zsolt G. 2005. "Katalógus = Catalogue." In *Szent Helyek a Térképeken: Térképtörténeti Kiállítás a Pannonhalmi Főapátság és a Schottenstift (Bécs) Anyagából = Sacred Places on Maps: A Cartographic Exhibition from the Collections of Pannonhalma (Hungary) and Schottenstift (Vienna)*, ed. Zsolt Török, [209]–[311]. Pannonhalma.

Rennell, James. James Rennell, surveyor, geographer, and oceanographer, was born in Devon on 3 December 1742. Rennell's productive life was lived in two unequal chapters. From joining the Royal Navy in 1756, he was active in the field until 1777 as, successively, naval officer, explorer, and surveyor for the East India Company in Bengal. He returned to London in 1778. He thereafter led a sedentary life studying geography and oceanography and making contributions to African mapping, physical and ancient geography, and the study of ocean currents. Rennell was elected a fellow of the Royal So-

FIG. 708. JAMES RENNELL, *THE LOW COUNTRIES BEYOND THE GANGES*, 1780. From the first issue of Rennell's *A Bengal Atlas: Containing Maps of the Theatre of War and Commerce on That Side of Hindoostan* (London, 1780), pl. 6. Size of the original: 28.8 × 61.4 cm. From the James Ford Bell Library, University of Minnesota, Minneapolis.

ciety of London in 1781 and in 1791 received its Copley Medal for his mapping work. Papers by him—on Indian river systems, the use of camels as instruments for measuring desert travel, and currents in the Atlantic Ocean—were published in the Society's *Philosophical Transactions*. Rennell was awarded the Royal Society of Literature's Gold Medal in 1825. With Admiral William Henry Smyth, Sir Arthur de Capell Brooke, and others, Rennell was much involved in the discussions and planning that led to the formation of the (Royal) Geographical Society, which was established in London in 1830, but he died on 29 March that year, only weeks before its inauguration. The oft-repeated claim that he was nominated as the society's first president is not borne out by the surviving evidence and must be regarded as apocryphal (Markham 1895, 193, 196).

Rennell was appointed "assistant Draughtsman or Surveyor" to the East India Company in April 1762, serving on the *London* with the hydrographer Alexander Dalrymple. They surveyed the Sulu islands (Philippines) and parts of the China coast in 1762 and 1763. In 1764, Rennell was commissioned by the East India Company as "a Surveyor of the New Lands" to undertake a survey of Bengal (Cook 1978, 6–7). For strategic reasons, Rennell began by surveying the Ganges River, charting the shortest perennially navigable course south to the Hooghly River and Calcutta. The surveys of the lower Ganges and Brahmaputra Rivers engaged him until October 1765, at which date he began a larger general survey, undertaken as a series of road traverses by quadrant and chain. Despite being severely wounded in February 1766 in an ambush by tribesmen, he continued to survey intermittently until 1771. When not in the field, Rennell worked in Dacca to compile general maps, and in January 1767 he received an administrative appointment as surveyor general of Bengal (Edney 1997, 133–37).

On returning to England in 1778, he was permitted to publish his Bengal maps as *A Bengal Atlas*, significant for the large scale and unprecedented accuracy of its maps, especially in terms of its depiction of roads, rivers, and settlements (fig. 708). A first issue of the atlas was ready by April 1780, but the shipment dispatched to Bengal was seized en route by the French and Spanish. Rennell put out a new issue in 1781, taking advantage of the situation to supplement and revise the initial work (Cook 1978, 25). He also began work on a general map of South Asia, *Hindoostan*, published in two sheets in 1782, complete with a comprehensive memoir in early 1783 (see fig. 588). Rennell expanded the map into the four-sheet *A New Map of Hindoostan* of 1788, again with a memoir. In the memoirs, Rennell commented on the significance of mapping for commercial development and provided insight into the difficulties faced by mapmakers in working with different linear measurements, whether in India or Europe (Rennell 1788, 3–4; Edney 1997, 9–15, 98–102). Thereafter, he continued to advise the East India Company on cartographic affairs (Edney 1997, 149–50).

In London, Rennell also advised Sir Joseph Banks and the Africa Association on geographical questions. In 1798, he produced a chart of variations in terrestrial magnetism in the seas around Africa and a map of northern Africa to illustrate the travels of Mungo Park. They appear in Rennell's "Geographical Illustrations" appendix to Park's 1799 *Travels in the Interior Districts of Africa*. The map is based on Park's journals but, like many maps of the time, was erroneous in its depiction of African topography and the course of the Niger River (Bassett and Porter 1991). Rennell also turned to a larger comparative project on the ancient and modern geography of western Asia. His *Geographical System of Herodotus* (1800), which contains a section on the ocean currents on both the east and west coasts of Africa, was part of this never-completed project. Rennell's *Charts of the Prevalent Currents in the Atlantic Ocean* were published posthumously (by his daughter) in 1832. Their style of depicting direction and strength of flow is more complex and detailed than the charts of some of his contemporaries', yet Rennell's work in oceanography was part of shared interests rather more than that of a pioneering individual. Rennell's biographers are mostly generous: Clements R. Markham (1895) tends to hagiography, while Andrew S. Cook (1978) shows how Rennell's Bengal work provided a vital basis for the mapping of India.

CHARLES W. J. WITHERS

SEE ALSO: East India Company (Great Britain); Geographical Mapping: Enlightenment; Nationalism and Cartography

BIBLIOGRAPHY

Bassett, Thomas J., and Philip W. Porter. 1991. "'From the Best Authorities': The Mountains of Kong in the Cartography of West Africa." *Journal of African History* 32:367–413.

Cook, Andrew S. 1978. "Major James Rennell and *A Bengal Atlas* (1780 and 1781)." In *India Office Library and Records Report for the Year 1976*, 5–42. London: Foreign and Commonwealth Office.

Edney, Matthew H. 1997. *Mapping an Empire: The Geographical Construction of British India, 1765–1843*. Chicago: University of Chicago Press.

Markham, Clements R. 1895. *Major James Rennell and the Rise of Modern English Geography*. London: Cassell.

Rennell, James. 1788. *Memoir of a Map of Hindoostan; or the Mogul Empire: With an Introduction, Illustrative of the Geography and Present Division of that Country: And a Map of the Countries Situated between the Head of the Indus, and the Caspian Sea*. London: M. Brown, for the author.

Repeating Circle.

See Instruments for Angle Measuring: Repeating Circle (Repeating Theodolite)

Reproduction of Maps.

MANUSCRIPT REPRODUCTION
ENGRAVING AND PRINTING
COLOR PRINTING
TYPOGRAPHIC PRINTING

Manuscript Reproduction. Map printing from engraved copperplates, an established commercial activity in Europe by 1700, offered the advantage of multiple identical copies, but drawing and copying maps by hand remained important in all modes of cartography. Such manuscript copying occurred during map construction from original data, compilation from existing source maps, and duplication of individual maps by or for a wide range of users. It was often a preliminary step but could also be the end product when only one or a few copies of a map were needed or if their circulation was restricted.

Drawing was not exclusive to mapmaking. Many eighteenth-century British book titles advertised the presence of drawings, figures, designs, plans, elevations, sections, perspectives, views, and maps. These were technical drawings, as opposed to artistic portrayals of people, events, and scenes, although that term for accurate graphic representations of artifacts, structures, or the built environment was not coined until the nineteenth century. Diverging from artistic representation, both technical drawing and mapmaking increasingly emphasized representation to scale, projection of three-dimensional shapes from different viewpoints, and conventional symbolization. Maps could be considered a type of technical drawing.

Ancient and medieval technical drawings were made but only rarely and with simple tools and techniques. Renaissance scientific discoveries, reflecting new interest in studying, understanding, and exploiting the material world, stimulated technical drawing in applications like architecture, engineering, surveying, fortification, and mining. The production of technical drawings by mathematical practitioners (as they were known) accelerated again after the mid-eighteenth century with the emergence of the Industrial Revolution.

TOOLS AND MATERIALS Pen and ink, lead pencils, and paper were the basic tools and materials of writing and drawing, familiar to eighteenth-century Europeans who could write. In northern Europe, about half of men but fewer women were literate (Houston 2001, 392). Artists employed little more in the way of drawing tools (fig. 709). However, mathematical practitioners used specialized instruments to make technical drawings. Such mathematical instruments were made across Europe, but France and England were centers of innovation

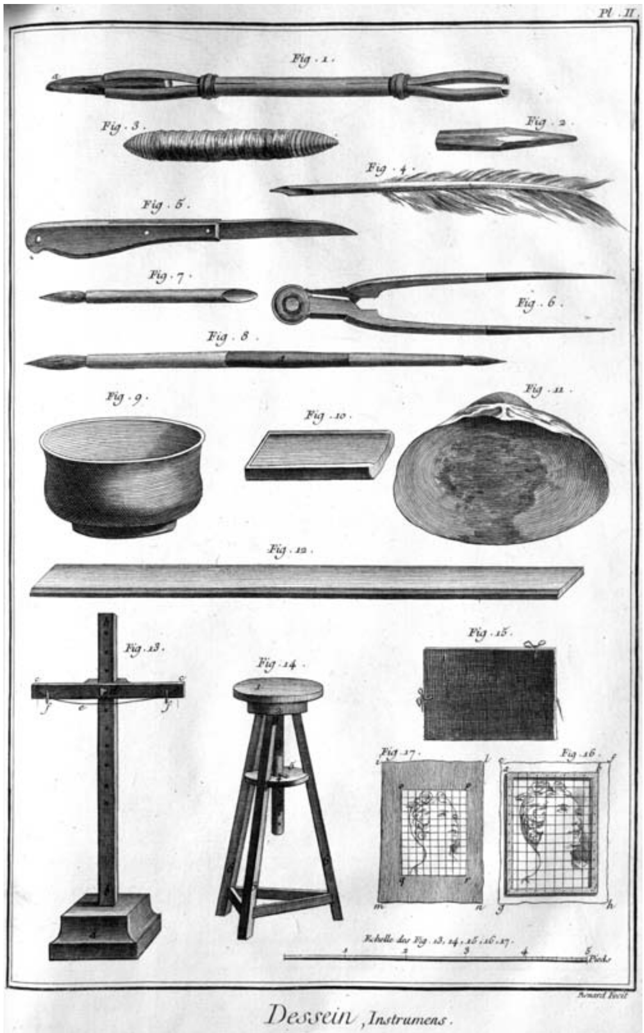

FIG. 709. DRAWING INSTRUMENTS, 1763. "Dessein, Instrumens," illustrating the *Encyclopédie* essay about drawing (*dessein*), shows the artist's toolkit: 1.–2. pencil holder and pencil; 3. stump; 4. quill pen; 5. penknife; 6. dividers; 7.–8. brushes; 9. bowl of water; 10. block for Chinese (India) ink; 11. shell for color mixing; 12. rule; 13. stand; 14. stool; 15. portfolio; 16. reduction screen; and 17. reduced drawing. From Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts méchaniques, avec leur explication*, plate vol. 3 (second installment, second part) (1763), "Dessein," pl. II.
Size of the original: 32.8 × 21.0 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

and production (Hambly 1988, 23–28). Instrumentmakers, traditionally members of guilds of metalworkers, clockmakers, and jewelers, became independent entrepreneurs. Responding to market demand, the variety and design of technical-drawing instruments improved. Manuals written by practitioners and instructors list and illustrate essential equipment (fig. 710).

At the beginning of the drawing process, dividers, set-squares (triangles), T-squares, protractors, and scaled rules (rulers) aided laying out drawings (Feldhaus 1967, 47–50). *The Art of Fortification Delineated*, an expanded English translation of a French manual, gives detailed descriptions of drawing equipment, such as four rules made of very hard wood (ebony, apple, or pear) in different lengths (six inches, one foot, one-and-a-half feet, and two-and-a-half feet), uniformly thick, and smoothly finished. Other useful items included penknives, needles, sliding brass pincers, and lead weights or pins for holding sheets of paper in place ([Buchotte] 1748, 21–23). There were instructions for a drafting table "against which one may rest the Stomach without spoiling the Paper on which we are designing. . . .because the Paper being partly under the Table, it will give no Trouble" ([Buchotte] 1748, 25).

Sticks of charcoal served for sketching, but the metal points (silver, lead, and tin) long used for drawing and writing had given way to blacklead (known as graphite after 1789). Pieces of graphite were inserted into reed, metal, or wooden holders or encased in wood to form a pencil (Feldhaus 1967, 65). A graphite sliding pencil with a spring was recommended, as was a pricker with a needle at one end and graphite at the other ([Buchotte] 1748, 19–20). A deposit of high-quality graphite discovered in Cumberland, England, in 1565 was nearly exhausted by 1700, and Continental sources were inferior. Wartime disruption of English trade led the French government to ask chemist Nicolas-Jacques Conté to develop an alternative, powdered graphite mixed with clay and baked to controllable hardness, patented in 1795 (Feldhaus 1967, 68–70; Watrous 1957, 130–42).

For writing and drawing with ink, the quill pen remained standard. Eighteenth-century technical-drawing manuals do not mention metal nibs, known by 1780 but stiff and scratchy until improved during the nineteenth century (Watrous 1957, 60). Quills of different sizes from geese, swans, ravens, and crows were used in technical drawing. Feathers from the right wing curved toward the thumb and were easier to hold ([Buchotte] 1748, 14–15). Goose quills imported from Scandinavia, England, and even North America were traded by the Dutch, who hardened them in hot sand (a process known as dutching) and sold them throughout Europe. Although quills were hawked and cut by vendors on city

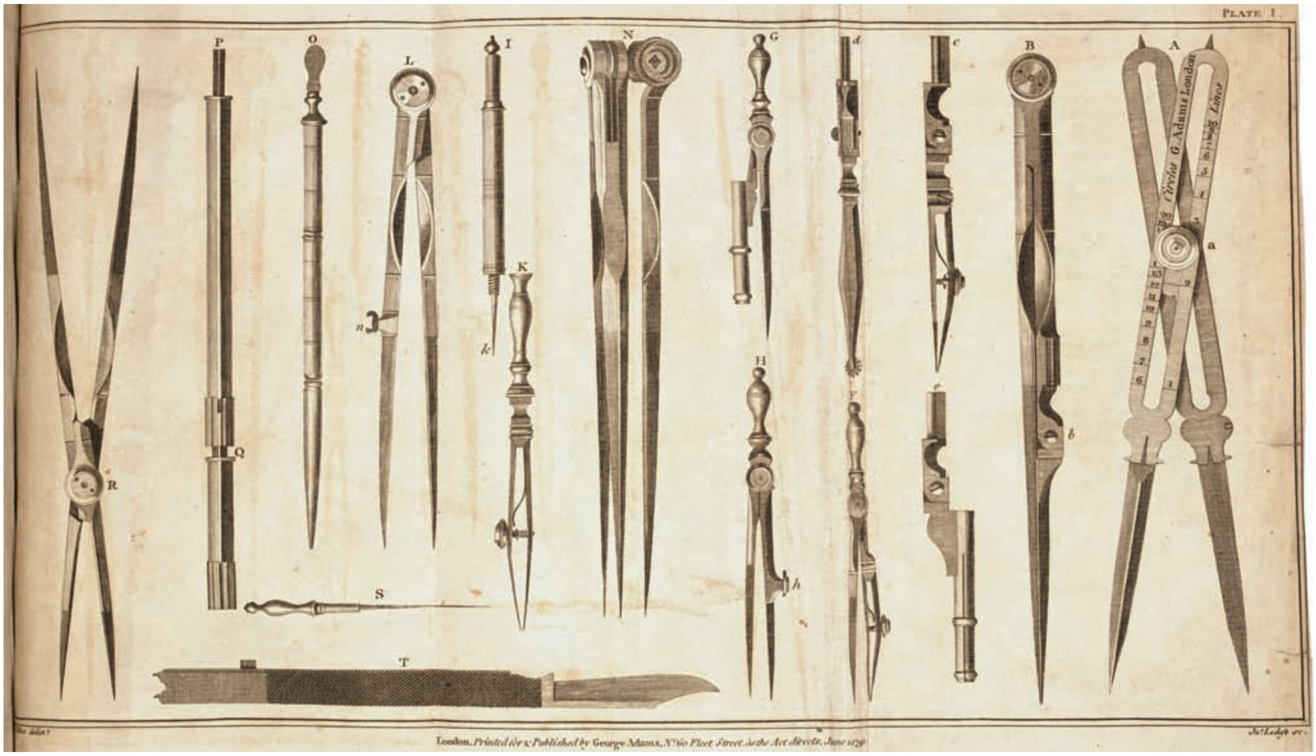

FIG. 710. MATHEMATICAL DRAWING INSTRUMENTS, 1791. This selection of mathematical drawing instruments includes: Aa. adjustable proportional compass; Bb. compass with plain point; c. pen point; d. dotting (roulette) point; e. compass extension; F. bow compass; G. compass with holder; Hh. hair compass; Ik. protracting pin; K. drawing pen; Ln. hair compass; N. triangular compass; O. tracing point; PQ. compass extensions; R. whole and half proportional compass; S. protracting pin; and T. scraper. From Adams 1791, pl. I. Size of the original: 17 × 31 cm. Image courtesy of the Linda Hall Library of Science, Engineering & Technology, Kansas City.

streets, a draftsman could trim his own quills into single (or even double) nibs of varying width with a penknife (Watrous 1957, 44–50) (fig. 711).

Double-bladed metal drawing pens (ruling pens) for inking straight lines date from Roman times (Feldhaus 1967, 87). Improvements by 1700 included hinging one blade (for cleaning) and adding a screw to adjust blade separation and line width. Some drawing pens even had a rotating toothed wheel for dashed or dotted lines, often used to symbolize hidden features or proposed work on architectural drawings, including fortifications (Hambly 1988, 57–58) or for uncertain features such as hypothetical coastlines, or for political divisions. Brass compasses, preferably six-inch and four-inch, had interchangeable points for measuring or drawing with ink or lead ([Buchotte] 1748, 19). Knuckle joints, allowing compass points to be vertical, had appeared about 1700 (Hambly 1988, 75).

The pantograph (also called a pantographer, parallelogram, or mathematical compass), a geometrical device for tracing, enlarging, and reducing images, discussed in detail below, was known but not common until the nineteenth century (Andrews 2009, 332; Price 2010, 13, 46–47). Teacher of mathematics George Adams Jr. provides some historical background: "I have not been able to ascertain who was the inventor of this useful instrument. The earliest account I find is that of the *Jesuit Scheiner*, about the year 1631, in a small tract entitled *Pantographice, sive ars nova delineandi*. The principles are self-evident to every geometrician; the mechanica[l] construction was first improved and brought to it's [*sic*] present state of perfection by my father, about the year 1750. It is one, among many other scientific improvements and inventions compleated by him, that others have ingloriously, and many years after, assumed to themselves" (1791, 374–75).

Pencil and charcoal were removed from paper by rubbing with bread crumbs. Although natural rubber was introduced to Europe from South America in 1731, rubber erasers first appeared in 1788, and large-scale commercial rubber production followed in the nineteenth century. Ink was erased by scraping with a curved knife blade, smoothing the paper afterward with a thumbnail (Price 2010, 44–45).

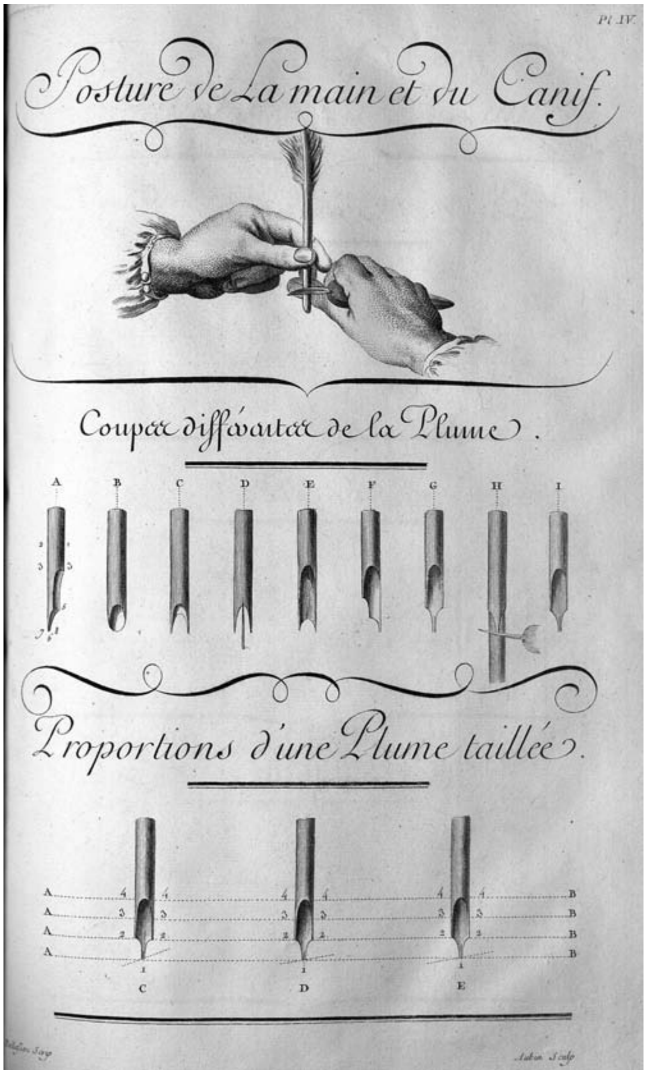

FIG. 711. WRITING TOOLS, 1763. This plate, illustrating the *Encyclopédie* essay about writing (*écritures*) shows a quill being cut and the various types and proportion of pen nibs. From Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts méchaniques, avec leur explication*, plate vol. 2 (second installment, first part) (1763), "Écritures," pl. IV.
Size of the original: 34.8 × 21.5 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

China ink (also called India ink), sold in solid blocks for rubbing up with water, found general use in technical and map drawing (Feldhaus 1967, 60–61). First imported from Asia during the seventeenth century, this lampblack-based ink was mixed with a glue or gum binder and a small amount of musk or camphor (the latter for insect- and mold-proofing) to produce dense black lines. Cheap inferior European imitations were gritty and brownish and to be avoided (Price 2010, 28–29).

Ink or colored pigments could be mixed with water and washed on with a brush to shade, ornament, or symbolize features of a drawing. The brushes (also called pencils), used for highlighting line symbols and washing areas with watercolors, consisted of tufts of animal hair set into a quill or fastened onto a wooden handle by a metal ferrule. Until the late eighteenth century, artists regarded watercolor as a utilitarian medium for tinting drawings and engravings (Price 2010, 36). Technical manuals of the earlier eighteenth century recommended pigments and gave instructions for preparing them from materials available at druggists and color shops, such as powders, friable stone, resinous gum, liquid, and dry cakes or filled seashells ([Buchotte] 1748, 2–6). The range of hues included blues, reds, whites, blacks, greens, yellows, and browns (*Albert Durer Revived* 1698, 10). Transparent pigments (such as litmus blue, sap green, verdigris, and gamboge) were preferred, but semitransparent pigments (such as carmine, bistre, and Prussian blue) and opaque pigments (such as vermilion, verditer, and ultramarine) were also usable on maps if applied thinly (Dossie 1796, 1:249–50). In 1780, William Reeves in England invented and began selling hard cakes of watercolor that could be rubbed up with water like ink. However, not until the nineteenth century did British color makers begin to manufacture easily workable semimoist cakes (Ayres 1998, 21, 212–13).

Paper, introduced to Europe from Asia during the tenth century, had largely replaced parchment and vellum made from animal skins as a surface for writing and drawing well before the eighteenth century. When the demand for paper increased in Europe after 1750, the scarcity of the cotton and linen rags that formed its raw materials became a problem (Feldhaus 1967, 53). Other paperlike materials known to indigenous peoples and encountered by European explorers were used occasionally for maps, such as the birchbark map shown to Pierre Gaultier de Varennes de La Vérendrye in 1728 by Ochagac, a Cree guide, at a French fur trading post north of Lake Superior in Canada (see fig. 393), but did not become established in Europe (Harvey 1980, 32, 42; Kingston 1927, 133). Attempts to make paper from other plant material were still experimental (Hunter 1947, 313–14).

Maps and plans required the largest commonly available paper sheets. In British terminology, and with dimensions in inches, the common sizes were: imperial atlas (24 × 35), elephant (21 × 31), imperial (18 × 25), superfine writing royal (17 × 22), medium (14 × 18), demy (12 × 16), and fool's-cap (14 × 19) ([Buchotte] 1748, 15–16). Similar dimensions were found on the

Continent, with names of sizes such as *Grand Aigle*, *Colombier*, *Chapelet*, *Nom de Jésus*, *Grand raisin*, *Petit raisin*, and *Carré* (Dainville 1956, 254–55). Sizes were limited by the paper mold: a sieve, formed by parallel wires chained together with thinner wire and set in a rectangular wooden deckle (frame), was used in hand paper making to dip a layer of wet pulp from a vat and form a sheet of paper. "Wove" paper, made using a woven screen, had a smoother surface. Introduced in England in 1757, its use grew toward the end of the century (Hunter 1947, 128). Small sheets of paper could be glued together to form larger sheets using adhesive, such as mouth-glue (a stick of glue held in the mouth, partially dissolved with spittle, and rubbed onto the edges to be joined). The best drawing paper had a fine and smooth grain, uniform body, bleached white color, and good tensile strength, and was sized ([Buchotte] 1748, 13–15). Sizing, either a bath in which the paper was dipped or an additive, was composed of animal or fish glue (and zinc sulfate or alum to prevent spoilage). It kept ink and watercolors from bleeding into the paper (Garlick 1986).

Artists had been making their own tracing paper (like the oiled paper used as a cheap substitute for window glass) since the fifteenth century or earlier (Price 2010, 47). Thin paper, such as fan-making paper, was brushed with oil and allowed to dry (Dossie 1796, 1:255; *Albert Durer Revived* 1698, 7–8). Reeves's shop was selling tracing paper in London by 1768 (Price 2010, 48).

COPYING TECHNIQUES The list of methods for copying maps varies from one manual to the next. Given that manuals were republished over decades and often borrowed content from earlier manuals, the changing use of different techniques is hard to trace, even though surviving manuscript maps provide physical evidence of their use. However, the manuals do comment on the relative advantages of the techniques.

Pricking was a traditional method of artists, who used a point to puncture the corners and ends of lines in a drawing or print, pounced (dusted) the pricked image with powdered charcoal, and connected the dots that formed (Watrous 1957, 6–8). The original drawing could be kept clean by pricking it onto an underlying sheet of blank paper and pouncing through that (*Albert Durer Revived* 1698, 8).

Some authors recommended pricking for simple profiles or sections but deemed it unsuitable for complex images, such as maps, landscapes, and civil or other architecture ([Buchotte] 1748, 49). Charles Hutton's manual (1790, 227) agreed: "This method is only to be practised in plans of such figures as are small and tolerably regular, or bounded by right lines." Nevertheless, it was used for maps. For example, the Concord Free Public Library in Massachusetts owns the pricker (a pin set into a leadless cedar pencil casing) that Henry David Thoreau used after surveying Walden Pond in 1846, when converting his rough compilation into a fair drawing (Petroski 1990, 123).

There were several methods of tracing maps, a good approach if the map was to be copied at the same size. One method described by Hutton was similar to the use of carbon paper:

> Rub the back of the rough plan over with black lead powder; and lay the said black part upon the clean paper, upon which the plan is to be copied, and in the proper position. Then with the blunt point of some hard substance, as brass, or such like, trace over the lines of the whole plan; pressing the tracer so much as that the black lead under the lines may be transferred to the clean paper: after which take off the rough plan, and trace over the leaden marks with common ink, or with Indian ink, &c.—Or, instead of blacking the rough plan, you may keep constantly a blacked paper to lay between the plans. (Hutton 1790, 227)

A variant involved tracing the image onto transparent oiled paper before retracing over blackened paper to transfer the image to drawing paper for inking (Dossie 1796, 1:253). Additional illumination could make ordinary paper transparent enough for tracing: "Lay a Paper Printed upon a bright Glass-Window, or Paper-Window that is Oyled with the back side of the Print upon the Window, then lay a clean Paper upon the Print, and draw the out-strokes upon the Paper, which you may visibly see, it being set up against the light" (*Albert Durer Revived* 1698, 8). A piece of glass in a folding frame (a forerunner of the modern light table) was even better (fig. 712):

> But the neatest method of any is this. Procure a copying frame or glass, made in this manner; namely, a large square of the best window glass, set in a broad frame of wood, which can be raised up to any angle, when the lower side of it rests on a table. Set this frame up to any angle before you, facing a strong light; fix the old plan and clean paper together with several pins quite around, to keep them together, the clean paper being laid uppermost, and upon the face of the plan to be copied. Lay them, with the back of the old plan, upon the glass, namely, that part which you intend to begin at to copy first; and, by means of the light shining through the papers, you will very distinctly perceive every line of the plan through the clean paper. In this state then trace all the lines on the paper with a pencil. Having drawn that part which covers the glass, slide another part over the glass, and copy it in the

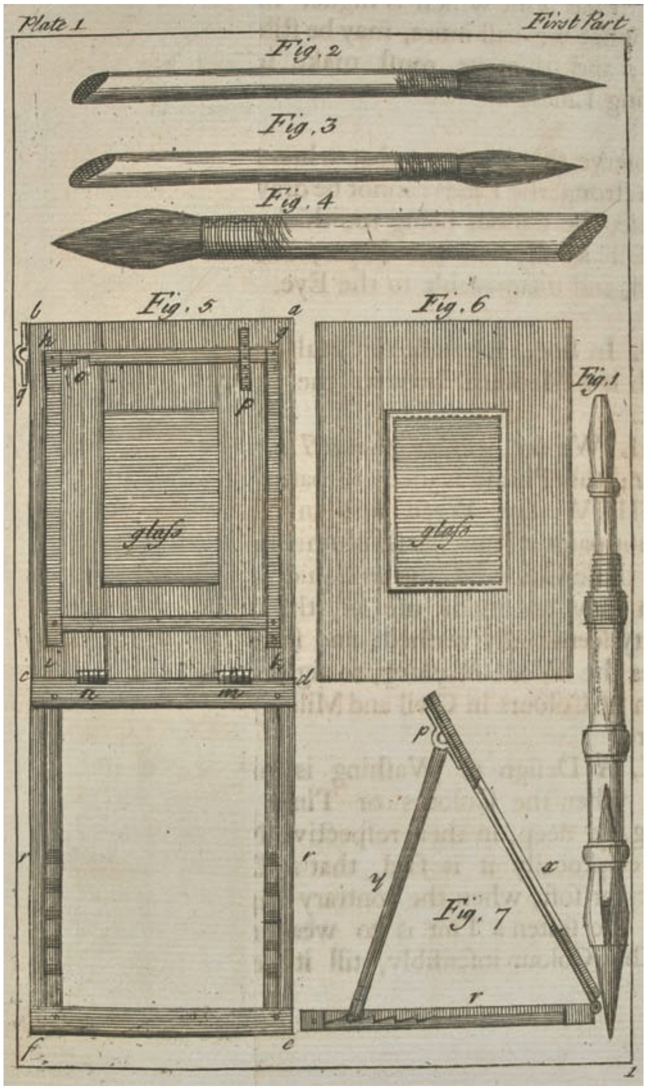

FIG. 712. MATHEMATICAL DRAWING INSTRUMENTS FOR MILITARY MAPPING, 1743. In addition to a pencil holder (1) and three brushes (2–4), this illustration of instruments used in drawing plans of military fortifications shows a tracing stand with a glass insert in three views (5–7). From [Buchotte] 1748, pl. I.

> same manner. And then another part. And so on till the whole be copied.
>
> Then, take them asunder, and trace all the pencil-lines over with a fine pen and Indian ink, or with common ink.
>
> And thus you may copy the finest plan, without injuring it in the least. (Hutton 1790, 228)

None of the copying methods described so far allows for change of scale, a common requirement in mapmaking. Eighteenth-century land surveyors, accustomed to plotting lines and angles when turning their surveys into maps, employed geometrical protraction for changing scale from an arbitrary central point (fig. 713). Robert Gibson wrote:

> Lay the map you would enlarge, over the paper on which you would enlarge it, and with a fine protracting pin, prick thro' every angular point of your map, join these points on your paper (laying the map you copy before you) by pencilled or popped lines, and you have the copy of the map you are to enlarge: in this manner any protraction may be copied on paper, vellum, or parchment for a fair map. . . .
>
> Then pitch upon any point in your copied map, for a center; from whence if distances be taken to its extreme points, and thence if those distances be set in a right line with (but from) the center, and these last points fall within your paper, the map may be increased on it to a scale as large again as its own. . . .

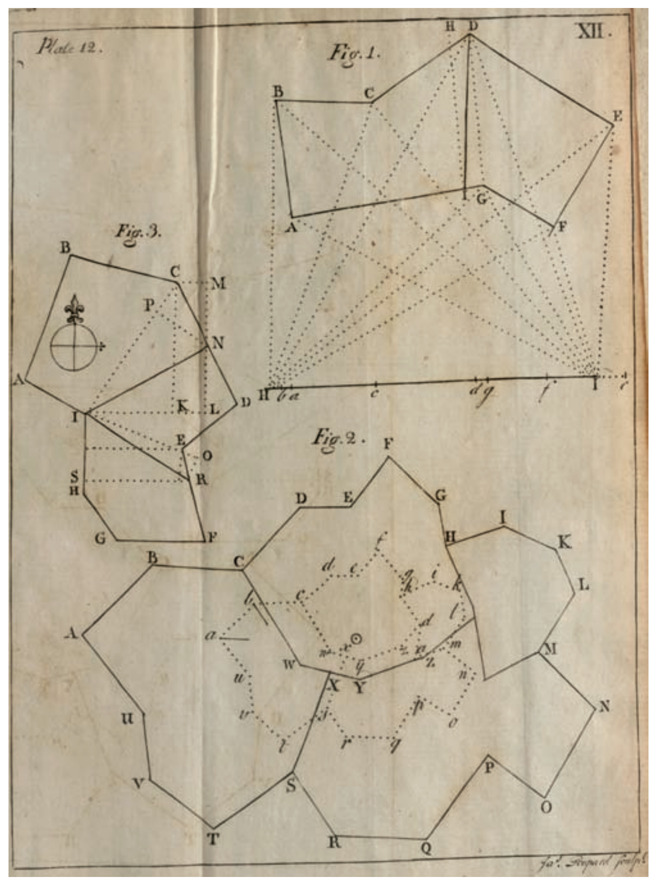

FIG. 713. METHODS OF PLOTTING, 1790. Reduction and enlargement by geometrical protraction are illustrated at the bottom of this plate (fig. 2). From Gibson 1789–90, pl. XII.

> Thus much is sufficient for enlarging maps, and from hence, diminishing of them will be obvious; for one fourth, one third, or half the distances from the several stations to the center, will mark out points, which, if joined, will compose a map similar to the given one, whose scale will be four times, three times, or twice as small as the given one. (Gibson 1789–90, 236–37, 39)

Copying by squares also allowed for a change of scale (fig. 714). Hutton's description in *The Compendious Measurer* is clear and succinct:

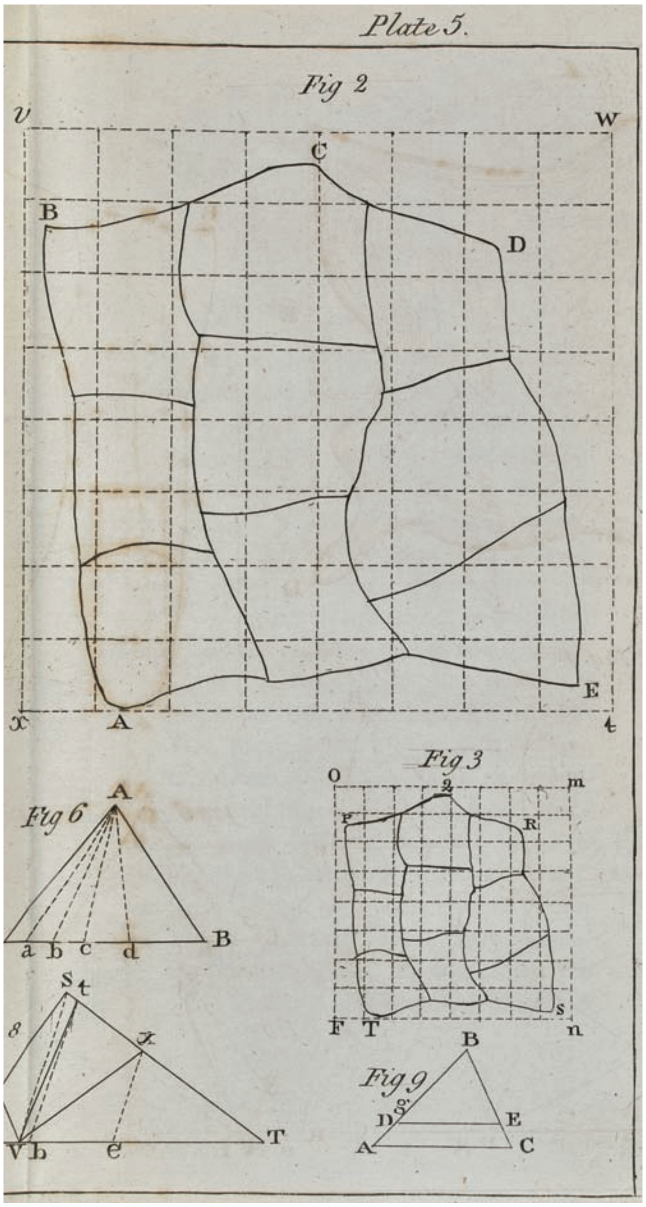

FIG. 714. GEOMETRY AND PLOTTING, 1798. The figures at the top and right (2–3) show how the land surveyor can reduce a map when copying it by squares. Detail from Davis 1798, pl. 5.

> Another method of copying plans, is by means of squares. This is performed by dividing both ends and sides of the plan, which is to be copied, into any convenient number of equal parts. . . . each equal to the former when the plan is to be copied of the same size, but greater or less than the others, in the proportion in which the plan is to be increased or diminished, when of a different size. Lastly, copy into the clean squares, the parts contained in the corresponding squares of the old plan; and you will have the copy either of the same size, or greater or less in any proportion. (1790, 227)

Robert Dossie rated this as the best method for those with drawing skill, because it engages the mind: "I shall only intimate, that, to those who can draw at all, the use of the squares is much more adviseable here, as well as in drawing after Nature, than any of the other methods; as it is much more improving, and on the whole less troublesome, to make a correct sketch this way than by any other" (1796, 1:260). Others are less positive, observing that if copying by squares is very exact, it is also very tedious ([Buchotte] 1748, 51). Surviving manuscript maps marked with squares illustrate the use of this technique.

Adams, an advocate of the pantograph, describes this mechanical method of copying a large map (fig. 715):

> Place the instrument upon a large table, and set the sliding boxes B and D, to the divisions marked 12. Put the crayon into the box B, place the box D upon the fulcrum or leaden foot; the tracing point at C. Then lay a piece of paper under the crayon, and the original drawing under the tracer, and move the tracing point over the principal strokes of the original, and the crayon will form the required copy. . . .
>
> Copy first as much as the pantographer will take in; then make three points on the original, and as many corresponding points on the copy. Then remove the fulcrum to another situation, but so, that when the tracing point is applied to the three points marked on the original, the crayon may exactly coincide with the other three points on the copy, and proceed as before; and so on for every change in the situation of your instrument, and by this means a pantographer of 2½ feet in length, will copy a drawing of any size whatsoever. (1791, 376–77)

Dossie felt that the pantograph hampered artistic expression: "This machine may be used for off-tracing maps, or other such simpler designs, or may afford amusement by off-tracing pictures, &c. to those who have no facility in drawing. But to the abler and more expert in these arts, where designs that demand spirit and pencil are in question, it seems an expedient below their regard, as performing, by an imperfect mechanical aid, what they can execute better by their own natural powers" (1796, 1:263). However, Adams took the

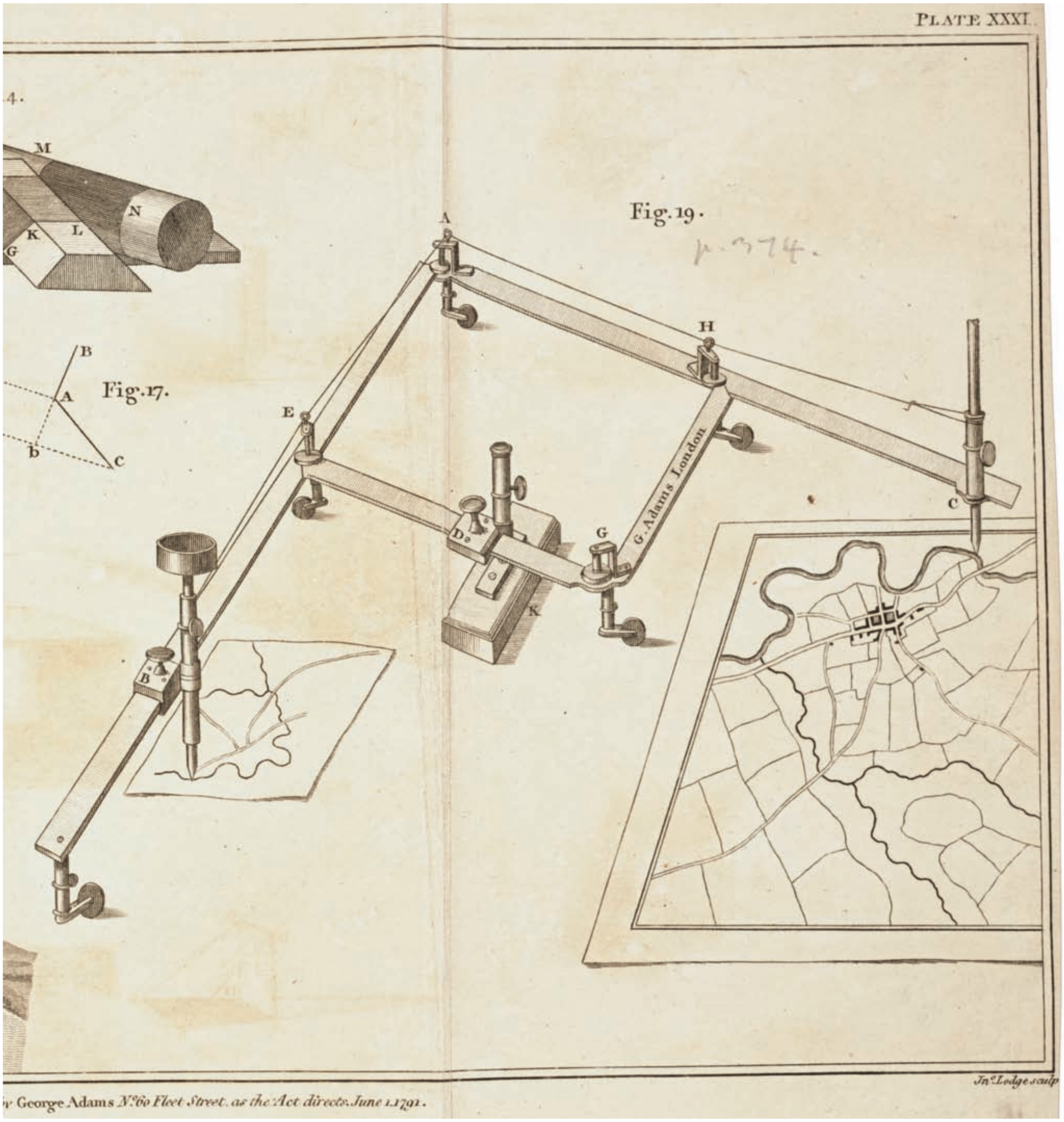

FIG. 715. PANTOGRAPH, 1791. George Adams Jr. illustrated the use of the pantographer (pantograph), whose design was improved by his father, to copy a map at a reduced scale. From Adams 1791, pl. XXXI. Size of the entire original: 17 × 31 cm; size of detail: ca. 17 × 17 cm. Image courtesy of the Linda Hall Library of Science, Engineering & Technology, Kansas City.

opposite view that the mechanical nature of the pantograph is its greatest virtue for the mapmaker: "There is no method so easy, so expeditious, nor even so accurate as the pantographer. It is an instrument as useful to the experienced draftsman, as to those who have made but little progress in the art. It saves a great deal of time, either in reducing, enlarging, or copying of the same size, giving the outlines of any drawing, however crooked or complex, with the utmost exactness; nor is it confined to any particular kind, but may with equal facility be used for copying figures, plans, sea-charts, maps, profiles, landscapes, &c." (1791, 374).

HISTORICAL DEVELOPMENT As a model, the situation in Great Britain provides a general outline of the development of manuscript techniques. Regional variations followed a similar pattern. In 1654–56 William Petty, entrusted by Oliver Cromwell with a major mapping project, the Down Survey of Ireland, had to hire and train draftsmen from diverse trades to plot large numbers of maps quickly from surveyors' notes: "Another sort of men, especially such as had beene of trades into which payntinge, drawinge, or any other kind of designinge is necessary, were instructed in the art of protractinge, that is, in drawinge a modell or plott of the lands admeasured. . . .The next worke was reducinge barrony plotts . . . within the compasse of a sheet of royal paper. . . .Some hands that were imployed in the said reducements did, for the most parte, performe the colouringe and other ornament of the worke" (quoted in Bendall 1997, 1:34). The existing pool of skilled labor was small because seventeenth-century land surveying and mapping was usually a family business passed from generation to generation or learned by apprenticeship (Bendall 1997, 1:9–10).

The situation in Great Britain changed during the eighteenth century, when the country experienced widespread urban development, fen drainage, harbor improvement, industry, and agriculture, all requiring maps but usually in small numbers of hand-drawn copies (Delano-Smith and Kain 1999, 224–28; Bendall 1997, 1:35–45). For example, from the 1750s to the 1860s, Parliamentary acts authorizing enclosure of common lands required a description and maps in two copies, one for the county clerk and one for local use (Delano-Smith and Kain 1999, 124–29). Like surveying and mapping, the trade in mathematical instruments and training in their use increased. Those engaged in the instrument trade often took pupils on the side. In one case, Andrew Pellin from Dublin already had surveying skills and left the weaving business in the 1690s to teach mathematics; to sell mathematical books, maps, and instruments; and to repair clocks and sundials. His students learned skills transferrable to other occupations, such as navigation, and "the most forward and skillfull are gone to sea in the Virginian fleet" (quoted in Bendall 1997, 1:39). Other teachers reached a wider audience by writing textbooks explaining and illustrating the use of mathematical instruments (Hambly 1988, 35–41).

Publication in France was more restrictive. Gaspard Monge, a French mathematician and a draftsman of military fortifications, developed a new system of descriptive geometry, but his army superiors forbade publication, preferring to keep it secret (Booker 1963, 86–113). On the other hand, it was in France that the great *Encyclopédie* (1751–72) by Denis Diderot and Jean Le Rond d'Alembert revealed the hitherto guild-bound secrets of science and technology. Its seventeen volumes of text and eleven volumes of technical illustrations were published in defiance of official disapproval.

Technical drawing was useful in so many professions that it became a standard part of education for a certain class of young British men during the eighteenth century. In England, pupils intended for careers in commerce, the army, or the navy learned drawing as a matter of course. Students of navigation learned how to construct plane and Mercator charts and plot the ship's daily course by pricking (Wilson 1723, 174–75). The standard curriculum of most military academies, from the mathematical school at the University of Leiden (founded 1601) to the Royal Military Academy at Woolwich (founded 1741), included mapmaking, fortification planning, and topographical drawing. By the 1790s, there were five drawing masters at Woolwich and one each at Marlow, Sandhurst, and High Wycombe (Bermingham 2000, 83–85).

In England, training in technical drawing spread beyond specialized education into general schooling (Taylor 1954, 143–44). This trend stemmed partly from teaching applied science at dissenting academies during the seventeenth century (Bermingham 2000, 85–90). Map copying was a standard way of teaching geography to beginning students, as documented in the catalog description of "*Dr. Watts's new and easy method of learning Geography*, or the situation of the countries of the earth and coasts of the sea, by copying maps upon a prepared plan of meridians and parallels" ([Bowles] [1753], 73). It even contributed to the rising popularity of landscape drawing as a female pastime (Bermingham 2000, 77–78), although the perceived conflict between landscape rendition and mapwork would occupy early nineteenth-century critics.

Technical education in France was more government controlled. Higher standards set by Armand Jean du Plessis, Cardinal Richelieu, in 1643 led to the establishment of shipbuilding schools in the late seventeenth century. After 1700, schools in seaports also taught navigation (including drawing) to schoolboys and seamen (Taylor 1954, 146). In order to train engineers for the Corps du Génie (founded 1675) and the Corps des Ponts et Chaussées (founded 1716), the École des Ponts et Chaussées was founded in 1747. Napoleon established the École centrale des travaux publiques (1794), the École des mines (1783), and the École polytechnique (1795). Numerous textbooks with technical illustrations were written for use in these schools. Just before 1740, Amédée-François Frézier, architect and military engineer, provided an early example of showing plan and elevation views in projection (Booker 1963, 39). French engineering students used their drawing skills to try out theories on paper and concoct fanciful projects glorifying the engineered landscape for annual competi-

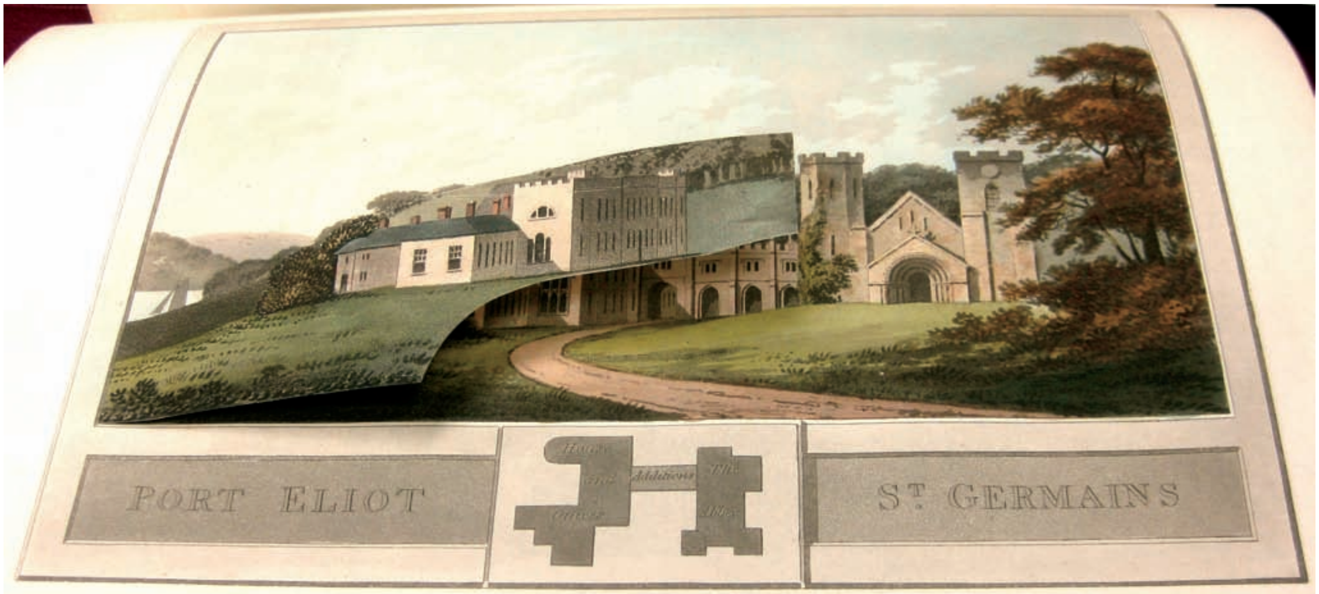

FIG. 716. PORT ELIOT ST. GERMAINS, 1803. Hand-colored engraving and aquatint etching on copperplate. The moveable flap as part of a technical drawing aided a viewer's understanding of a proposed project. Here, Repton uses the flap to demonstrate the impact of a new addition to Port Eliot House near Plymouth, England, in its setting near the cathedral of Saint Germains. From Humphry Repton, *Observations on the Theory and Practice of Landscape Gardening* (London: Printed by T. Bensley for J. Taylor, 1803), facing 192.
Size of the original: 17.6 × 25.8 cm; length of flap: 15.2 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

tions (Langins 2004, 150–51; Picon 1992, 211–27) (see fig. 631).

Manuscript maps and other technical drawings developed different roles in various fields of eighteenth-century activity. Military engineers in France were expected to manage large projects, such as fortifications, acting as general contractors and overseeing workmen, while keeping accounts and reporting progress to superiors. For communication up and down this hierarchy, technical drawings conveyed information more effectively than speeches or writing (Langins 2004, 144–59).

In England, architecture's association with mathematics made it acceptable for the upper class to become architects, but builders could also do so (Ayres 1998, 8–9). Early eighteenth-century architects drew sketches for clients, while giving verbal instructions to craftsmen (Ayres 1998, 3–7). Late in the century, architects assumed control of the design process and made detailed drawings for workmen to follow exactly, while builders became general contractors who supervised subcontractors and reported to the architect (Ayres 1998, 20–21).

Eighteenth-century technical drawings were also used to attract a wider clientele for landscape gardening and architectural improvements. Landscape architect Humphry Repton added moveable flaps showing before-and-after images to aid visualization of his grand projects by prospective clients (fig. 716). "To make my designs intelligible, I found that a mere *map* was insufficient; as being no more capable of conveying an idea of the *Landscape*, than the *ground-plan* of an house does of its *elevation*. To remedy this deficiency, I delivered my opinions in writing, that they might not be misconceived or misrepresented; and I invented the peculiar kind of slides to my sketches, which are here imitated by the engraver" (Repton 1794, xv). At the same time, illustrations in books and magazines spread new architectural ideas, enticing the rising middle class to emulate the upper classes in improving their dwellings (Ayres 1998, 12, 19).

These examples indicate that the emerging Industrial Age had an impact on technical drawing. Not only did makers of technical drawings take advantage of improved mathematical instruments and materials, but they also created manuscript maps and plans that played a new role in communicating technical information to a wider audience.

KAREN SEVERUD COOK

SEE ALSO: Color and Cartography; Landscape, Maps, and Aesthetics; Modes of Cartographic Practice; Ponts et Chaussées, Engineers and École des (School of Bridges and Roads; France)

BIBLIOGRAPHY
Adams, George. 1791. *Geometrical and Graphical Essays, Containing a Description of the Mathematical Instruments Used in Geometry, Civil and Military Surveying, Levelling and Perspective*. London: Printed for the Author, by R. Hindmarsh.

Albert Durer Revived: Or, a Book of Drawing, Limning, Washing, or Colouring of Maps and Prints: And the Art of Painting. 1698. London: Printed by F. Collins, for John Garrett.

Andrews, J. H. 2009. *Maps in Those Days: Cartographic Methods before 1850*. Dublin: Four Courts Press.

Ayres, James. 1998. *Building the Georgian City*. New Haven: Yale University Press.

Bendall, Sarah. 1997. *Dictionary of Land Surveyors and Local Map-Makers of Great Britain and Ireland, 1530–1850*. 2d ed. 2 vols. Originally comp. Francis W. Steer and ed. Peter Eden. London: British Library.

Bermingham, Ann. 2000. *Learning to Draw: Studies in the Cultural History of a Polite and Useful Art*. New Haven: Yale University Press.

Booker, Peter Jeffrey. 1963. *A History of Engineering Drawing*. London: Chatto & Windus.

[Bowles, John]. [1753]. *A Catalogue of Maps, Prints, Copy-Books, &c*. London: Printed for John Bowles and Son.

[Buchotte, Nicolas]. 1748. *The Art of Fortification Delineated*. Trans. J. Dinsdale. London: E. Owen, G. Bickham, J. Wren. Based on Nicolas Buchotte's *Les régles du dessein, et du lavis*. New ed. Paris: Ch. Ant. Jombert, 1743.

Dainville, François de. 1956. *Cartes anciennes de l'Église de France: Historique, répertoire, guide d'usage*. Paris: J. Vrin.

Davis, William. 1798. *A Complete Treatise of Land Surveying, by the Chain, Cross, and Offset Staffs Only*. London: Printed for the author.

Delano-Smith, Catherine, and Roger J. P. Kain. 1999. *English Maps: A History*. Toronto: University of Toronto Press.

Dossie, Robert. 1796. *The Handmaid to the Arts*. New ed. 2 vols. London: Printed for A. Millar, W. Law, and R. Cater; and for Wilson, Spence, and Mawman, York.

Feldhaus, Franz Maria. 1967. *Geschichte des technischen Zeichnens*. Wilhelmshaven: Franz Kuhlmann.

Garlick, Karen. 1986. "A Brief Review of the History of Sizing and Resizing Practices." *Book and Paper Group Annual* 5:94–107.

Gibson, Robert. 1789–90. *A Treatise of Practical Surveying*. 5th ed. Philadelphia: Joseph Crukshank.

Hambly, Maya. 1988. *Drawing Instruments, 1580–1980*. London: Sotheby's Publications.

Harvey, P. D. A. 1980. *The History of Topographical Maps: Symbols, Pictures and Surveys*. London: Thames and Hudson.

Houston, R. A. 2001. "Literacy." In *Encyclopedia of European Social History from 1350–2000*, 6 vols., ed. Peter N. Stearns, 5:391–406. Detroit: Charles Scribner's Sons.

Hunter, Dard. 1947. *Papermaking: The History and Technique of an Ancient Craft*. 2d ed. New York: Alfred A. Knopf.

Hutton, Charles. 1790. *The Compendious Measurer; Being a Brief, yet Comprehensive, Treatise on Mensuration and Practical Geometry*. London: Printed for G. G. J. and J. Robinson, and R. Baldwin, in Paternoster-Row; and G. and J. Wilkie, St. Paul's Church-yard.

Kingston, C. S. 1927. "The Western Sea in the Jesuit Relations." *Oregon Historical Quarterly* 28:133–46.

Langins, Janis. 2004. *Conserving the Enlightenment: French Military Engineering from Vauban to the Revolution*. Cambridge: MIT Press.

Petroski, Henry. 1990. *The Pencil: A History of Design and Circumstance*. New York: Alfred A. Knopf.

Picon, Antoine. 1992. *French Architects and Engineers in the Age of Enlightenment*. Trans. Martin Thom. Cambridge: Cambridge University Press.

Price, Lois Olcott. 2010. *Line, Shade and Shadow: The Fabrication and Preservation of Architectural Drawings*. New Castle: Oak Knoll Press.

Repton, Humphry. 1794. *Sketches and Hints on Landscape Gardening*. London: Printed by W. Bulmer.

Taylor, E. G. R. 1954. *The Mathematical Practitioners of Tudor & Stuart England*. Cambridge: For the Institute of Navigation at the University Press.

Watrous, James. 1957. *The Craft of Old-Master Drawings*. Madison: University of Wisconsin Press.

Wilson, Henry. 1723. *Navigation New Modell'd: Or, a Treatise of Geometrical, Trigonometrical, Arithmetical, Instrumental, and Practical Navigation*. 2d ed. London: Printed for T. Page and W. Mount.

Engraving and Printing. From the advent of printing in Europe in the fifteenth century, maps were reproduced in print either by a relief process, usually from a woodcut block, or by an intaglio process from engraved or etched copperplates. David Woodward has discussed and analyzed both processes as they developed in the Renaissance (2007). By the middle of the seventeenth century, the relief method of printing from woodcut blocks declined and was rarely used for maps intended for distribution as separate sheets. For most modes of cartography during the period 1650 to 1800, intaglio printing was the only method that could come close to replicating the lines and tones of manuscript maps and meet the period's demands for clarity and precision. There was no shortage of manuals concerning engraving for the artisan to consult or for modern researchers to study, beginning with the *Traicté des manieres de graver* by Abraham Bosse (1645), who was apprenticed to the map editor Melchoir I Tavernier in 1620. Bosse's work subsequently enjoyed thirty further editions until 1801 (Stijnman 2012, 83). Ad Stijnman lists 228 titles for the eighteenth century alone in his full bibliography of engraving manuals (2012, 419–597). A rich modern bibliography is also available for the study of engraving in all its parts. However, the special concerns of map engraving have not captured the full attention of many researchers, and the references for this entry comprise those that concern the engraving and etching of maps.

Map engraving and printing were described in well-illustrated articles in Denis Diderot and Jean Le Rond d'Alembert's *Encyclopédie*, detailing standard procedures and new engraving and printing techniques that developed in the eighteenth century. The main concerns for eighteenth-century cartography centered around the graphic representation of topography, especially relief, at a large scale, the clarity and legibility of the writing on maps, the skills and training of engravers, and the time and costs of engraving and printing.

COPPERPLATE ENGRAVING By the eighteenth century, most printed maps combined engraving (*gravure*), executed with a burin or graver that gouged a line or a symbol into the plate, and etching (*gravure à l'eau-forte*), accomplished with an acid that bit the lines made by a

FIG. 717. PROCESS OF PREPARING A COPPERPLATE TO BE DELIVERED TO THE ENGRAVER (FIGS. 6 AND 7 AT RIGHT). Detail from Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts mécaniques, avec leur explication*, plate vol. 3 (second installment, second part) (1763), "Chaudronnier," pl. III (upper register). Size of the entire original: 34.5 × 21.5 cm; size of detail: 10.5 × 21.5 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

stylus or needle making more shallow incisions in the copper. This mixture of processes was still the dominant method for reproducing maps in 1803, when Louis Albert Guislain Bacler d'Albe, director of the Dépôt de la Guerre, prescribed the methods of engraving and printing to be used by the French military and summarized techniques that had developed successfully for topographic maps through the century (Bacler d'Albe 1803).

Engraving or etching was done on a matrix, a plate of beaten copper, a few millimeters thick. Soft red copper was best; yellow copper, because of its high zinc content, was too hard. The copperplate had to be soft enough to be cut smoothly with a burin, but hard enough not to wear out too quickly with printing. The plate had to be free from flaws in its forging. It was beaten with a hammer to make it evenly strong and then rubbed with a pumice stone. After lubrication with a few drops of olive oil, it was burnished and finally rubbed with charcoal made from beech wood quenched in urine or other acid, then rubbed with an even finer pumice stone to make it perfectly smooth (Bacler d'Albe 1803, 87–88). By the early eighteenth century, plates could be bought ready prepared for the engraver (fig. 717).

A preliminary task in the design transfer was to engrave as necessary the meridian lines and parallels lightly with a steel point onto the plate before covering it with an etching ground. The design had to be transferred to the copperplate in reverse so that when printed (which reversed it again) it was in the same orientation as the original design. The design was traced onto a sheet of oiled paper, which was then turned over so that the design could be transferred in reverse after the plate had been covered with an etching ground (or varnish). Often the paper was dusted on the side that touched the varnish with black or red powder. After placing the oiled paper on the copperplate, the engraver went over the lines of the map and the design would transfer in black or red onto the plate (Watelet 1757, 880; Bacler d'Albe 1803, 76).

The design was etched onto the plate after it had been covered with an acid-resistant ground. While two different kinds of ground were employed, the hard ground developed in the early seventeenth century by artists who wished to produce etchings that looked like engravings was less used for map engraving. Preference was given to a soft ground because of its easy drawing surface.

FIG. 718. ETCHING AND ENGRAVING IN A WORKSHOP. The following activities are labeled and described in the accompanying text: applying the ground with taffeta ball (fig. 1, far right); blacking the plate (fig. 1 bis); different techniques for applying acid to the plate or part of the plate (figs. 2, 4, 5); using the etching needle in copying the design, with diffused light from the chassis (*i*) (fig. 3); using the burin, with the cushion under the plate (fig. 6, lower left; label obscured by shadow); and hammering out mistakes (fig. 7, behind fig. 1). Detail from Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts méchaniques, avec leur explication*, plate vol. 5 (fourth installment) (1767), "Gravure, en taille-douce," pl. I (upper register).
Size of the entire original: 33.5 × 20.7 cm; size of detail: 10.1 × 20.7 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

Recipes varied although the ingredients and their proportions were much the same. William Salmon (1701, 1:76) recommended for the soft varnish three ounces of virgin wax to two ounces of mastic to one ounce of asphaltum, proportions repeated in the *Encyclopédie* and attributed to Abraham Bosse (Watelet 1757, 879). *The English Encyclopædia* (1802, 3:328) prescribed two ounces each of white wax and asphaltum, half an ounce each of black pitch and Burgundy pitch. All recipes produced a waxy, resiny substance that resisted the action of acid. The engraver melted the wax and pitch in a clean glazed earthenware pot and gradually added the powdered asphalt, stirring constantly with a spatula. He then simmered it over a gentle flame, stirring frequently, until a drop on a plate, allowed to cool, broke after it had been bent double two or three times between the fingers. He took the varnish off the heat, allowed it to cool a little and poured it into water that had been warmed to the same temperature as the varnish. He rolled it into balls and stored them ready for use in pieces of taffeta. By 1750 it was possible to buy balls of varnish ready for use. The soft ground was applied by heating the plate to the point where the contents of the taffeta melted as they were dabbed on and spread evenly over the surface. The ground was then smoked black using a torch. Small plates could be held with a clamp as this was done; larger ones were suspended from the ceiling. When cool, the plate could be worked (fig. 718).

Engravers worked in the best possible light, usually from an upper-story window or aided by a large diffusing screen to keep direct sunlight from reflecting on the burnished copper. If forced by necessity to work at night, a device with three oil lamps and a diffusing screen was used. The etcher drew the image onto the plate with wooden-handled needles with points of various sizes. The point cut through the ground, revealing the copper beneath, and the design could be seen as copper colored on the smoked black background. The map's basic information was etched on the plate first:

> As for the manner of engraving, this is the method that is most common and produces the best results.

> The engraver draws everything that is a line with the needle on the varnish, such as the walls of enclosures, roads, plans of villages, towns, and hamlets. One only draws the outlines of rivers, seas, lakes, ponds. Woods, heaths, vineyards, market gardens, cultivated land, meadows, marshes, and roads lined with trees should be done entirely in etching. . . . Features, such as farms, mills, &c. should be drawn and shaded on the varnish with the needle. . . . Mountains, ridges, hills, and dunes should be mostly etched with stronger lines for the shaded sides, or using a finer point for the illuminated sides. That is generally all you can draw on the varnish. (Anonymous 1767, 2)

Bacler d'Albe further explicated the process for engraving the lettering, etching the mountains, and rendering water with burin and drypoint (Bacler d'Albe 1803, 79–82).

With the main topographical features drawn, the plate was ready for the acid bath. The two methods preferred for maps were either to submerge the plate in the nitric acid bath or to pour acid down the face of a plate placed above a trough that gathered the acid and drained it into a bowl (Watelet 1751, 885). It required some skill and experience to know how much acid to use and when to stop. Plates that were bitten too deeply could be ruined, the effect of broad, black lines being coarse and ugly. Etched lines were wider than they were deep and considerably shallower than engraved lines. This meant that they held less ink than engraved lines and looked grey by comparison when printed. It was possible to create tonal variation by biting some parts of the plate more deeply than others. This was done by painting varnish onto ("stopping out") the lines that had been bitten sufficiently deeply, before returning the plate to the acid. With the biting completed the ground was taken off the plate and it was ready for engraving. Sometimes the engraver went over the etched lines of the design with a burin to deepen and strengthen them. It was possible to reapply ground after engraving for further etching if the map required it (Bacler d'Albe 1803, 78).

For engraving, round-pointed drypoint gravers were used to scratch fine lines, square-ended burins to make the largest strokes, and lozenge-shaped burins to make fine ones. The lozenge-shaped gravers made thinner, deeper cuts than the square-ended ones. A stone covered with olive oil was used to whet the gravers, and a cushion made of a leather bag filled with fine sand supported the plate. Rules and parallel rules helped to line up script and to draw bearings and other straight lines; spiked punches and roulettes produced grainy texture. Standard punches could be used for a variety of cartographic signs, usually on less expensive maps.

Holding the burin with the finger along the blade and the tool flat to the plate, an engraver cut a line into a copperplate. For a curved line he turned the plate against the pressure of his instrument, resting it evenly on his bag of sand. Greater pressure produced a deeper line and slighter pressure a finer line. The deeper cuts made by lozenge-shaped gravers held more ink than the shallower strokes made by square-ended gravers and therefore appeared blacker when printed. Thus, the choice of graver affected the density of light represented on the plate. Engraved strokes generally held more ink than etched strokes and their profile gave the printed engraved line greater brilliance than an etched line. The very finest lines were scratched in with a drypoint. Both etching and drypoint threw up ridges of waste copper (burr) and these had to be carefully cut away.

Small errors could be smoothed out with a burnisher. Major errors had to be beaten flat by hammering the reverse of the copper to push it up with a hammer on a small anvil. This weakened the plate by making it thinner and ultimately reduced the number of impressions that it was capable of printing, so mistakes were expensive in terms of damage to the plate as well as wasted effort.

All aspects of map engraving involved specialization: some engravers only did the rivers, coastlines, and other undulating lines, others drew the straight lines of the scale and grid of longitude and latitude, still others the effects of relief and other topographical features, and yet others engraved the lettering, as all writing on maps printed from copperplate was engraved or etched. The position of the letters might be scratched in by the person responsible for the design and then finished by the writing engraver. After oiling the plate to lessen its shininess and placing it on the cushion, the writing engraver used a ruler and compass to draw two parallel lines indicating the height of the lettering. He drew the letters with a double or single point and then carefully cut them with a burin, working first from below and then from above. As the lettering was all engraved in reverse he might use a mirror to check his work. Italic lettering was the quickest and cheapest to execute. Capitals and roman letters, both slanted and upright, used to distinguish important names of towns and provinces and of larger features, were more demanding and cost four times more than italic lettering.

The final job, usually undertaken by the master in charge, was to attempt to harmonize the style and appearance of the plate, especially if different parts of it had been engraved by different people. According to Bacler d'Albe (1803, 82), the master would use drypoint to add coherence and elegance to any areas he found lacking substance or style.

NEW TONAL PROCESSES Increasingly after 1770, map engravers employed various tonal processes invented during this period to add texture to their plates and to better represent the topographical features that were becoming more common on printed maps during the later eighteenth century. The advantage of these methods over detailed work with the burin was that they were cheaper and more quickly accomplished. Their disadvantage was that their lines on the plate wore out more quickly, requiring more frequent retouching of the plate to yield more impressions. While they could sometimes be manipulated to produce some interesting grainy effects in topographical maps, they could also produce a messier finish than pure engraving with adverse consequences for the legibility of the map.

The earliest method was mezzotint (*manière noire*), a process invented in the seventeenth century to imitate the rich tonal gradation of oil paintings. It was widely adopted, especially in England, to reproduce portraits and other oil paintings. A rocker was employed to roughen the plate all over so that it would hold ink and print rich black. The light tones were then smoothed away with scrapers and burnishers. It was not a process that lent itself naturally to cartography, but its tool, the rocker, could be used to produce a rough texture for different landscape features. Similarly, map engravers occasionally adopted the techniques of the crayon manner (*manière à la crayon*), developed in France around 1750 in order to produce facsimiles of chalk drawings, which also employed roulettes and punches designed to impart the grain of chalk on the uneven surface of laid paper, and map engravers sometimes made use of these tools in order add tone to contours. Bacler d'Albe credited Harry Ashby with the use of rockers in the *manière noire* for mountains in J. F. W. Des Barres's *The Atlantic Neptune* (Bacler d'Albe 1803, 72).

Aquatint (*gravure au lavis*), invented around 1770, imitated the effect of watercolor washes to produce facsimiles of watercolor drawings. In aquatint, a porous etching ground was laid on the plate so that when washed with acid, the acid bit around the particles—usually of resin—that covered the plate, causing a series of tiny circles when printed. Larger particles produced bigger, rougher circles. The ground could be painted on with a brush and the tone could be varied by biting to different depths. Henry Pelham's *A Plan of Boston in New England with Its Environs* (1777) (fig. 719) employed aquatint executed by the specialist engraver Francis Jukes. Such a method was employed by the engraver Benjamin Henry, who used drypoint, roulette wheel, and an abrasive stone tool on the plate to shade the coastline and hills of plates in Alexander Dalrymple's *A Collection of Plans of Ports in the East Indies* (1774–75) (Cook 1981, 51, figs. 5–10).

PAPER Once the copperplate was ready for printing, the next step was the selection of paper, which came in several different sizes and grades of quality. It was made from recycled clothing and bed linen, with paper from the longer fibers of traditional linen rags preferable to that made from the cheaper cotton rags that became common toward the end of the eighteenth century. The Dupuy family of Ambert in Auvergne and the Johannots of Annonay closer to the Rhone were the principal makers of the finest copperplate paper, which they exported all over Europe. Another center near Angoulême made slightly less fine paper for export to Holland and often for reexport to England. In the middle of the eighteenth century, Britain imported nearly all of its copperplate paper from France or Holland or Genoa, which was the principal source for Italy and nearby countries (Pacha and Miran 1996, 61–76). For Covens & Mortier, map publishers in Amsterdam, paper was "one of the most important cost factors in map and atlas production, so that it determined the price to a great extent" (Van Egmond 2009, 226).

About 1755 an anonymous memorandum to the British Society for the Encouragement of Arts, Manufactures and Commerce contrasted the "Disadvantages of English Paper" with the "Qualities of French Paper." The faults in local paper resulted partly from mechanization:

> English Rags, being cut by Engines, make the Fibres so short, tho' coarse, that the more Size is required to bind them together, to render them firm and serviceable, and makes the Paper of a harder nature. The Paper, being hardened by excessive Sizeing, its elasticity is taken off, which prevents its sucking out the Ink from the Plate, and occasions the Print to be more Feeble and Pale. The Knotts in the Rags, are drawn through the Engine, and not broke; consequently remain in the Paper, and, if taken out, make a Hole.

French paper, however, had all the qualities required for fine prints: it was strong, soft, supple, and uniform in texture:

> French Rags were beat with Hammers. By this means the Fibres are long and fine, and therefore hold together with less Size, and the Paper proves the softer and fitter for Printing. The Paper, by not being so much Sized, keeps its elasticity, and sucks the Ink out of the Plate, therefore renders the Print more Brilliant and full of Colour. The Knotts in the Rags are crushed by the Hammers. (Royal Society of Arts Guard Book, vol. 3, quoted in Balston 1957, 35n1)

The best French paper also had a natural whiteness that English mills struggled to match.

The midcentury wars stimulated English production of printing paper, and by late in the century, when the

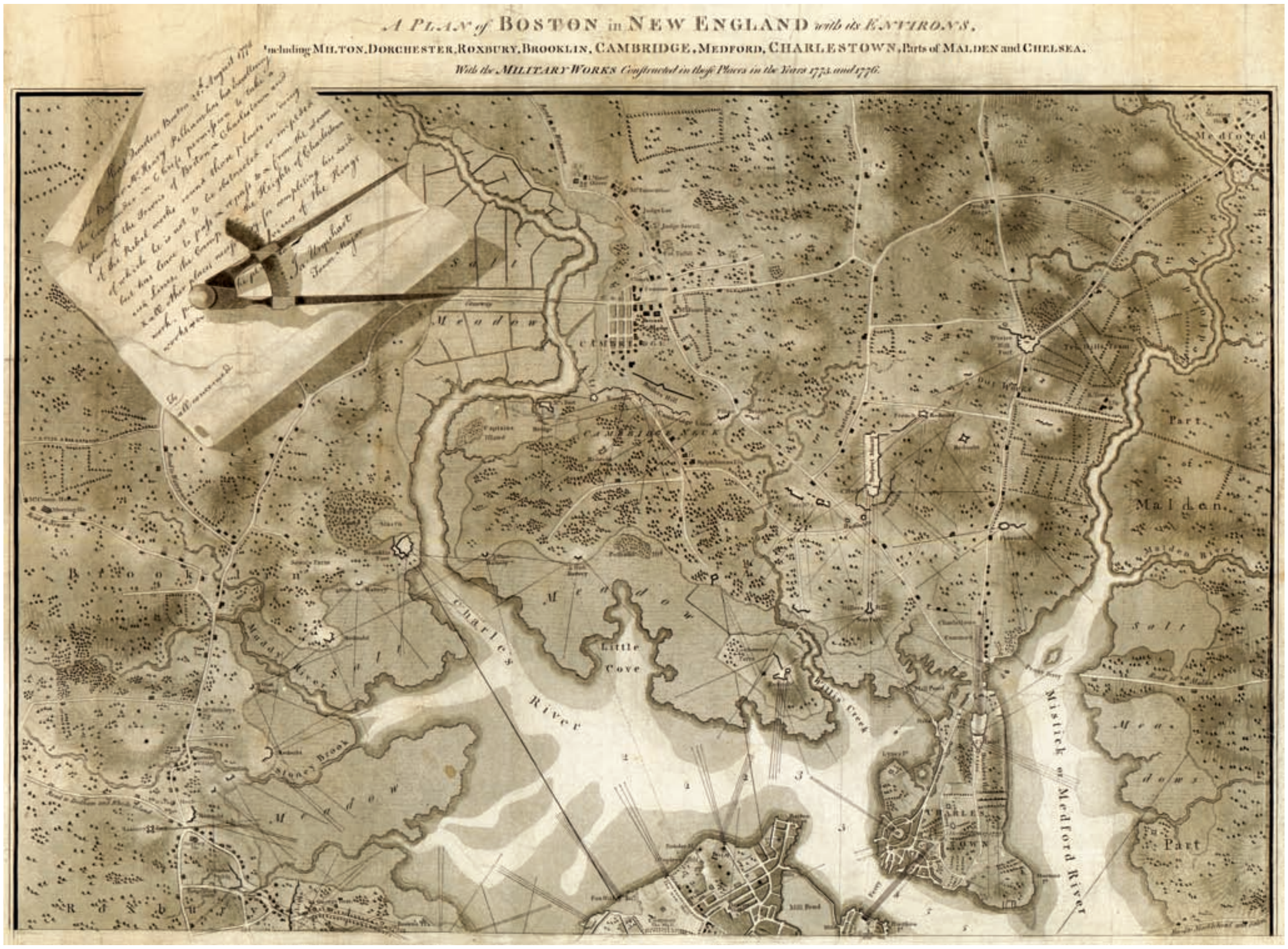

FIG. 719. UPPER SHEET OF HENRY PELHAM, *A PLAN OF BOSTON IN NEW ENGLAND WITH ITS ENVIRONS* (LONDON: HENRY PELHAM, 2 JUNE 1777). This plan was finely engraved using aquatint technique by Francis Jukes, well known for his prints in aquatint and mezzotint.

Size of the sheet (one of two): 63.5 × 79.5 cm. Image courtesy of the William L. Clements Library, University of Michigan, Ann Arbor (Maps 4-I-1777 Pe).

revolutionary and Napoleonic Wars had cut off all legitimate foreign supplies, papermakers in England such as James Whatman and Edmeads & Pine were able to supply the domestic market there. Whatman developed wove paper (*vélin*), which was the principal eighteenth-century innovation in papermaking. All earlier papers were laid—made on a mold featuring parallel lines of wires that left their mark on the sheet of paper in a series of ridges. Wove paper employed a meshed mold that yielded paper with a smoother surface that took a color wash much better. Since maps were usually hand colored, wove paper also appealed to map engravers and printers. In 1781 Mathieu Johannot received a medal for his development of wove paper in France. By the early nineteenth century, Dutch mills had turned to wove paper and laid paper quite quickly became obsolete (Pacha and Miran 1996, 55–76).

The softness that made paper good for printing also made it too absorbent for coloring. Paper was either sized between the two processes, or mapsellers used paper containing more size than was usually employed for prints (Bacler d'Albe 1803, 89). Although subtle effects of light and shade expressing relief could be a priority in maps, and sized paper did not have the suppleness of the best French paper, the need for coloring dictated the use of sizing in the paper, corroborated by the *Encyclopædia Britannica*, which spoke of "the paper used for drawing, or for coloured maps." The encyclopedia reported that "The Dutch were not long ago almost wholly in possession of this manufacture" (*Encyclopædia Britannica* 1797, 13:714).

French paper came in standard sizes, differing somewhat from common British sizes, among which were Royal (*Grand raisin*, 25½ × 19 inches; 650 × 480

NOMS des différens formats de papier.	POIDS MOYEN de chaque rame en hectogr.	VÉLIN. — PRIX des 5 hectogr. ou livre de 16 onces.	ORDINAIRE. — Prix de la rame.	DIMENSIONS des FEUILLES.		PRIX de l'impression, à raison de 100 épreuves.		NOMBRE D'ÉPREUVES que peut tirer un ouvrier par jour.	
				Largeur.	Hauteur.	au CHIFFON.	à LA MAIN.	au CHIFFON.	à LA MAIN.
	hect.	fr. c.	fr.	M	M	fr.	fr.		
Grand aigle....	709.	2. 00.	90.	0. 975.	0. 665.	16.	30.	70 ou 80.	25 ou 30.
Colombier.....	435.	2. 00.	70.	0. 845.	0. 570.	12.	20.	90 100.	35 40.
Chapelet.......	391.	2. 00.	70.	0. 800.	0. 580.	12.	20.	100 110.	40 50.
Nom de Jésus...	293.	1. 65.	45.	0. 690.	0. 525.	9.	18.	100 110.	40 50.
Grand-raisin, format Didot....	186.	1. 50.	36.	0. 650.	0. 480.	4.	9.	140 150.	60 70.
Petit-raisin, format ordinaire..	156.	1. 50.	30.	0. 585.	0. 445.	3.	6.	180 200.	80 100.
Carré.........	98.	1. 50.	18.	0. 530.	0. 420.	2.	4.	225 250.	125 140.

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FIG. 720. TABLE OF FRENCH PAPER AND DIFFERENT FORMATS. Table includes the weight, prices, dimensions, costs of printing, and number of impressions that could be taken in a day for each size. From Bacler d'Albe 1803, 91.

mm), *Nom de Jésus* (watermarked IHS, 27 × 20¾ inches; 690 × 525 mm), Imperial (*Chapelet*, 31½ × 23 inches; 800 × 580 mm), Elephant (28 × 23 inches), *Colombier* (watermarked with a dovecote, 33¼ × 22½ inches; 845 × 570 mm), Atlas (34 × 26 inches), and *Grand Aigle* (watermarked with a double-headed eagle, 38½ × 26 inches; 975 × 665 mm). Paper was sold in reams of 20 quires of 24 sheets (480 sheets) or reams of 500 sheets. The table of different formats of paper in Bacler d'Albe (1803) includes the weight, prices, dimensions, costs of printing, and number of proofs that could be taken in a day for each size (fig. 720).

Advertisements for maps in London newspapers generally spoke in terms of sizes and rarely specified the origin of the paper. The sizes most commonly cited were Imperial and Elephant. Maps were also printed on materials other than paper. In 1756, for instance, Robert Sayer and Elizabeth Bakewell advertised that some examples of their map of Jamaica were "printed on Silk for the Curious" at double the normal price (*London Evening Post*, 18 December 1756). French mapsellers similarly advertised maps printed on silk and taffeta as well as on paper, attested by the catalogs of Roch-Joseph Julien, Jean Lattré, and Didier Robert de Vaugondy.

PRINTING Printing a copperplate was normally consigned to a specialist copperplate printer (*imprimeur en taille douce*). The copperplate press was equipped with two rollers between which the plate and dampened paper were passed under very great pressure to transfer the ink from the lines incised in the plate onto the paper. Repeated pressure during multiple printings smoothed out the copper so that impressions gradually lost contrast and declined in quality. Most engravers had at least one roller press in order to take "progress proofs" to check their work as they went along and even to print small editions of plates in their possession on demand (Casselle 1976, 49–50). However, nursing a valuable copperplate through the process of printing large numbers of impressions, while minimizing the need for retouching and maximizing the potential yield, was the province of a skillful specialist who might pull a thousand acceptable impressions from an engraved plate before giving it back to an engraver to retouch or rework. Eventually, a plate would become too thin and fragile for further retouching, and at that stage, if there were further demand for the image, a new plate would have to be engraved. When a plate was small and a very large print run was required (which happened most often with popular periodicals like the *Gentleman's Magazine*), or when the map was very popular, two or more identical plates might be engraved, a method employed by the Homann firm in Nuremberg. First editions of maps were normally smaller in number; François de Dainville gives examples from contemporary contracts that cite first pulls of 250, 400, and 500 impressions (Dainville 1956, 255), and 200 to 300 may be close to the norm. Pierre Patte, architect and engraver for the Cassini *Carte de France*, suggested that plates be retouched after 400 pulls, especially those for topographical maps (Pelletier 2013, 157).

The printing process (fig. 721) began by warming the plate to expand the incisions to receive the printing ink (German black preferred), which was applied with a dabber. The thick ink was pushed in so that it filled all the lines. For geographical maps, with little etched topography, the plate was carefully wiped with muslin cloths (*au chiffon*) imbibed with urine to clean all ink from its surface without removing any from the lines. For the more finely detailed topographical maps, the plate might be cleaned by hand (*à la main*), a method that was less wearing for the plate, but more time consuming and expensive (Bacler d'Albe 1803, 85–86). Then the plate was placed on a flat bed padded with felts to be passed between two rollers of the press. The inked plate lay face up with a sheet of dampened paper laid on top. Several blankets evened the pressure over both. As it passed at great pressure between the rollers of the press, the paper was pressed into and absorbed the ink out of the grooves in the plate, so that when the paper was peeled off the plate the ink was standing out in relief. The sheet of paper was then hung over lines to dry, while the plate was warmed, re-inked, and wiped for the next impression (fig. 722).

The process of producing a single impression took several minutes at best. The larger sheets of paper could

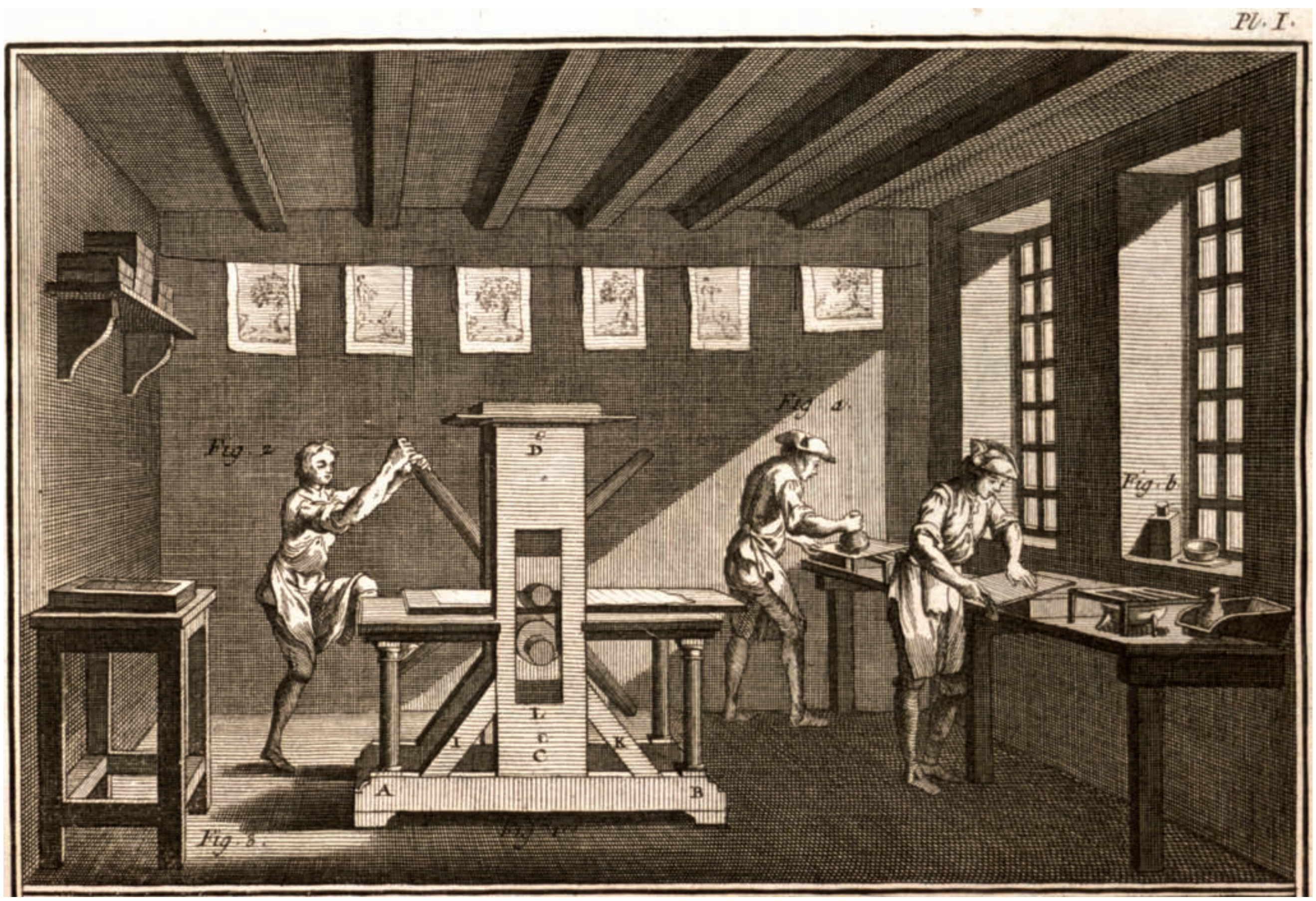


FIG. 721. SHOP OF A COPPERPLATE PRINTER. The rolling press, the preparation of the plate for printing, and the damp printed maps and images drying. Detail from Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts méchaniques, avec leur explication*, plate vol. 7 (sixth installment) (1769), "Imprimerie en taille-douce," pl. I (upper register).
Size of the entire original: 34.1 × 20.5 cm; size of detail: 13.5 × 20.5 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

FIG. 722. TRADE CARD FOR GEORGE BEACHER, "COPPER-PLATE-PRINTER," 1740s. Engraved by Jacob Bonneau, the card shows Beacher's workshop with the roller press in action and prints hanging to dry above bales of different sizes of paper in the foreground; the inking table is to the left.
© The Trustees of the British Museum, London (Trade Cards Heal, 99.25).

be printed at a rate of seventy to eighty impressions per day if cleaned with a rag, twenty-five to thirty impressions per day if cleaned by hand. Some sources describe a hundred impressions per day with two teams of printers working the press (Van Egmond 2009, 227). The wetting and drying of the paper produced one major headache for mapmakers: when the paper dried it shrank. While not a problem for pictorial prints, for mapmakers the difficulty lay in the fact that sheets shrank unevenly, thus distorting the map's accuracy of scale. There was no perfect answer to this problem, but various attempts were made to compensate for shrinkage when accuracy was paramount. Philippe Buache calculated that a manuscript map should be enlarged by a sixtieth before its design was transferred to the plate to compensate for shrinkage. Aaron Arrowsmith's *Map of England and Wales* (1815) included a table of "Scales shewing the unequal shrinking of paper" (Pedley 2005, 65–66, fig. 17).

REPRODUCING TOPOGRAPHICAL MAPS Rendering topographical features at larger scales posed the biggest challenge for map engravers. Topographical information was particularly important for the military and of increasing interest to enlightened reformers, agrarian planners, and administrators. The ability to show different land forms, land use, and types of habitation on the engraved plate influenced the mixed method of etching and engraving described in detail the *Encyclopédie* plate illustrating engraving in geography, topography, and music (Anonymous 1767) (fig. 723). The illustration shows three types of map engraving: the purely geographical, that is, at a small scale with few topographical features; semitopographical, with some elevations, worked land, heaths, meadows, marshes, and woods shown en masse, not in detail; and topographical, which represents more precisely the nature of the terrain. The author of the notes to the plate described in detail the process for achieving the topographical detail:

> Once the plate has been bitten, one uses the burin and the drypoint to finish and perfect what we have already mentioned. The rivers, which have only been outlined in etching, will have waves added with strokes of the burin. Lakes, ponds, seas, and generally all water surfaces should be expressed through fine, smooth burin strokes. Sand should be done with the drypoint, with points closely spaced along the shore and lighter and more thinly spread toward the middle or toward the river bank where it meets the sea. Clumps of houses in towns and villages should be also stippled with the drypoint for the sake of neatness. The slopes of mountains, hills, etc. should be elongated with fine tapering lines made with a burin or drypoint to soften the crude etched lines. Clearings in woods and heaths can be variegated with little dotted drypoint strokes for the sake of variety and to produce masses that are more or less sandy or garnished with vegetation.
>
> There are engravers who do all that we have just described with the etching needle, but however much care they take in attempting to express the various tonal gradations that this work requires, a map that is entirely etched will always be displeasing or coarsely made, in comparison with the models that we have before us. (Anonymous 1767, 2)

The mixed method of etching followed by work with a burin was precisely that used for the Cassini *Carte de France*, a semitopographical work. Pierre Patte felt that elements of topography were the most important in the preparation of the plate: the woods first, followed by towns, rivers, mountains and hills, with vineyards, meadows, and marshland more lightly treated (Pelletier 2013, 156).

Lettering was far more conspicuous and of greater intrinsic importance in a map than in most prints; its size,

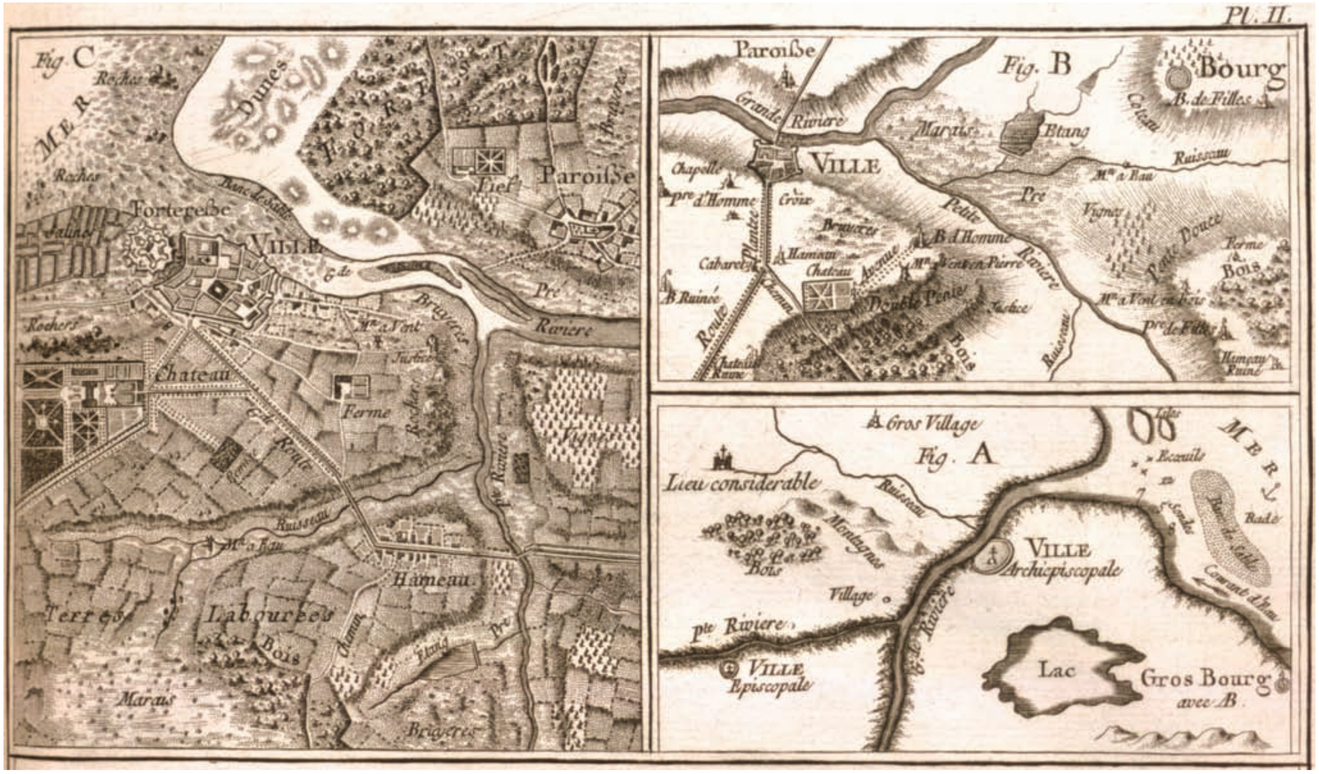


FIG. 723. THREE KINDS OF MAP ENGRAVING. The example displays geographical (bottom right), semitopographical (top right), and topographical (left). Detail from Denis Diderot and Jean Le Rond d'Alembert, eds., *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, 17 text vols. and 11 plate vols. (Paris: Briasson, David, Le Breton, Durand, 1751–72), *Recueil de planches, sur les sciences, les arts libéraux, et les arts méchaniques, avec leur explication*, plate vol. 5 (fourth installment) (1767), "Gravure en lettres, en géographie et en musique," pl. II (upper register).
Size of the entire original: 35.2 × 22.3 cm; size of detail: 12.4 × 22.3 cm. Image courtesy of the Department of Special Collections, Memorial Library, University of Wisconsin–Madison.

style, and tasteful disposition were crucial to the legibility and decorative appeal of a map. César-François Cassini (III) de Thury took particular note of the letter engravers for the *Carte de France*, remarking that "the art of the engraver consisted of placing names without confusion and in a way that leaves no doubt about what they refer to" (Pelletier 2013, 153). He further emphasized the necessity of special training for lettering engravers, even paying them more than the market price, saying that any skill not justly recompensed would become neglected (Dainville 1956, 224). The size, scale, and rendering of lettering formed the disputed subject of the lawsuit between the Delahaye family of engravers and the Robert de Vaugondys in the production of the *Atlas universel* (1757) (Pedley 1984). Bacler d'Albe devoted eighteen pages to the "characters and heights of writing on maps" completed by a fourteen-page "table of characters and heights . . . of letters to be used in draft sketches, fair copies, and engraving of plans and topographical, chorographical, and geographical maps . . . according to the scales adopted at the Dépôt général de la Guerre" (Bacler d'Albe 1803, 92–125, quotation on 111).

In 1794 the French map engraver Guillaume-Nicolas Delahaye, who engraved and etched both the lettering and the topography for many map editors, including Jean-Baptiste Bourguignon d'Anville, Didier Robert de Vaugondy, and Thomas Jefferson (during his stay in Paris), and most famously for the *Carte des chasses du roi* (1807), described his own unusual method in an application for support to the Bureau de consultation des arts et métiers in 1794. Delahaye lightly etched in the lettering of the map immediately after the basic design was laid down in order to establish the layout of the names before tracing the other elements on the map. Having copied the original design to oiled paper, correcting the writing as he did so, Delahaye would "place blank tracing paper, reddened on the side facing the plate onto the varnished plate that is going to receive the design. Then I put my oiled design and the blank reddened paper on the plate, checking that it won't move, pulling the edges of the design down over the plate." He then took a blunt, rounded needle to trace over his design. As he pressed lightly onto the reddened paper the red transferred to the blackened surface of the varnish:

"with a rounded steel stylus, I draw only the writing on the design, and I draw the interior frame exactly." Once he had his design and the writing showing red on black he would "pull the oiled paper and the reddened paper off the plate and draw on the varnish with another steel stylus, the entire frame with a straightedge, very exactly." He did not at this stage further touch the lettering but he could see where it should be, ensuring its correct distribution and location (quoted in Pedley 2005, 50).

The final component handled by a separate specialist was the pictorial engraving in the cartouche and in other decorative areas, a subject discussed in more detail elsewhere in this volume. The decorative cartouche surrounding a map's title and scale and other information was often designed by an artist who specialized in decoration for other printed work (frontispieces, chapter heading vignettes, and cul-de-lampes, as well as illustrations in books). The designs were etched by an engraver who normally worked on picture engraving, not on maps (Worms and Baynton-Williams 2011, xiv–xv). In France, the separation of design and execution was noted in the signatures as "inv" or "invenit" for the design and "sc" or "sculpsit" for the etching. This is exemplified in the work of Pierre-François Tardieu, who engraved the cartouche designed by Charles-Nicolas Cochin for Didier Robert de Vaugondy's *Mappemonde* (1752), and Hubert-François Gravelot, who designed cartouches and often engraved them for his brother, d'Anville (Pedley 2005, 59–60, fig. 13). In the Netherlands, ornamentation was also the province of particular designers and engravers; Pieter Mortier employed *peintre-graveurs* such as Jan Goeree and Cornelis Huyberts to both design and engrave title cartouches on maps (Van Egmond 2009, 223–24).

ENGRAVERS During the period ca. 1650 to 1800, the main centers for high-quality map engraving in Paris, London, Amsterdam, Rome, Nuremberg, and Augsburg determined the success of the map trade. In regions where engravers were lacking, printed maps were imported through the book trade until such time as engravers, like Tomás López in Spain, could establish a trade and business in map engraving after his training in Paris with the geographer d'Anville and the map engraver Guillaume Dheulland.

Art historians, collectors, and dealers have produced an extensive bibliography on art print engravers, establishing biographies, identification of works, and formation of schools. Map engravers, however, have been relegated to the background, considered a lesser branch of engraving, since their work was neither valued as highly in monetary terms nor necessarily original in its content. Some engravers such as C. Aldring, the most prolific of the Cassini engravers, are practically unknown to art historians (Dainville 1956, 224). Nonetheless, as Laurence Worms and Ashley Baynton-Williams have demonstrated, a close study of the master-apprentice relationship among map engravers and their social and economic milieu can provide a deeper understanding of the constraints and incentives affecting the reproduction of maps in print. Indicators of aspirations are found in the scale of apprenticeship fees paid and later success may be found in the engraver's address (Worms and Baynton-Williams 2011, xiii, xv–xx). Training in design and art combined with knowledge of geography, survey, and mathematics gave the map engraver a background unique among his or her colleagues. The anonymous author of the notes to "Gravure en lettres" in the *Encyclopédie* held that map engravers should know how to design both geographical and topographical maps and should take lessons from geographers and engineers who taught these skills; thus the engraver would be someone who reunited "the art of the engraver with the science of the geographer and the engineer" to create maps "the most correct, the best expressed with the truest detail, and the best experienced" (Anonymous 1767, 2).

As there were no training schools established for engravers, expertise was handed down from master to apprentice. The master-apprentice system in London depended on guilds or company organization, while in Paris it operated as a free trade, with no guild restrictions. (However, printers of copperplates in Paris were strictly regulated by their guild statutes, established in 1692.) Within this system and through the study of the genealogy of master-apprentice links, the tight knit world of engravers reveals the growing specialization required for maps. Thomas Jefferys's several apprentices exemplify the trend: John Spilsbury refused a commission to engrave portraits, being "no engraver of heads, but of maps, plans, writing, ornaments, etc." (Hannas 1972, 19). William Faden, another of Jefferys' pupils, engraved nothing but maps, which he published himself; Harry Ashby specialized almost exclusively in lettering, used for good effect in the title pages of *The Atlantic Neptune*, and engraving bill heads and bank notes (Hornsby 2011, 175). The engravers of the *Carte de France* similarly divided the work between the letter engravers and those who specialized in rivers and other undulating features, such as geographical outlines, and the straight line work of frame, grid, and scales (Pelletier 2013, 150–54). A similar division of labor is seen in the glimpse of the engraver's workshop offered by Mme Delahaye (probably Marie Anne Mallet), sister-in-law to Guillaume-Nicolas Delahaye, in her affidavit arguing for fees owed for engraving the plates of the Robert de Vaugondy *Atlas universel* (Pedley 1984).

In France, engravers enjoyed a close relationship with map publishers, both financial and physical. In 1672, upon receiving the privilege for the *Atlas nouveau* in partnership with the geographer Guillaume Sanson, the engraver Alexis-Hubert Jaillot hired François Caumartin to work for him daily for 550 livres a year; a month later he employed the letter engraver Louis Cordier, who lodged with him until Cordier's death in 1711. Caumartin's contract with Cordier spells out clearly the latter's responsibilities: for 84 livres per plate, he would engrave the "cartouches, hachures of the sea, and plans of fortified towns and generally all the other things that compose the plan of the map. . . . as well as all the large lettering of place-names"; to execute the "small lettering" Cordier was to choose two other engravers (Pastoureau 1984, 231). In 1689 Nicolas de Fer employed the letter engraver Jean Baptiste Liébaux to work for him for four days a week during 1690, the year de Fer was named "géographe du Grand Dauphin," poised for the success of his multivolume *Les Forces de l'Europe*. After de Fer's death in 1720, many plates for his maps were found at the homes of various engravers (Préaud et al. 1987, 121; Pastoureau 1984, 169). Similar contracts for engraving work are found in the Netherlands, where Pieter Mortier engaged the engraver Jacobus de Latere to work exclusively for him six days a week, ten hours a day, in return for two guilders per day and a workshop with "fire and light, as well as aqua fortis and wax" (Van Egmond 2009, 224). In the Homann firm, engravers were offered full-time employment, accounting for that publisher's house style. Similarly, the Dépôt de la Marine in Paris maintained a staff of engravers for the production of marine charts, as did the Dépôt de la Guerre. Where engravers did not live on the premises, proximity of address aided the movement of plates in the cycle of map publisher to engraver to printer and back again. In Paris, engravers primarily lived on the Left Bank, close to the copperplate printers. In London, engravers clustered near centers of the book and print trade—St. Paul's, the Royal Exchange, and Holborn—and near the principal retail streets—the Strand and Fleet Street (Worms and Baynton-Williams 2011, xi). The engravers of Des Barres's *The Atlantic Neptune* lived around Soho or Russell Square, near to Des Barres on Denmark Street, making it easy for him to supervise their work (Hornsby 2011, 173–75). Giovanni Antonio Rizzi Zannoni formed a veritable school of engraving for work on the *Atlante marittimo* and *Atlante geografico del Regno di Napoli*, as part of the Officina Topographica in Naples.

The dearth of detailed studies on the engravers themselves, their biographies, social milieus, and training, is coupled with similar scant attention to the costs of engraving and its effect on the production of printed maps. Scholars have begun to gather the archival sources that provide a fuller picture of the constraints imposed by the high labor cost of engraving (Van Egmond 2009; Pedley 2005; Heinz 1997, 2002; Dörflinger 1983). D'Anville's proposal for a general atlas in the 1740s estimated the costs of engraving and printing a folio map with an initial print run of 500 to be 75 percent for engraving, and 25 percent for ink, paper, printing, and coloring (Pedley 2018). Costs varied from region to region, depending on the demand for engraving skills and the relative costs of other aspects of production (imported paper, for example, could add significantly to the costs). Yet engraving consistently dominated the largest percentage of the total costs (Van Egmond 2009, 225). Printing fewer maps only saved on paper and presswork; the cost of engraving was fixed no matter how many maps were printed. In comparison to the price asked for a printed map, the engraving of the plate could represent as much as five to seven hundred times the price, making large sales the only route to profitability. The value for the map editor and mapseller came from the possession of the engraved plates, which represented a capital investment and were treated as assets by law in bankruptcy or in estate inventories and as intellectual property in copyright disputes.

The other factor affecting map production and the ultimate success of commercial cartographic projects was the time required for engraving (Carhart 2004). Cassini III reckoned that an engraver could complete only two sheets of the *Carte de France* per year (Pelletier 2013, 150). Records of some of the projects to map the provinces based on the survey work of the *Carte de France* detail the length of time required for the preparation of the designs and the engraving of the plates, as well as the costs. Philippe Buache contracted in 1748 with the diocese of Narbonne to create a map in four sheets, which appeared sixteen years later in 1764. One of Cassini's engravers, the *ingénieur géographe* Joseph-Dominique Seguin, prepared and engraved the *Carte particulière du duché de Bourgogne* in fifteen plates in three years (1761–64). Yet the subsequent project, the *Carte de la Guyenne*, begun in 1761, required fourteen years to complete the surveys and another eleven years to engrave the first four of several plates (Pelletier 2013, 205–36). The seasons could also affect the work: one of the engravers wrote to the *intendant* of Guyenne that summer was a good period for etching, saving the burin work for the winter (Dainville 1956, 230n56). Delahaye supervised the engraving and printing of six of the twelve densely topographical sheets of the *Carte topographique des environs de Versailles* (also known as the *Carte des chasses du roi*) over four years (1780–84); the entire map was not completed until early in the nineteenth century, over twenty years later. Time and money, then as now, were the factors that could make or break the successful production of printed maps.

TIM CLAYTON

SEE ALSO: Calcografia Camerale (Copperplate Printing Administration; Rome); Color and Cartography; Household Artifacts, Maps on; Iconography, Ornamentation, and Cartography; Map Trade; Officina Topografica (Topographical Mapping Office; Naples); Privilege and Copyright

BIBLIOGRAPHY

Anonymous. 1767. "Gravure en lettres, en géographie et en musique." In *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, ed. Denis Diderot and Jean Le Rond d'Alembert, 17 text vols. and 11 plate vols., plate vol. 5 (fourth installment), *Recueil de planches sur les sciences, les arts libéraux et les arts méchaniques avec leurs explication*, commentary on pls. I–II (pp. 1–3). Paris: Briasson, David, Le Breton, Durand.

Bacler d'Albe, Louis Albert Guislain. 1803. "Gravure: Notice sur la gravure topographique et géographique." *Mémorial Topographique et Militaire, rédigé au Dépôt Général de la Guerre*, no. 5:65–91.

Balston, Thomas. 1957. *James Whatman, Father & Son*. London: Methuen.

Carhart, George S. 2004. "How Long Did It Take to Engrave an Early Modern Map? A Consideration of Craft Practice." *Imago Mundi* 56:194–97.

Casselle, Pierre. 1976. "Le commerce des estampes à Paris dans la seconde moitié du 18ème siècle." Thèse, Ecole nationale des chartes, Paris.

Clayton, Tim. 1997. *The English Print, 1688–1802*. New Haven: Yale University Press.

Cook, Andrew S. 1981. "Alexander Dalrymple's *A Collection of Plans of Ports in the East Indies* (1774–1775): A Preliminary Examination." *Imago Mundi* 33:46–64.

Dainville, François de. 1956. *Cartes anciennes de l'Église de France: Historique, répertoire, guide d'usage*. Paris: J. Vrin.

Diderot, Denis, and Jean Le Rond d'Alembert, eds. 1751–72. *Encyclopédie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*. 17 text vols. and 11 plate vols. Paris: Briasson, David, Le Breton, Durand.

Diefenbacher, Michael, Markus Heinz, and Ruth Bach-Damaskinos, eds. 2002. *"Auserlesene und allerneueste Landkarten": Der Verlag Homann in Nürnberg, 1702–1848*. Nuremberg: W. Tümmels.

Dörflinger, Johannes. 1983. "Time and Cost of Copperplate Engraving—Illustrated by Early Nineteenth Century Maps from the Viennese Firm Artaria & Co." *Imago Mundi* 35:58–66.

Egmond, Marco van. 2009. *Covens & Mortier: A Map Publishing House in Amsterdam, 1685–1866*. Houten: HES & De Graaf.

Encyclopædia Britannica; or, A Dictionary of Arts, Sciences, and Miscellaneous Literature. 1797. 3d ed. 18 vols. Edinburgh: Printed for A. Bell and C. Macfarquhar.

The English Encyclopædia: Being a Collection of Treatises, and a Dictionary of Terms, Illustrative of the Arts and Sciences. 1802. 10 vols. London: Printed for G. Kearsley.

Griffiths, Antony. 1980. *Prints and Printmaking: An Introduction to the History and Techniques*. London: British Museum Publications.

Grivel, Marianne. 1986. *Le commerce de l'estampe à Paris au XVII^e siècle*. Geneva: Droz.

Hannas, Linda. 1972. *The English Jigsaw Puzzle, 1760–1890*. London: Wayland Publishers.

Heinz, Markus. 1993. "A Research Paper on the Copper-Plates of the Maps of J. B. Homann's First World Atlas (1707) and a Method for Identifying Different Copper-Plates of Identical-Looking Maps." *Imago Mundi* 45:45–58.

———. 1997. "A Programme for Map Publishing: The Homann Firm in the Eighteenth Century." *Imago Mundi* 49:104–15.

Hornsby, Stephen J. 2011. *Surveyors of Empire: Samuel Holland, J. F. W. Des Barres, and the Making of "The Atlantic Neptune."* Montreal and Kingston: McGill-Queen's University Press.

Pacha, Béatrice, and Ludovic Miran. 1996. *Cartes et plans imprimés de 1564 à 1815: Collections des bibliothèques municipales de la région Centre*. Paris: Bibliothèque Nationale de France/Agence Interprofessionelle Régionale pour le Livre et les Médias.

Pastoureau, Mireille. 1984. *Les atlas français, XVI^e–XVII^e siècles: Répertoire bibliographique et étude*. Paris: Bibliothèque Nationale, Département des Cartes et Plans.

Pedley, Mary Sponberg. 1984. "New Light on an Old Atlas: Documents Concerning the Publication of the *Atlas Universel* (1757)." *Imago Mundi* 36:48–63.

———. 2005. *The Commerce of Cartography: Making and Marketing Maps in Eighteenth-Century France and England*. Chicago: University of Chicago Press.

———. 2018. "Convaincre ses mécènes: Un plan d'affaire prévisionnel pour faire commerce de cartes." In *Une carrière de géographe au siècle des Lumières: Jean-Baptiste d'Anville*, ed. Lucile Haguet and Catherine Hofmann, 85–109. Oxford: Voltaire Foundation/Bibliothèque Nationale de France.

Pelletier, Monique. 2013. *Les cartes des Cassini: La science au service de l'État et des provinces*. New ed. Paris: Éditions du CTHS.

Préaud, Maxime, et al. 1987. *Dictionnaire des éditeurs d'estampes à Paris sous l'Ancien Régime*. Paris. Promodis.

Salmon, William. 1701. *Polygraphice: Or, The Arts of Drawing, Engraving, Etching, Limning, Painting, Vernishing, Japaning, Gilding, &c*. 8th ed. enl., 2 vols. London: A. and J. Churchill. and J. Nicholson.

Stijnman, Ad. 2012. *Engraving and Etching, 1400–2000: A History of the Development of Manual Intaglio Printmaking Processes*. London: Archetype Publications in association with HES & De Graaf.

Verner, Coolie. 1975. "Copperplate Printing." In *Five Centuries of Map Printing*, ed. David Woodward, 51–75. Chicago: University of Chicago Press.

Watelet, Claude-Henri. 1757. "Gravure." In *Encyclopedie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, ed. Denis Diderot and Jean Le Rond d'Alembert, 17 text vols. and 11 plate vols., 7:877–90. Paris: Briasson, David, Le Breton, Duran.

Woodward, David. 2007. "Techniques of Map Engraving, Printing, and Coloring in the European Renaissance." In *HC* 3:591–610.

Worms, Laurence, and Ashley Baynton-Williams. 2011. *British Map Engravers: A Dictionary of Engravers, Lithographers and Their Principal Employers to 1850*. London: Rare Book Society.

Color Printing. Color printing is the reproduction of maps with two or more printing colors. In the period 1650 to 1800, color was generally added by hand to maps after printing was complete. Publishing houses developed the art of hand coloring as a specialty, as much for its decorative quality as for transmitting information, and established certain conventions for this common practice (Woodward 2007, 602–6).

Prior to 1650, attempts were made to print in color from woodcut, the relief printing technique. After 1650, the intaglio method from copperplates dominated map printing. Abraham Bosse described a technique of printing in color from two plates (1645, 72–73) for which he and Charles de La Fontaine had received a patent in 1637 (Stijnman 2012, 358). A first copperplate was prepared in the usual way; a second copperplate identical in size to the first was etched or engraved with only those areas meant to be colored. The second plate was printed onto thick paper, after which the designated areas were colored by hand and allowed to dry. Then the first plate, engraved with the full scene or map, was printed onto the already colored paper. A variation of this two-plate method involved the preparation of each plate by incising only those parts of a map to be printed in a single color. After a careful registry and superimposition of each plate on the paper, the paper was printed twice, once for each color.

Later in the seventeenth century in the Netherlands, Johannes Teyler developed a technique of coloring the copperplate with a rolled rag dolly (*poupée*) dipped in different colored inks, for which he received a patent in 1688. The Amsterdam map publishers Gerard Valk and Petrus I Schenk acquired a patent for printing in colors in this way in 1695 and published volumes of views and perspectives using the *à la poupée* method (Stijnman 2012, 348–49). Maps printed in a single color from one plate also appeared. A copy of Schenk's *Theatrum Bellicum* from 1712 (Chicago, Newberry Library, Case F 4052.792), has 162 plates entirely printed in sepia.

Map publishers in England and France experimented with using two plates, one for each of two colors, with registration marks on each plate to line up the paper. Philippe Buache used the technique to compare coastlines printed in red and black for his map of the south coast of Newfoundland (1741). Jacques-Nicolas Bellin produced several charts for the Dépôt de la Marine on which rhumb lines were printed in red or green from a separate plate (Pedley 2005, 46, pls. 2, 3), and on which the separate plate marks and registration points are plainly visible. Roch-Joseph Julien printed the topography of hills and forests in sepia and place-names and roads in black on the *Tableau topographique qui comprend la partie septentrionale du landgraviat de Hesse Cassel et de la principauté de Waldeck* (1762) (see fig. 463). Map publishers Jean Lattré and Louis-Charles Desnos used the same two-plate technique to print maps in sepia and black showing the stages of the solar eclipse visible across Europe in 1764 (see fig. 950). The engraver Guillaume Dheulland used two plates for stars (black) and constellations (red) for Pierre-Charles Le Monnier's *Nouveau zodiaque* (1755) (see fig. 156). Thomas Jefferys's map of the Gulf of Mexico published in *A General Topography of North America and the West Indies* (1768) employed a red plate and a black plate. Maps in the *Atlas Suisse* by Johann Rudolf Meyer and Johann Heinrich Weiss (sixteen sheets, ca. 1:120,000, 1796–1802) show a second printed color (blue) for glaciers (see fig. 861).

Another technique of color printing built upon the method developed by J. C. Le Blon, a native of Frankfort, who worked as a painter in Amsterdam before moving to London. His method of overprinting primary colors was published in London as *Coloritto; or the Harmony of Colouring in Painting = L'harmonie du coloris dans la peinture* (1725) with English and French on facing pages. Le Blon's methods were reprinted with considerable additional information (*L'art d'imprimer les tableaux*, 1756) and summarized in the *Encyclopédie* by Antoine Gauthier de Montdorge (1757). They involved printing from four plates: a plate for each of the primary colors (blue, yellow, and red) and a plate printed in black as needed. All plates were prepared as for mezzotint or *manière noire*, which achieved an effect of pastel or chalk drawing, allowing better shading and depth, and Le Blon's student Jacques-Fabien Gautier-Dagoty employed the technique for a series of thematic maps (fig. 724). This method was further refined by the engraver Louis-Marin Bonnet, who employed the tonal methods of mezzotint and stipple on separately

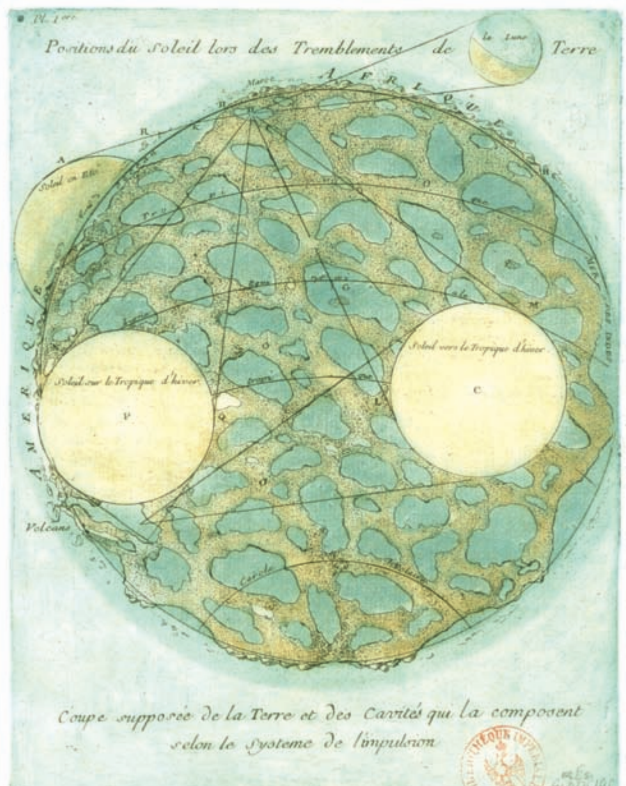


FIG. 724. JACQUES-FABIEN GAUTIER-DAGOTY, *POSITIONS DU SOLEIL LORS DES TREMBLEMENTS DE TERRE*, 1756. Gautier-Dagoty employed Le Blon's method of three-color printing (red, blue, and yellow) and the use of a fourth plate printed in black. From Gautier-Dagoty's *Cartes en couleur des lieux sujets aux tremblements de terre dans toutes les parties du monde selon le sistème de l'impulsion solaire* (Paris: Chez l'Auteur, 1756), pl. 1.
Size of the original: ca. 26 × 20 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge DD 5195 [RÉS]).


Neu Topograph. Karte
Von der ūmliegend-Gegend von
WIEN.
2.te Verbäßerte Auflag
Da von allen Hauptstædten Karten Gestochen seind, so hat der Verfaßer in einer neū art mit farben zu stechen ein Versuch gemacht, es wird zu der Reisse ersichtlicher sein und ist noch in Keinen Land in vorschein Gekom̄en
Wien den 25 Novemb: 1786
SAUGARTEN
Burckersdorf
Hadersdorf
Weidling au
Mariabrun
Hacking
Hiedldorf
Mauer
Lainz
Speising
Hezendorf
Baumgarten
Mariahielf
Schönbrun
Meidling
Penzing
Ottakring
Dornbach
Hernals
Weinhaus
Währing
Döbling
Heiligenstadt
Kahlenberg
Leopoldsberg
Kloster Neuburg
Weidling
Nußdorf
Lang Enzersdorf
Strebersdorf
Jedlersee
Jedlersdorf
Stammersdorf
Lusthaus
Stadlau
Bisamberg
Sud
Nord

inked plates to produce the colored maps in Charles Louis François Fossé's *Idées d'un militaire* (1783) (Pedley 2005, 47, pl. 1). In Vienna between 1782 and 1787 maps of the surroundings of Vienna intended for use by the general public were printed in color (fig. 725) (Mokre 1997, 99). These maps employed at least three copperplates: inked in black for lettering, relief presentation, rivers, and minor roads; red for settlements, main roads, and fortifications; and green for land use. Additional colors such as blue for the Danube or brown for vegetation were added by hand.

Because maps printed in color may be easily mistaken for manuscript maps or for printed maps with hand color added, many map catalogs often do not record color printing if the cataloger has not paid sufficient attention to the fine details of registration marks or multiple plate marks on the paper; thus, the rarity of color printed maps may be exaggerated. Yet the time-consuming processes of registration and careful superimposition of the plates as well as the resulting high cost of production meant that attempts to print color from engraved plates were sporadic. Even so, the understanding of the three primary colors and black and the imposition of one color over another informed the further development of color printing in the nineteenth century.

INGRID KRETSCHMER

SEE ALSO: Color and Cartography; Map Trade

BIBLIOGRAPHY

Bosse, Abraham. 1645. *Traicté des manieres de graver en taille dovce svr l'airin: Par le moyen des eaux fortes, & des vernix durs & mols*. Paris: Chez ledit Bosse.

Gautier de Montdorge, Antoine. 1757. "Gravure en couleur, à l'imitation de la peinture." In *Encyclopedie, ou, Dictionnaire raisonné des sciences, des arts et des métiers*, ed. Denis Diderot and Jean Le Rond d'Alembert, 17 text vols. and 11 plate vols., 7:899–902. Paris: Briasson, David, Le Breton, and Duran.

Mokre, Jan. 1997. "The Environs Map: Vienna and Its Surroundings, c. 1600–c. 1850." *Imago Mundi* 49:90–103.

Pedley, Mary Sponberg. 2005. *The Commerce of Cartography: Making and Marketing Maps in Eighteenth-Century France and England*. Chicago: University of Chicago Press.

Stijnman, Ad. 2012. *Engraving and Etching, 1400–2000: A History of the Development of Manual Intaglio Printmaking Processes*. London: Archetype Publications in association with HES & De Graaf.

Woodward, David. 2007. "Techniques of Map Engraving, Printing, and Coloring in the European Renaissance." In *HC* 3:591–610.

Typographic Printing. Typography (*Typometrie*, *Landkartensatz*) provided a process for the reproduction of maps, today obsolete, by using specially made movable type for rivers, settlements, roads, and land use. Such "geographical" type fonts were combined with regular letter type (for geographical names) within one form for relief printing. The cooperation between a printer and a typefounder was paramount, since a map could require as many as three hundred sorts of type (Hoffmann-Feer 1969, 6).

Johann Gottlob Immanuel Breitkopf, a printer and typefounder in Leipzig, made initial attempts from 1756 to use typography for reproducing music. The geographer, amateur mapmaker, and publisher August Gottlieb Preuschen experimented with movable types for composing maps in Karlsruhe as early as 1773. He joined the enterprising Basel typefounder Wilhelm Haas, who created special types, to publish the typographical map of the canton of Basel in 1776. Shortly thereafter, in autumn 1777 (and not 1776 as the cartouche states), Breitkopf published *Gegend um Leipzig* (fig. 726) and a separate publication that attacked Haas's work, citing the difference between "composing (or setting up)" and "fudging" typographic maps. Breitkopf emphasized the immense technical problems facing the map compositor in laying out geographical fonts: the need for lines to bend, cross, break, and move in various directions in order for a map not to be severely schematized (Harris 1975, 115–16; McMurtrie 1925, 8–10).

Nevertheless, in the second half of the eighteenth century, map printing with movable types was regarded as a technique cheaper than copperplate printing and more suitable for producing large numbers of copies joined with text. In Basel, Haas's son, also named Wilhelm, continued his father's work until 1803, when the last of his "typometric maps" was published (Hoffmann-Feer 1969, 47; Wanner 1979, VI–VIII). In other European countries, such as France, Germany, Austria, and Britain, map printing with movable types was occasionally employed through the 1830s (McMurtrie 1925, 11–12).

"Typography" was broadly discussed in contemporary literature, like the work of Anton Friedrich Büsching. The examples from Basel—such as the large map of Sicily published by Haas using Preuschen's techniques (1777)—demonstrate efforts to emulate the style of copperplate engraving. Breitkopf endeavored to improve map printing by typographic means. Because movable types resulted in schematized map images, typographic reproduction was used primarily for maps with simple

(*facing page*)
FIG. 725. DETAIL FROM *NEU TOPOGRAPH.KARTE VON DER UMLIEGEND-GEGEND VON WIEN*, 1786, BY "MAUER" (JOSEPH DANIEL VON HUBER?). The map of Vienna was printed from three copperplates—black, red, and green—with the blue added by hand after printing. Size of the entire original: 40 × 51 cm; size of detail: ca. 33.0 × 24.5 cm. Image courtesy of the Kartensammlung, Österreichische Nationalbibliothek, Vienna (FKB C.18.6 Kar).

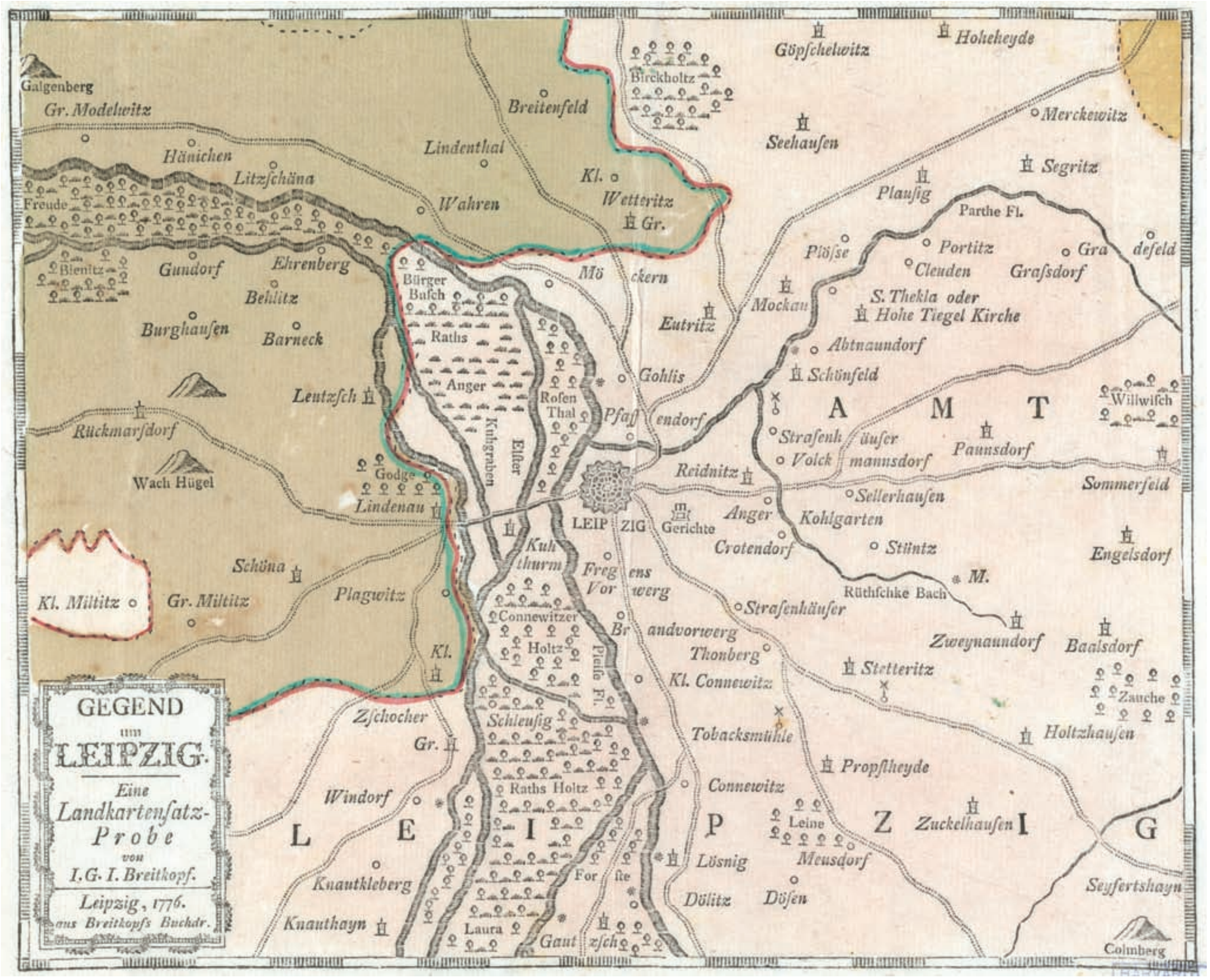


fig. 726. JOHANN GOTTLOB IMMANUEL BREITKOPF, *GEGEND UM LEIPZIG: EINE LANDKARTENSATZ-PROBE*, 1777. Breitkopf's hand-colored map of the area around Leipzig was one of the early experiments in typographic map reproduction, using an array of different types set into a single block for all the geographical features.

Size of the original: 19 × 23 cm. By permission of Pusey Map Library, Harvard University, Cambridge (MAP-LC G6299. L3A1 1776 .B7).

topographic elements, like post-route maps, but it did not find broad application. Eduard Hoffmann-Feer (1969) illustrated only twenty-five examples of maps, such as a 1798 map of Basle (fig. 727).

After the invention of lithography, map printing by movable types was limited to special cases. Some maps and atlases printed by this technique were published as late as the 1830s and 1840s, for example, the *General-Postkarte des Kaiserthumes Oesterreich und der nächsten Grenzländer* (four sheets, ca. 1:1,500,000, 1837) and *Austria: Erster typometrischer Atlas* (twenty-five sheets, 1841), both by Franz Raffelsberger and printed in color. The printing house of Firmin Didot applied for a patent in 1823 for a method that combined typographic reproduction with multiplate color printing, as described in detail by Harris (1975, 116–29).

INGRID KRETSCHMER

SEE ALSO: Map Trade: German States

BIBLIOGRAPHY

Harris, Elizabeth M. 1975. "Miscellaneous Map Printing Processes in the Nineteenth Century." In *Five Centuries of Map Printing*, ed. David Woodward, 113–36. Chicago: University of Chicago Press.

Hoffmann-Feer, Eduard. 1969. *Die Typographie im Dienste der Landkarte*. Basel: Helbing & Lichtenhahn.

Horn, Werner. 1948. "Die Typometrie, ein vergessenes Verfahren

FIG. 727. DETAIL FROM THE *CARTE TYPOMÉTRIQUE DU CANTON DE BASLE*, 1798. The legend shows some of the different geographic fonts used to create the map. A further note on the map states that its first printing required fourteen days of work. Published by Wilhelm Haas, Son. Dedicated to one of the Cassinis, the map is dated using the French Revolutionary calendar: 7 Vendémiaire de l'an 7, i.e., 28 September 1798.
Size of the entire original: 20 × 19 cm; size of detail: 14 × 11 cm. Image courtesy of the Universität Bern, Zentralbibliothek, Sammlung Ryhiner (Ryh 3212:14).

der Kartenherstellung." *Petermanns Geographische Mitteilungen* 92:90–97.

McMurtrie, Douglas C. 1925. *Printing Geographic Maps with Movable Types*. New York: Privately Printed.

Preuschen, August Gottlieb. 1778. *Grundriß der Typometrischen Geschichte*. Basel: Schweighauser.

Tschudin, Peter F. 2007. "Typometrie: Eine erfolgreiche Technik zur Herstellung aktueller Karten." *Cartographica Helvetica* 36:27–34.

Wanner, Gustaf Adolf. 1979. "400 Jahre Haas'sche Schriftgießerei." *Gutenberg-Jahrbuch*, I–XVI.

Revolution, American. The American Revolutionary War (1775–83) was extraordinary in that it was a civil war with global impact, involving the British, the Americans, and the French as protagonists. During the first three years of the war, the far better-equipped and trained British Army not only failed to adapt to the American light infantry tactics of *petit guerre*, but also squandered promising conventional opportunities to deliver a fatal blow. In 1778, the entry of French forces into the war placed the British on the defensive. Eventually, the main British force under Lord Charles Cornwallis found itself entrapped at Yorktown, Virginia, by a combined Franco-American army. Cornwallis surrendered on 19 October 1781. With that, the conflict was effectively over. Throughout this period, the volume, diversity, innovation, and quality of the mapmaking exceeded that of any previous European conflict.

The British authorities provided the opening cartographic salvo when they permitted over two hundred official manuscripts drawn during the colonial period to be printed and disseminated by enterprising publishers. The British Board of Trade and the Admiralty provided official support to J. F. W. Des Barres to publish *The Atlantic Neptune*, a sea atlas of the colonial coastlines (1774–82) for the use of the Royal Navy. William Faden gradually acquired a collection of recently made manuscript maps from America, and these were largely the basis for the numerous maps and atlases of key engagements he published, such as *The North American Atlas* (1777) and *Atlas of Battles of the American Revolution* (ca. 1784–87). In addition, Robert Sayer and John Bennett in 1755 issued *The American Atlas*, containing many important general maps originally published by Thomas Jefferys, such as Henry Mouzon's *An Accurate Map of North and South Carolina* (1775), and also *The American Military Pocket Atlas* or so-called Holster Atlas (1776) intended for use by mounted troops. Publishers in Paris produced derivatives of important British maps, such as Georges-Louis Le Rouge's *Atlas Ameriquain septentrional* (1778). Thus, cartographic information was shared early in the war not only with the general public in Britain, but also among the opposing sides involved in the war.

The commanders of all three principal armies showed an exceptional interest in cartography, each forming units expressly mandated to conduct reconnaissance and mapping activities. Over one thousand manuscript maps survive as testament to the extraordinary skill of the various army engineers and the diverse cartographic needs of their commanders.

The British employed by far the largest number of mapmakers, created the majority of maps, and had access to the best archival sources. The most important British mapping units were the Corps of Engineers, led until 1778 by John Montresor, and the Guides & Pioneers, a reconnaissance and espionage unit led by Samuel Holland.

The Americans engaged far fewer skilled engineers, although they benefited from the efforts of the seasoned veteran Bernard Romans and recruited the French officer Louis Lebègue Duportail to lead the army's newly formed engineering corps. Washington was also well served by his technically proficient official geographers, Robert Erskine and Simeon De Witt.

The French forces included the extremely disciplined and professional *ingénieurs géographes*, including the brothers Louis-Alexandre Berthier and Charles-Louis Berthier, Jean-Nicolas Desandroüins, and Michel Capitaine du Chesnoy. Their prominence reflects the fact that from 1778 the Americans relied heavily on the great skill of French cartographers in an effort to match that of the opposition.

J. B. Harley (1978, 4–5) defined three broad categories into which the maps of the American Revolutionary War could be classified predicated on a map's intended purpose, the nationality of the mapmaker, and whether the map was actually employed as intended. The three categories were: (1) the cartography of military movement, (2) battle and theater maps, and (3) fortification and siege cartography.

A definitive operational aspect of the American Revolution is that armies were compelled to travel exceptionally great distances during campaigns, inspiring the cartography of military movement. An important consequence of this imperative was reconnaissance mapping done in anticipation of an operation, which usually involved making sketches, *brouillons*, or *figures à vue*, depicting only critical rather than seminal details of a tactical imperative. An early, rudimentary example of reconnaissance mapping occurred in the early days of 1775 when British general Thomas Gage deployed two untrained volunteers, Henry de Berniere and John Brown, to map the countryside outside Boston. At the other technical extreme was the map of the French *ingénieurs*, "Reconnoissance des ouvrages du nord de l'Isle de Newyork" (1781), done with careful measurements to formal standards.

The most celebrated cartographic examples of military movement include the itinerary maps made by the engineers serving the French commander, Jean-Baptiste Donatien de Vimeur, comte de Rochambeau, showing their carefully choreographed movement along routes between nightly encampments on their march from Providence to Yorktown in 1781 (fig. 728). Another style of route map is Benjamin Lodge's finely executed manuscript outline of General John Sullivan's American expedition to the Finger Lakes of New York (1779). Montresor's manuscript of General William Tryon's raid on Danbury, Connecticut (1777), forming an elliptical silhouette, captures the tactical essence of the venture. Drafted after the fact, their purpose was to act as the maps of record depicting the route and sequence by which the armies had moved during the campaigns.

FIG. 728. DETAIL FROM AN ITINERARY OF THE FRENCH MARCH TO YORKTOWN, CA. 1782, BY FRENCH *INGÉNIEURS GÉOGRAPHES*. The colored manuscript "Carte générale des camps et marches et des troupes françaises sous les orders du Lieutenant General Comte de Rochambeau" depicts the route of Rochambeau's army from Providence to Yorktown, 10 June to 30 September 1781, indicating the encampments with red squares and red lettering. Camps on the return march in 1782 are shown as green rectangles with black lettering.
Size of the entire original: 44 × 169 cm; size of detail: ca. 21 × 11 cm. Image courtesy of the Geography and Map Division, Library of Congress, Washington, D.C. (G3716.S3 1782 .C6 Vault: Roch 65).

Owing to the challenges of formal surveying in active military theaters, very few new general topographical maps were produced during the war. Given this, John Hills's "A Collection of Plans &c. &c. &c. in the Province of New Jersey," made for General Henry Clinton, is especially impressive (Guthorn 1972, 24–27). This atlas was made shortly after the harrowing British retreat across that province in 1778, and it displays Hills's characteristic synergy of new observations combined with a sophisticated use of representational techniques. Its twenty maps generally depict only information tactically critical to an army on the move, such as roads, rivers, and towns. Like most itinerary maps, they served as a record of past operations, but in this case, as with a reconnaissance map, they could act as a potential aid for any future sorties in that province.

Campaign sequence mapping illustrates the various battle positions of forces as they advanced overland, and it is aptly represented by Faden in his *A Plan of Part of the Provinces of Pensylvania* (1784). Based on Hills's manuscripts, it depicts the entire British Philadelphia campaign through a sequence of battle lines that seem to move across the landscape with an almost rhythmic quality. *A Plan of New York Island* (1776), also published by Faden, illustrated the phases of the massive British invasion of New York. In the *Plan of the Operations . . . in New Jersey* (1777), he depicted the less choreographed interaction of British and American forces following Washington's crossing of the Delaware River (Nebenzahl and Higginbotham 1974, 86–87, 92–93).

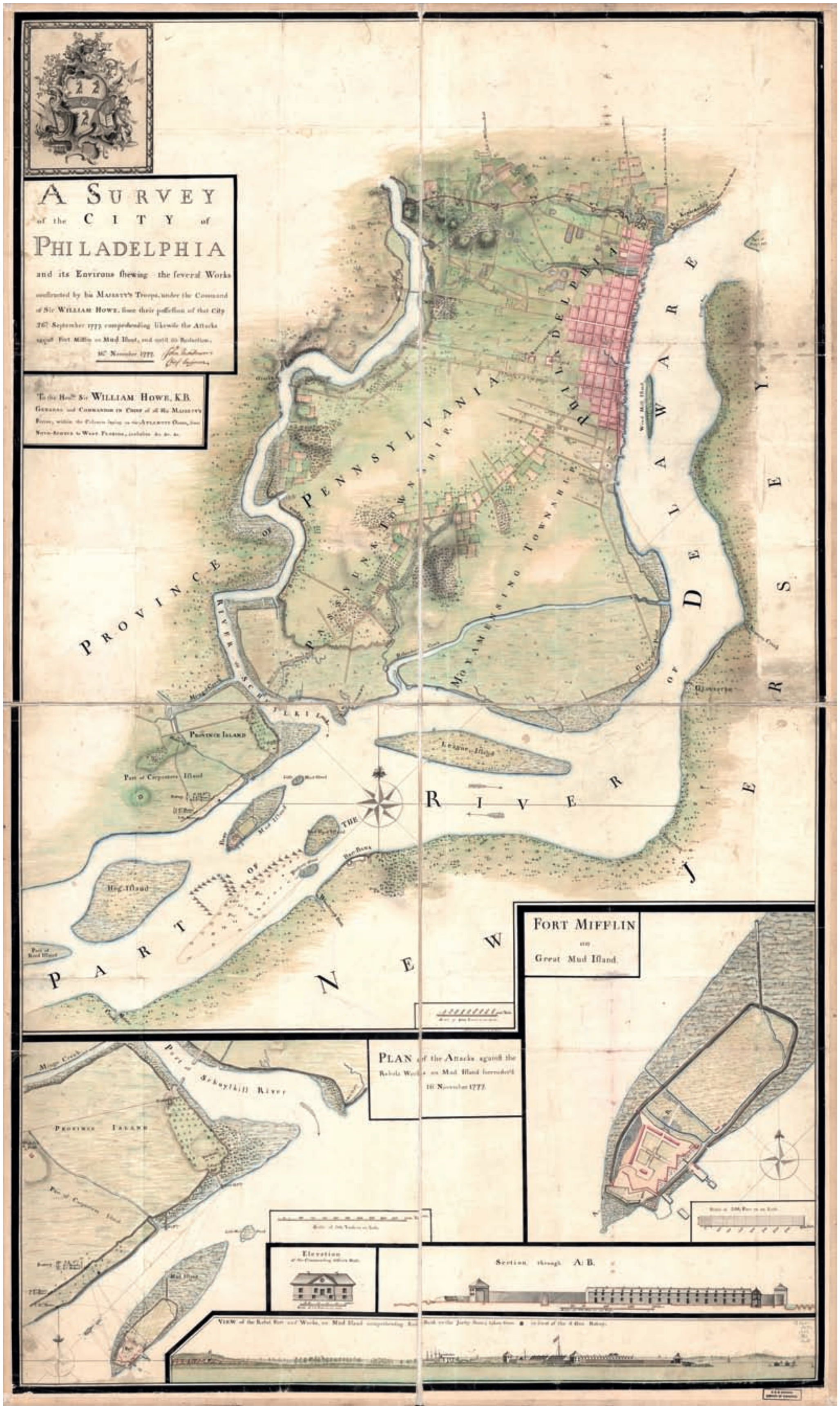
Battles represented the apex of military activity, and their cartographic depiction was already a well-established genre, placing familiar conventions and symbols onto a large-scale topographical rendering. The purpose of these maps was to serve both as a source of information for the curious public and to commemorate important events. One of the most innovative of these plans is Thomas Hyde Page's *A Plan of the Action at Bunkers Hill* (1775–78), printed by Faden, which uses an overlay to depict two different stages of action (Nebenzahl and Higginbotham 1974, 46–47). Of the dozens of other more conventional battle maps, two of the finest are Montresor's manuscripts depicting the 1777 battles of Brandywine and Germantown, subsequently printed by Faden. The most celebrated American commemorative battle map was printed in Philadelphia by Sebastian Bauman, in 1782, at the behest of Washington; it victoriously illustrates the Siege of Yorktown.

Mapping relating to the theater of conflict did not necessarily depict military action, but rather attempted to showcase the arena of battle. While sometimes made to commemorate past endeavors or to inform the public, when the map's subject was within an active military theater, it could also serve as an operational aid. Among the more evocative of this type are two commemorative maps: John Montresor and Pierre Nicole's map of Philadelphia (1777), presented to Sir William Howe (fig. 729), and George Taylor and Andrew Skinner's "A Map of New York" (1781), presented to George III, both of which are highly accomplished topographical renderings.

The mapping of fortifications and their active besiegement closely followed orthodox European military conventions as taught in military academies and prescribed in textbooks. Some of the finest defense plans included the several maps Montresor made of Boston for General Gage depicting both British and American fortifications on the eve of the Battle of Bunker Hill. The British engineer Abraham D'Aubant's "Project for the Defence of the Town of Newport" (1777) and the Berthier brothers' plan of Rhode Island (1780) (fig. 730) provide a fascinating comparison as Rhode Island was alternatively a base for both the British and the French. Over thirty printed maps were also made depicting the Siege of Yorktown, of which Des Barres's engraving of Edward Fage's manuscript and Le Rouge's *Plan de l'armée de Cornwallis attaquée et faitte prisoniere dans York Town* (1781), based on the Berthier brothers' plans, are among the most detailed.

At the conclusion of the American Revolution, maps played a starring role at the preliminary peace negotiations at Paris in the summer of 1782. Several of the delegates, representing all four parties, explicitly recorded that copies of John Mitchell's *A Map of the British and French Dominions in North America* (1755) were accorded the authority of being the primary cartographic reference during the deliberations. Specifically, the Mitchell map was employed to express visually the extent of their respective optimal claims. It was also used to demarcate the approximate boundaries of the United States as finally agreed. The most famous surviving example is the so-called "red-line map" used by Richard Oswald, the chief British negotiator (British Library, London, Cartographic Items Maps K.Top.118.49.b). Critically, the official boundary resolution contained in the Treaty of Paris of 3 September 1783 had no maps or diagrams appended to it, leaving the legal basis for the boundary to be expressed textually. While serious errors and ambiguities on the map had misinformed the text of the treaty, leading to border disputes that were not resolved until the Webster-Ashburton treaty of 1842, the mapping of the American Revolution redefined the manner in which a conflict should be recorded or captured by maps (Edney 1997, esp. sec. IV).

ALEXANDER JAMES COOK JOHNSON


A SURVEY
of the CITY of
PHILADELPHIA
and its Environs shewing the several Works
To the Hon.ble Sir WILLIAM HOWE, K.B.
PROVINCE OF PENNSYLVANIA
PHILADELPHIA
RIVER DELAWARE
PART OF NEW JERSEY
THE RIVER
Province Island
Mud Island
Hog Island
FORT MIFFLIN
on
Great Mud Island.
PLAN of the Attacks against the
Rebels Works on Mud Island surrender'd
16 November 1777.
Province Island
Schuylkill River
Elevation
Section through A B.

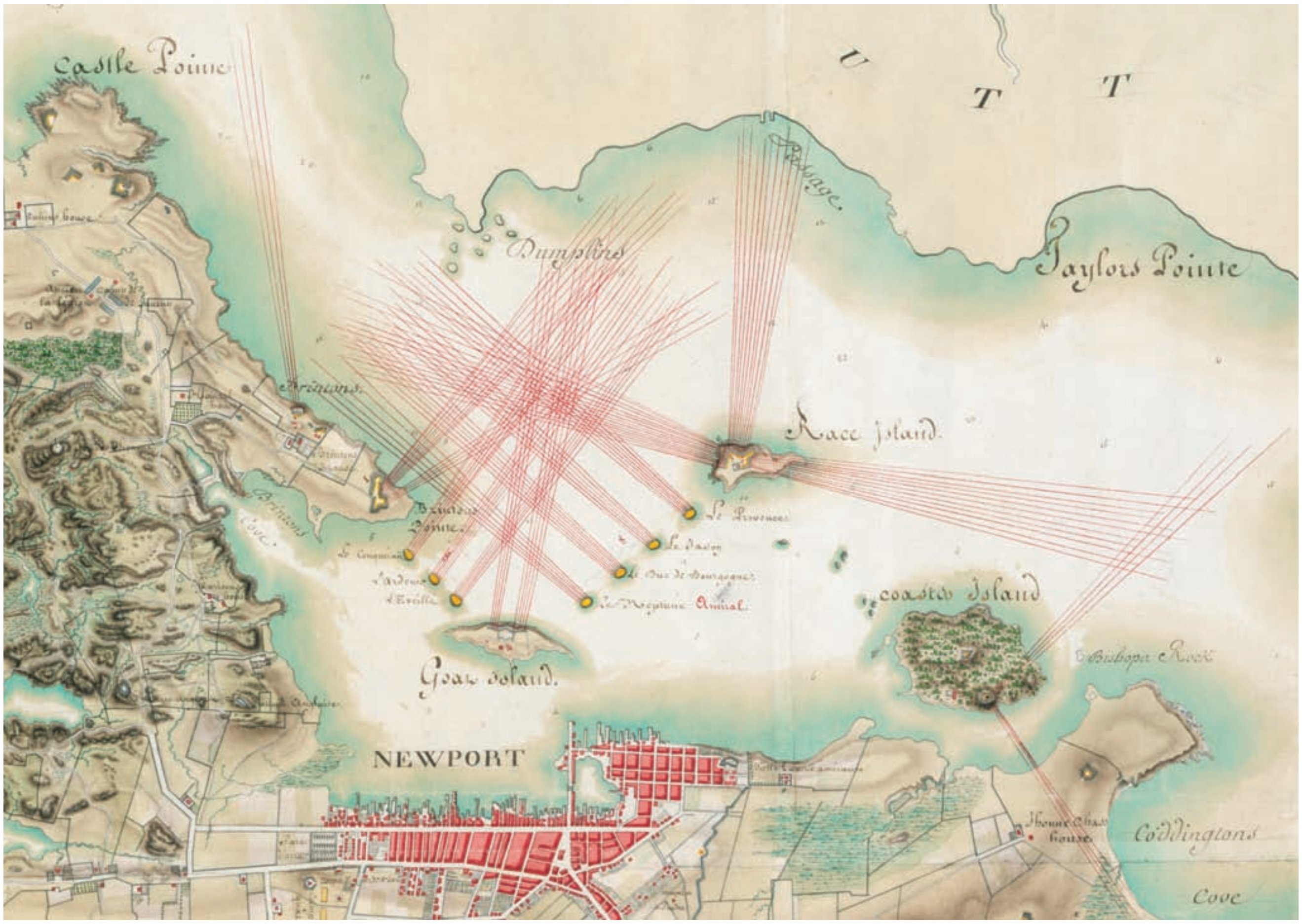


FIG. 730. DETAIL FROM A FRENCH DEFENSE PLAN FOR NEWPORT, RHODE ISLAND, 1780. Louis-Alexandre Berthier and Charles-Louis Berthier, "Plan de Rhode-Island," colored manuscript. A well-executed defense plan including the harbor of Newport, which became the French headquarters in 1780. Trajectory lines emanate from artillery positions, anticipating their range in case of a seaborne invasion.
Size of the entire original: 120.7 × 114.6 cm; size of detail: ca. 25.5 × 36.5 cm. © Service historique de la Défense, Vincennes (6 M LID 140).

SEE ALSO: British America; Military Cartography; United States of America

BIBLIOGRAPHY

Edney, Matthew H. 1997. "The Mitchell Map, 1755–1782: An Irony of Empire." Osher Map Library and Smith Center for Cartographic Education, University of Southern Maine. Online publication.

Guthorn, Peter J. 1966. *American Maps and Map Makers of the Revolution*. Monmouth Beach: Philip Freneau Press.

———. 1972. *British Maps of the American Revolution*. Monmouth Beach: Philip Freneau Press.

Harley, J. B. 1978. "The Contemporary Mapping of the American Revolutionary War." In *Mapping the American Revolutionary War*, by J. B. Harley, Barbara Bartz Petchenik, and Lawrence W. Towner, 1–44. Chicago: University of Chicago Press.

Marshall, Douglas W. 1976. "The British Military Engineers, 1741–1783: A Study of Organization, Social Origin, and Cartography." PhD diss., University of Michigan.

Marshall, Douglas W., and Howard H. Peckham. 1976. *Campaigns of the American Revolution: An Atlas of Manuscript Maps*. Ann Arbor: University of Michigan Press.

(*facing page*)
FIG. 729. JOHN MONTRESOR AND PIERRE NICOLE, "A SURVEY OF THE CITY OF PHILADELPHIA AND ITS ENVIRONS," 1777. Colored manuscript, 1:14,400. This carefully drawn topographical map, a commemorative work showcasing the arena of conflict around the recently captured American capital, was presented to Sir William Howe. The insets in the lower part of the map relate to the successful British siege of Fort Mifflin on Mud Island, during which Montresor was in the ironic position of reducing a bastion he had himself designed.
Size of the original: 151 × 89 cm. Image courtesy of the Geography and Map Division, Library of Congress, Washington, D.C. (G3824. P5S3 1777 N5).

Nebenzahl, Kenneth, and Don Higginbotham. 1974. *Atlas of the American Revolution*. Chicago: Rand McNally.

Rice, Howard C., and Anne S. K. Brown, trans. and eds. 1972. *The American Campaigns of Rochambeau's Army, 1780, 1781, 1782, 1783*, vol. 2, *The Itineraries, Maps and Views*. Princeton: Princeton University Press; Providence: Brown University Press.

Revolution, French. Fresh studies of the French Revolution (1789–99) have shown that during the course of the last decade of the eighteenth century, this event created three different "spaces" in France. First, the annexation of a fringe of Western Europe created an exterior space; second, the establishment of a homogeneous administrative framework created an interior space (Nordman 1989, 223); third, new codes produced a space represented by texts and images. Cartography was integral to visualize and organize each of these spaces, best described in the efforts that created the second and third spaces.

During the first three years of the Revolution, the constitutional monarchy expropriated the great mapping efforts of the end of the Ancien Régime, especially the Cassinis' *Carte de France*, which remained incomplete in 1789, when the engineer Louis Capitaine was still verifying maps of Saint-Malo, Dinan, and Vannes in Brittany. Even so, civilians and soldiers alike judged this detailed representation of French territory to be indispensable. Indeed, the Cassini map, conceived on a geometric base, free of provincial delimitations, corresponded perfectly to the need for a new division of territory, the interior space created by the Revolution. Even before the boundaries of the new *départements* were set, Capitaine was charged with reducing the *Carte de France* to one quarter of its original scale, to 1:345,600, which he executed in eighteen-sheets in 1789. Capitaine produced a revision in 1790, titled *Carte de la France dédiée au roi*, with the departmental delimitations added; it was not, however, the first map to show the *départements*. A few months before, Capitaine's smaller-scale *Carte de la France suivant sa nouvelle division en departements et districts* had appeared (fig. 731). Dedicated to the Assemblée nationale, the map was published by the Société de la carte de France, the financial backers of the *Carte de France*, and was a commercial success, earning a great deal of money. Several competing initiatives for single maps as well as atlases met the cartographic demand spurred by the division of France into new *départements*.

Thus, in 1790, while Capitaine was planning an atlas of *départements*, Pierre Dumez and Pierre-Grégoire Chanlaire published the first sheets, at 1:267,000, of their *Atlas national*. Capitaine published a general map as a guide and aid for the atlas of France, sold by subscription and by individual sheet, but his enterprise stopped there. The *Atlas* of Dumez and Chanlaire was a great success, its quality unanimously praised. An abridged edition was published in 1791 (fig. 732), and under the Empire the original edition was republished and corrected several times (1806, 1810, 1815). In total, around fifteen atlases of France were published between 1790 and 1795, some by well-known publishers and some by men new to the book market who were often pursuing a political agenda. Yet the abolition of printing privileges was the main reason for the rise in production. Indeed, between March 1790 and July 1793 (when literary property was once again protected), there was no legal recourse against counterfeiters, and map publishers copied each other shamelessly and with impunity. Moreover, publishers hoping for a broad audience showed a competitive ingenuity. For example, between 1790 and 1793 Louis Brion de la Tour published the eighty-four maps in Louis-Marie Prudhomme's journal, *Révolutions de Paris*. Edme Mentelle published several atlases designed for teaching the new administrative divisions of France, notably *La République française en 88 départements* in 1794. During this period, the rapid production of up-to-date maps prevailed over quality engraving and printing. Paradoxically, the broad dissemination of these maps ran parallel with the military's decision to keep its own cartographic production confidential.

At this time, the armies' desire to suppress information about topography, especially in border areas, was vigorously enforced. On 21 September 1793, the Convention nationale decreed that the Paris Observatory be divested of the plates and printed copies of the *Carte de France* to transfer them to the Dépôt de la Guerre. The official report of this confiscation mentions 165 finished plates and their impressions, 11 plates in the process of being engraved, 1 plate in the process of being prepared, and 4 sheets of surveyed areas that still needed to be traced (Berthault 1898–99, 1:59–60). This confiscation, regarded as a "nationalization" of the Cassini map, demonstrates the rivalry between the military engineers, who considered themselves to be the true topographical specialists, and those engineers who worked under the supervision of Jean-Dominique Cassini (IV). However, the confiscation also alleviated worries about how printed maps were distributed to theaters of military operation and shielded them from the malevolent eyes of the enemy. The military need for maps explains the recruitment of twelve engravers to restore the Cassinis' copperplates. No corrections seem to have been made to the *Carte de France* before 1803, but the frequent use of its sheets during this period illuminated its limitations. Officers especially deplored the absence of any updates and the lack of consistent uniform rules applied to the compilation of individual sheets. These complaints led to

FIG. 731. LOUIS CAPITAINE, *CARTE DE LA FRANCE SUIVANT SA NOUVELLE DIVISION EN DEPARTEMENTS ET DISTRICTS*, *DEDIÉE À L'ASSEMBLÉE NATIONALE* (PARIS, 1790). Map scale, 1:864,000. Size of the original: 124 × 114 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge F Carte 6408).

FIG. 732. PIERRE DUMEZ AND PIERRE-GRÉGOIRE CHANLAIRE, *DÉPARTEMENT DU BAS RHIN DÉCRÉTÉ LE 13. JANVIER 1790*. From *Atlas national de France* (Paris: Bureau de l'Atlas National, 1791), no. 25. Size of the original: 52.5 × 60.0 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge CC 2330 [80C]).

the creation of the Commission topographique of 1802, under the chairmanship of the director of the Dépôt de la Guerre, that sought to standardize cartographic conventions and graphic codes in use at the time.

During the Revolution, the Dépôt de la Guerre was, in fact, considered the official cartographic authority. In 1793, it was reorganized and placed under the leadership of Etienne-Nicolas Calon, *ingénieur géographe* and member of the Convention. The institution then took responsibility for conserving map collections and training *ingénieurs géographes*. Though difficult at first, this new teaching role encouraged the military corps of *ingénieurs géographes* to grow from only twenty people in 1789 to a larger and more structured unit through the course of the Revolution and the Empire. However, the other aspect of the Dépôt de la Guerre's mission—map production and conservation—had mixed results.

The initial goal was to centralize the cartographic collections. In 1793, when the *Carte de France* was handed over to the Dépôt de la Guerre, the Ministre de la Marine et des colonies, Gaspard Monge, ordered the transfer of maps to his own Dépôt from former ministers and naval officers who had emigrated and from foreign collections. In 1794, the Agence des cartes was created and placed under the supervision of the Commission des travaux publics, with the goal of bringing together all plans, maps, and reports and conserving them for consultation by government bodies. However, this very ambitious plan failed. In 1795, Calon conceived a museum of geography, military topography, and hydrography that would unite all the documents conserved at the three dépôts: de la Guerre, de la Marine, and des Affaires étrangères. The museum would support staff to draw up new maps and train young *ingénieurs géographes*. The first article of a decree proposal debated in 1795 summarized these objectives: "A central establishment will be formed to practice and perfect the science of geography in every respect, while adapting it to the views of the government and in the interest of the public" (Broc 1974, 39, citing Archives nationales [France], Mar G 93, fols. 167–75). Although these successive initiatives failed, they show that the map was becoming an indispensable tool for the management and control of territory during this period.

The creation on 23 September 1791 of the Bureau du cadastre also confirms this trend. This institution responded to the demand expressed in *les cahiers de doléances* for the creation of a general cadastre to enable better repartition of land taxes. Gaspard Marie Riche de Prony was placed in charge and sought to make it a center of data collection, which explains why the Bureau du cadastre was joined to the Ministère de l'intérieur from 1792. In October 1795, a school of geography was formed to train the employees of the Cadastre, specifically those carrying out surveys of the *départements*. These great hopes were shattered once again. The École des géographes opened just eighteen months later, as a polytechnical school, but the transition went poorly, and the school finally closed in 1802 after the state abandoned the Cadastre itself (Bret 1991, 124–25). During its existence, the Bureau du cadastre only produced one map: that of the Seine *département*, of which only a few scraps remain today.

Despite the uneven institutional results, the period of the Revolution may be characterized by a desire to structure the administrative and political space of the country—a process that required maps as administrative tools omnipresent in government files, thereby creating the third space of the Revolution. The archives of the Ministère de l'intérieur show how often maps were used for becoming acquainted with, mastering, and representing territory. The work accompanying the creation of the *département* system attests to this. Two uses seem to have developed: printed maps of France used to display potential administrative divisions (fig. 733), and manuscript maps drawn specifically to show territorial organization and to support arguments formulated by local authorities concerned with having their voices heard at the Assemblée nationale. In a less circumstantial context, Nicolas Louis François de Neufchâteau, in a statistical project presented in the year VIII (1799–1800), proposed a brief description of each *département*, highlighting natural and industrial production, manufacturing, commerce, inland navigation, draining and irrigation possibilities, and the customs of inhabitants; he further envisioned that these descriptions be accompanied by "*Plans Topographiques* détaillés" (Broc 1975, 463–64). Although this part of the plan was abandoned, his proposal demonstrates how the map could be a tool of synthesis for administrators and a means to represent land configuration. The role of cartography in the expedition to Egypt evokes these different uses. Indeed, the forty-seven maps of the *Atlas géographique*, one volume of the multivolume *Description de l'Égypte* (1809–22), illustrate how well the map represents knowledge of a territory. The work, placed under the leadership of Pierre Jacotin, focused on the contemporary state of Egypt, not on its ancient geography, as Jean-Baptiste Bourguignon d'Anville had done. In order to be an administrative tool, maps had to be based on rigorous astronomical observations, precise toponymic lists, and exhaustive territorial studies. The Revolutionary era witnessed clearly defined expectations, but the cartographic techniques required to fulfill them remained to be fully developed.

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SEE ALSO: Administrative Cartography: France; *Carte de France*; Cassini Family: Cassini (IV), Jean-Dominique; Commission topographique of 1802; Geographical Mapping: France; Nationalism and Cartography; Property Mapping: France; Thematic Mapping: France

BIBLIOGRAPHY

Alleaume, Ghislaine. 1999. "Entre l'inventaire du territoire et la construction de la mémoire: L'œuvre cartographique de l'expédition d'Égypte." In *L'expédition d'Égypte, une entreprise des Lumières 1798–1801: Actes du colloque international organisé par l'Académie des inscriptions et belles-lettres et l'Académie des sciences, sous les auspices de l'Institut de France et du Muséum national d'histoire naturelle*, ed. Patrice Bret, 279–94. [Paris]: Technique & Documentation.

Berthaut, Henri Marie Auguste. 1898–99. *La Carte de France, 1750–1898: Étude historique*. 2 vols. [Paris]: Imprimerie du Service Géographique.

Bret, Patrice. 1991. "Le Dépôt général de la Guerre et la formation scientifique des ingénieurs-géographes militaires en France (1789–1830)." *Annals of Science* 48:113–57.

Broc, Numa. 1974. "Un musée de géographie en 1795." *Revue d'Histoire des Sciences* 27:37–43.

———. 1975. *La géographie des philosophes: Géographes et voyageurs français au XVIII^e siècle*. Paris: Editions Ophrys.

Gillispie, Charles Coulston. 2004. *Science and Polity in France: The Revolutionary and Napoleonic Years*. Princeton: Princeton University Press.

Godlewska, Anne. 1988. *The Napoleonic Survey of Egypt: A Masterpiece of Cartographic Compilation and Early Nineteenth-Century*


Carte de France
divisée suivant le Plan proposé
à
l'Assemblée Nationale
par
son Comité de Constitution
le 29 Septembre 1789
ANGLETERRE
LA MANCHE
RÉGION DU NORD-OUEST
RÉGION DU NORD
RÉGION DU NORD-EST
RÉGION DE L'OUEST
RÉGION DU CENTRE
RÉGION DE L'EST
RÉGION DU SUD-OUEST
RÉGION DU SUD
RÉGION DU SUD-EST
PAYS BAS
LUXEMBOURG
PALATINAT
SUISSES
SAVOYE
PIÉMONT
MER MÉDITERRANÉE
BRETAGNE
NORMANDIE
LE MAINE
ANJOU
POITOU
ORLÉANOIS
CHAMPAGNE
BOURGOGNE
FRANCHE COMTÉ
BOURBONNOIS
MARCHE
LIMOUSIN
ANGOUMOIS
SAINTONGE
PÉRIGORD
LIONNOIS
DAUPHINÉ
PROVENCE
LANGUEDOC
GASCOGNE
ROUSSILLON
Isles d'Hières

Fieldwork. Ed. Edward H. Dahl. Monograph 38–39, *Cartographica* 25, nos. 1 and 2.

———. 1999. *Geography Unbound: French Geographic Science from Cassini to Humboldt*. Chicago: University of Chicago Press.

Konvitz, Josef W. 1987. *Cartography in France, 1660–1848: Science, Engineering, and Statecraft*. Chicago: University of Chicago Press.

Laboulais, Isabelle. 2012. *La Maison des mines: La genèse révolutionnaire d'un corps d'ingénieurs civils (1794–1814)*. Rennes: Presses Universitaires de Rennes.

Nordman, Daniel. 1989. "Une représentation géographique du territoire sous la Révolution: Le 'jardin patriotique,'" *Lectures* 24: 223–40.

Nordman, Daniel, et al. 1989. *Le territoire (1): Réalités et représentations*. Vol. 4 of *Atlas de la Révolution française*, ed. Serge Bonin and Claude Langlois. Paris: Éditions de l'École des Hautes Études en Sciences Sociales.

Pelletier, Monique. 1990. "La carte de Cassini à l'époque révolutionnaire." In *Cartes, cartographes et géographes: Actes du 114e Congrès national des sociétés savantes (Paris, 1989), Section de géographie*, 15–23. Paris: Editions du CTHS.

Rizzi Zannoni, Giovanni Antonio. Giovanni Antonio Rizzi Zannoni was born in Padua on 2 September 1736, the son of Girolamo Rizzi Zannoni and Elena Marchiori. Although it has been suggested that he may have followed courses at the University of Padua as a pupil of Marchese Giovanni Poleni, it seems more likely that he was self-taught; a document from 1756 details various journeys within Italy and Europe that he claimed to have made from the age of ten onward, although there is no reference at all to any continuous course of study in any specific school or university (Valerio 1993, 86n67). The putative apprenticeship under Poleni is based solely on Rizzi Zannoni's own account in the "Abrégé des travaux du Sr Zannoni" drawn up in 1774 (Drapeyron 1897, 402–5). In the 1750s he left Padua for Germany, where he worked, particularly in Nuremberg, until 1759; there he produced various maps included in the atlases of the Homann Heirs, under whom he probably apprenticed as a mapmaker. After this point, his life and work may be divided into three distinct periods: Paris (1760–66), Padua (1776–81), and Naples (from 1781 until his death on 20 May 1814).

In Paris, Rizzi Zannoni honed his skills in the use of astronomical observations for determining longitude and correcting and compiling small- to medium-scale maps for the commercial market. During this period, he never engaged in on-site surveying but functioned as a *géographe de cabinet*, participating in debates in the Académie des sciences on cartographic questions related to geodesy and astronomy. In 1761, the publication of his *Epistula* attracted the attention of astronomers and geographers throughout Europe as it called for simultaneous observations of the passage of Venus across the sun in order to determine the different longitudes of various locations in Central Europe. On 20 March 1765, he was appointed correspondent of the Gesellschaft der Wissenschaften zu Göttingen. His first commercial publication, with Louis-Alexandre Du Caille, was the *Étrennes géographiques* (Ballard, Paris 1760) with twenty-six small maps.

In 1767 the king of Naples appointed Rizzi Zannoni to complete the *Carta geografica della Sicilia Prima*, a project begun by Ferdinando Galiani in 1762; Rizzi Zannoni finished it in 1769, while still in Paris. When the Naples map was completed, he began work on a map of Poland; announced to the public in 1770, his *Carte de la Pologne* was completed in 1772 in twenty-four sheets with a plan of Warsaw and was often bound as an atlas (see fig. 848). Although Rizzi Zannoni occasionally boasted of participating in a secret mission to North America from 1763 to 1765 to establish the boundaries between the French and British territories after the Seven Years' War, there is no documentary evidence to confirm this adventure (Valerio 1993, 88n75).

His growing reputation as a competent cartographer had important political repercussions. On 22 March 1772, he received a *brevet d'ingénieur hydrographe de la Marine*, and, despite outspoken opposition from the astronomer Joseph-Jérôme Lefrançais de Lalande (Konvitz 1987, 75), he managed to obtain the post of *premier ingénieur* at the Dépôt de la Marine previously held by Jacques-Nicolas Bellin, who had just died. However, French concern about a foreigner holding such an important and sensitive post forced him to resign in August 1773. In 1775 the French foreign minister, Charles Gravier, comte de Vergennes, appointed him as head of the Bureau topographique pour la démarcation des limites, a position that did not involve internal military affairs and political decisions. He was merely required to record existing boundaries and frontiers and indicate them on maps.

(*facing page*)
FIG. 733. *CARTE DE FRANCE DIVISÉE SUIVANT LE PLAN PROPOSÉ À L'ASSEMBLÉE-NATIONALE PAR SON COMITÉ DE CONSTITUTION LE 29 SEPTEMBRE 1789*, BY LÉON HENNEQUIN. Paris: Dessenne–Palais Royal. Although the map was printed, this title was written in manuscript on a glued-on label. Size of the original: 57 × 65 cm. Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge C 4925 RÉS).

FIG. 734. DETAIL FROM THE MAP OF THE COURSE OF THE DANUBE FROM ULM TO INGOLSTADT, [1776]. Although not in Rizzi Zannoni's hand, this manuscript map was made under his direction and is early evidence of his work as a surveyor at a large scale—the dominant mapping mode for the remainder of his life. The detail shows the eastern half of the map, with the river's course to Ingolstadt.

Size of the entire original: ca. 25 × 119 cm; size of detail: ca. 24 × 59 cm. Image courtesy of the Biblioteca Nazionale "Vittorio Emanuele III," Naples (sezione manoscritti e rari, B 9/27).

Rizzi Zannoni continued to work on his own commercial enterprises, but his investment of time and money in a map of the eastern Turkish Empire dedicated to Vergennes resulted in near bankruptcy and a need to leave Paris to escape his creditors (Konvitz 1987, 35–36). His numerous contacts within the Venetian community in Paris led the astronomer and meteorologist Giuseppe Toaldo to convince him to return to an academic position in Padua. Their correspondence confirms Rizzi Zannoni's departure from Paris in June 1776, with his clear hope of returning. He traveled to Padua in stages through Baden and Bavaria, where he visited the main observatories of southern Germany and was a guest of local rulers and electors. In Munich for about four months, at the explicit behest of Maximilian III Joseph, he launched a subscription for a map of Bavaria and began on-site surveying along the course of the Danube from Ulm to Ingolstadt "in order to give an exact and refined understanding of this river" (Valerio 2005, 222) (fig. 734). The project unfortunately lacked sufficient subscribers to be completed.

Rizzi Zannoni's arrival in Padua at the end of November 1776 marked his transition from *géographe de cabinet* to on-site surveyor, applying techniques of triangulation and astronomical observations to the creation of large-scale maps. In nearby Venice, thanks to Toaldo, he met scholars and local aristocrats, hoping to gather materials, instruments, and funding necessary for a map of the regions of the Venetian Republic. He worked on this project throughout 1777, traveling to Friuli and Istria to perform the triangulations and astronomical observations necessary for the construction of the map, which unfortunately was never completed. During these travels, he met Prince Wenzel Anton von Kaunitz, to whom he submitted a project for a map of Lombardy centered on Milan on 13 November 1777, perhaps at the prince's explicit request. When this project also failed, he began work on a large-scale map of the territory of Padua in 1778—twelve sheets, ca. 1:20,000, of which four were published by 1781 (see fig. 422). In 1779, Rizzi Zannoni was appointed *pensionario* of the Accademia di Scienze Lettere e Arti, Padua.

On 17 April 1781, the Neapolitan *residente* in Venice submitted a request to the Venetian Senate that Rizzi Zannoni be granted a six-month leave "to carry out his work of correcting and improving the topographical map of that said kingdom" (Valerio 1993, 112–13). Although Galiani had proposed this scheme as a "rectification" of Rizzi Zannoni's 1769 map, published in Paris, his description as rectification was intended to circumvent the reluctance of the court and scientific circle in Naples to support a new mapping project (Valerio 1993, 121–22). In fact, the project resulted in the first work of modern geodetic cartography in southern Italy.

By June 1781, Rizzi Zannoni was in Naples, reunited with Galiani in planning a map of the entire kingdom from on-site surveys. His six-month leave was extended for four years, after which he settled in Naples. There, from 1781 to 1795, he actively participated in the transformation of the kingdom's topographical institute from a Commissione per la Carta Geografica del Regno into a veritable geographical and topographical workshop, which he led both administratively and scientifically, and finally into the Deposito Topografico during the ten years of French rule. During the Napoleonic Wars in Italy (1793–95), Rizzi Zannoni surveyed the boundaries between the Papal States and the Kingdom of Naples and surveyed and plotted a map of a large part of the territory between that border and the city of Rome.

With the French army in Naples, Rizzi Zannoni saw an opportunity to return to Paris in 1799. He left in May, with his wealth of cartographic material in tow, but got no further than Rome, blocked by the inability of the French in the south to unite with the army of Italy in the north. Forced to return to Naples after English troops entered Rome, Rizzi Zannoni continued secret negotiations with the French for appointment as head of the Dépôt de la Guerre, but his excessive demands caused the negotiations to break down in 1803 (Valerio 1993, 185–203).

During Bourbon rule in Naples, Rizzi Zannoni enjoyed the title of *geografo del Re*, thus becoming the last true court geographer in a European world undergoing rapid and radical transformation both socially and scientifically. With the French departure in 1806, Rizzi Zannoni continued working to complete the map of the Kingdom of Naples. In 1807 he was appointed head of the Deposito Topografico, established by Giuseppe Bonaparte, king of Naples (later José I).

During thirty years in Naples, Rizzi Zannoni published the *Atlante geografico del Regno di Napoli* (1788–1812, thirty-one sheets, ca. 1:114,000; see fig. 270); a four-sheet map of Lombardy (1795); a five-sheet map of northern Italy (1799; see fig. 423); a six-sheet map of the Kingdom of Naples (1807); and various administrative and military maps of that kingdom. He supervised maritime work for the *Atlante marittimo delle Due Sicilie* (1785–92, twenty-three sheets, ca. 1:90,000, engraved by Giuseppe Guerra), based on surveys performed with the aid of the Bourbon king's navy (Valerio 1993, 145, 164–65). However, his project for a fifteen-sheet map of Italy, first launched in 1803, produced only a single sheet: the map of Sicily, published in 1805. Rizzi Zannoni's contributions straddled several modes of mapping and secured his place as one of the eminent Italian mapmakers of the European Enlightenment.

VLADIMIRO VALERIO

SEE ALSO: Geographical Mapping: Italian States; Map Trade: Italian States; Reproduction of Maps: Engraving and Printing; Topographical Surveying: Italian States

BIBLIOGRAPHY

Blessich, Aldo. 1898. "Un geografo italiano del secolo XVIII: Giovanni Antonio Rizzi Zannoni (1736–1814)." *Bollettino della Società Geografica Italiana* 35:12–23, 56–69, 183–203, 453–66, 523–37.

Drapeyron, Ludovic. 1897. "J.-A. Rizzi Zannoni géographe italien (1736–1814): Son séjour en France." *Revue de Géographie* 41:401–13.

Gullino, Giuseppe, and Vladimiro Valerio, eds. 2015. *Giovanni Antonio Rizzi Zannoni: Scienziato del Settecento veneto*. Venice: Istituto Veneto di Scienze, Lettere ed Arti.

L'Italia del Cavaliere Rizzi Zannoni: Carte a stampa dei territori italiani. 2014. Exhibition catalog. Giussano: Grafiche Bossi.

Konvitz, Josef W. 1987. *Cartography in France, 1660–1848: Science, Engineering, and Statecraft*. Chicago: University of Chicago Press.

Valerio, Vladimiro. 1985. "A Mathematical Contribution to the Study of Old Maps." In *Imago et mensura mundi: Atti del IX Congresso Internazionale di Storia della Cartografia*, 3 vols., ed. Carla Clivio Marzoli, 2:497–504. Rome: Istituto della Enciclopedia Italiana.

———. 1993. *Società uomini e istituzioni cartografiche nel Mezzogiorno d'Italia*. Florence: Istituto Geografico Militare.

———. 2005. "Da Parigi a Monaco di Baviera nel 1776: Il rientro in Italia di Giovanni Antonio Rizzi Zannoni." *Geotema* 27:215–26.

———, ed. 2006. *Atlante marittimo del Regno di Napoli, 1785–1792*. Naples: Voyage Pittoresque.

Road Map. See Transportation and Cartography: Road Map

Robert de Vaugondy Family. Gilles Robert Vaugondy (1688–1766), mathematics teacher and geographer, established his Paris map business from Sanson stock, inherited from Pierre Moullart-Sanson in 1731 and purchased in 1733 from Jean Mariette, heirs respectively to Nicolas Sanson and Pierre I Mariette. Appointed *géographe du roi* in 1734, Gilles reissued Sanson maps and designed original maps for books on historical subjects through the 1730s and 1740s, usually signing his name "Gilles Robert." Joining forces with booksellers he published two world atlases, *Atlas portatif universel et militaire* (1748) (fig. 735) and *Atlas universel* (1757), flouting corporate regulations forbidding booksellers from selling prints.

Educated by his father, Didier Robert de Vaugondy (1723–1786) published his first book, *Abregé des differens systèmes du monde; de la sphere, et des usages des globes*, in 1745 and added the particule *de* to his name. His eighteen-inch (46 cm) globes for Louis XV secured his title *géographe du roi* in 1751. In 1756 he became *géographe du duc du Lorraine* (the duke was a former king of Poland, Stanisław Leszczyński) and *associé étranger* of the Académie des sciences et belles lettres founded by Stanisław in Nancy. Appointed *censeur royal* in 1773, he lost two nominations (1773, 1782) as *adjoint géographe* in the Académie des sciences to Jean-Baptiste Bourguignon d'Anville and Jean-Nicolas Buache. Beset by personal tragedy, Didier Robert de Vaugondy sold his stock to Jean Fortin in 1778 (Pedley 1992, 118–21).

FIG. 735. *INTRODUCTION À LA COÑOISSANCE ET À L'USAGE DES CARTES*, FROM GILLES ROBERT VAUGONDY, *ATLAS PORTATIF UNIVERSEL ET MILITAIRE* (PARIS, 1748). In the introduction to the atlas, Gilles indicated that this map was intended to explain common map signs and the measurement of distances by the scale or degrees of latitude.
Image courtesy of the Bibliothèque nationale de France, Paris (Cartes et plans, Ge FF 9869).

Charles-François Delamarche acquired the stock and with his son Félix sold Vaugondy maps well into the nineteenth century. Didier died in debt in 1786.

As a *géographe de cabinet*, working almost entirely as a compiler of varied sources, Didier designed geographical and urban maps for a general market: wall maps of the world and four continents, Paris tourist guides, atlases, celestial maps, armillary spheres, and globes. Yet mathematical cosmography informed all his work. He proposed (but never completed) a six-foot (183 cm) terrestrial globe that would show the flattening of the earth at the poles, demonstrating gravity's effect. His theories on map projections engaged Rigobert Bonne and Giovanni Antonio Rizzi Zannoni in debate. Geographer of choice for Enlightenment authors, Didier prepared maps for Charles de Brosses's *Histoire des navigations aux terres australes* (1756), the first volume of the *Histoire naturelle* of Georges-Louis Leclerc, comte de Buffon (1749), and Charles-Louis de Secondat Montesquieu's *l'Esprit des lois* (1755); he collaborated with Duc Emmanuel de Croÿ-Solre on maps for the Kerguelen expedition. Didier's *Essai sur l'histoire de la géographie* (1755) was an early Enlightenment attempt at a history of cartography, and his *Nouvel atlas portatif destiné* *principalement pour l'instruction de la jeunesse* (1762) was aimed at the competitive and growing school market, as its introductory discourse attests.

Vaugondy maps were sold and copied throughout Europe. Although Voltaire associated him in stature with Joseph-Nicolas Delisle, Philippe Buache, and d'Anville, Didier's relationship with other geographers was vexed. He annoyed d'Anville with minute criticism; his rejection of the putative discoveries of the fictitious Admiral Bartholomew de Fonte pitted him against Buache and Delisle. Buache disdained Didier's commercial involvement with booksellers, and Buache's nephew, Jean-Nicolas, considered Didier's geography out of date. Didier published the texts of his critics next to his own, leaving his readers to judge. He eschewed the practice of long memoirs whose arid prose attracted few readers and fewer sales, instead offering just enough scholarly justification to ensure their authority, as found in the introduction to the *Atlas universel*. Without royal pension or patronage, he relied solely on teaching and commerce for income. A summary biographical treatment (Weiss 1854–65) and a complete analysis (Pedley 1992) have been published.

MARY SPONBERG PEDLEY

SEE ALSO: Geographical Mapping: France; Map Trade: France; Sanson Family

BIBLIOGRAPHY

Pedley, Mary Sponberg. 1992. *Bel et utile: The Work of the Robert de Vaugondy Family of Mapmakers*. Tring: Map Collector Publications.

Warren, Bill. 1995. "A Most Curious Map." *Map Collector* 73:13–18.

Weiss, Charles. 1854–65. "Robert de Vaugondy." In *Biographie universelle ancienne et moderne*, new ed., 36:138–39. Paris: Michaud.

Route Map. See Transportation and Cartography: Route Map

Roy, William. William Roy (4 May 1726–1 July 1790) was born at Miltonhead in the parish of Carluke, Lanarkshire, in Scotland. From 1747 to 1755 he was a civilian assistant quartermaster to Colonel David Watson, undertaking the Military Survey of Scotland in the aftermath of the Jacobite Rebellion (1745–46). The experience he gained during eight years as principal surveyor on this project was of fundamental importance in shaping his survey and mapping objectives, leading not only to the formal establishment of a military survey company in 1784, but also to the initiation, through the commissioning of the "father of accurate theodolites" in 1784 from Jesse Ramsden (O'Donoghue 1977, 78), of geodetic survey in Britain and the foundation of the Ordnance Survey in 1791.

Commissioned as practitioner engineer on 23 December 1755, and lieutenant of the 53rd Foot on 4 January 1756, Roy was stationed in the south of England, making reconnaissance surveys in advance of expected troop movements during the Seven Years' War (1756–63). Watson's precept, "that in Military Maps nothing should ever be represented at Guess or Random," remained Roy's guiding principle in all his survey work thereafter (quoted in O'Donoghue 1977, 32). His plans of encampments, his topographical mapping in Germany, and his manuscripts of the published map of the 1759 Battle of Minden (fig. 736), all show mastery of the medium of watercolor and command of representation of relief that are at least the equal of celebrated watercolorist Paul Sandby, whose colleague he was on the Military Survey of Scotland.

From 1763, Roy developed his views on the necessity for a national survey. His promotion to deputy quartermaster general of the Forces in South Britain on 11 November 1761 was followed by a commission as lieutenant colonel (23 July 1762), and on 19 July 1765 he was appointed to "inspect, survey and make Reports from time to time of the State of the Coast . . . of this Kingdom" (quoted in O'Donoghue 1977, 52). His report and map, "Military Description of the South-East Part of England" (1765), were followed in 1766 by a revised "Considerations on the Propriety of Making a General Military Map of England," presented to King George III. Having influenced the introduction of surveying in the Tower Drawing Room curriculum in 1776, he became, in 1784, the first colonel in charge of the engineer company designated "Surveying and ready for Field Service" (quoted in O'Donoghue 1977, 46). He was selected by the Royal Society to undertake in 1784–87 a triangulation of southeast England designed to link with the French triangulation in order to establish the relative positions of the observatories in Greenwich and Paris, winning on 30 November 1785 the Royal Society's Copley Medal for his measurement of the baseline on Hounslow Heath. Roy was a fellow of the Royal Society and a fellow of the Society of Antiquaries of London. His plans of the remains of Roman military camps in Scotland were published posthumously in 1793 in *The Military Antiquities of the Romans in Britain*; they constitute the most important source of archaeological cartography for these sites today. Roy was promoted to major general on 19 October 1781.

YOLANDE HODSON

SEE ALSO: Geodetic Surveying: (1) Enlightenment, (2) Great Britain; Greenwich-Paris Triangulation; Military Cartography: Great Britain; Scotland, Military Survey of (Great Britain); Topographical Surveying: Great Britain

BIBLIOGRAPHY

Hodson, Yolande. 2011. "The Lucubrations of His Leisure Hours: William Roy's *Military Antiquities of the Romans in Britain*, 1793." *Scottish Geographical Journal* 127:117–32.


JOURNAL of the Motions of HIS BRITANNIC MAJESTY'S ARMY, from July 14. to August 1. 1759.
RELATION OF THE BATTLE.
Minden Marsh
To Prince FERDINAND of Brunswick,
This Plan of the Battle of Thonhausen gained
August 1. 1759. by His Britannic MAJESTY'S Army,
under the command of His Serene Highness
over the French Army, commanded by
Marshal Contades, and taken from an
Actual Survey, is with the greatest Respect humbly
Dedicated by William Roy Captain of Engineers

O'Donoghue (Hodson), Yolande. 1977. *William Roy, 1726–1790: Pioneer of the Ordnance Survey*. London: British Museum Publications.

Roy, William. 1793. *The Military Antiquities of the Romans in Britain*. London: Society of Antiquaries of London.

Russia. Russian cartography in the long eighteenth century was dominated by the reforms of Peter I. At the time he assumed sole rule as czar in 1696, Russian territory already stretched from the Baltic Sea, Byelorussia, and the Ukraine in the west to Siberia and the northern Pacific regions in the east, south to the regions just north of the Black and Caspian Seas, and north to the Arctic Ocean. Under his reign and that of his successors through the eighteenth century, the territory increased to include parts of modern Finland, Estonia, and Lithuania to the west, and to the Sea of Azov and the Crimea on the Black Sea in the south.

Mapping these vast regions had already occupied czars in the previous century. They had established a centralized system of administrative departments to collect maps and to map local areas, boundaries, and newly occupied regions (Goldenberg 2007). These seventeenth-century maps featured a pictorial style—some elements of which would persist into the eighteenth century (Kivelson 2006, 17–28)—and an absence of coordinate grids or uniform orientation; instead, they relied for their spatial structure on the network of river systems and distances measured in time or simple units (Goldenberg 2007, 1903).

Peter I's well-known trips to Western Europe in 1697–98 and 1716–17 exposed him to institutions, technologies, and industries that served as models for extensive reforms in Russia. The reforms included the expansion of the central state bureaucracy in Moscow with a czar-appointed senate to control ministerial activities, the establishment of the "new town" of St. Petersburg (founded 16 [27] May 1703), and the foundation of the Akademiya nauk (1724) on European models. Symbolically, they culminated in Peter I's declaration of the Russian Empire in 1721, together with the replacement of the Russian title of "czar" by the Western European title of "emperor." Peter I's trips especially informed his understanding of cartography as an important tool of state building, and in 1720 he issued general regulations, General'nyy reglament, that called for every government department to possess accurate information, derived from general and particular land maps or geographical drawings (*chertëzhi*) that would be produced over time and would describe all boundaries, rivers, cities, towns, villages, churches, forests, and so forth (I Polnyy suod zakonov Rossiyskoy imperii, tom 6, no. 3682; *Polnoye sobraniye* 1830, 6:157).

Peter I further realized that the existing forms of Russian cartography could not serve the needs of a country that looked westward to Europe for military technology, trade, and cultural exchange, and west and south for territorial expansion to guard against encroachments on Russia's western margins. Without a firm basis in mathematical principles, the old graphic techniques were inadequate for industrial and infrastructure purposes such as building dams and canals, locating mineral deposits and timber forests, and expanding fortifications and lines of communication. Peter I's newly established navy required charts of the Baltic and the Black Seas, and even the Mediterranean, and his army needed better topographical maps. Land surveys were required to better understand and rationalize the realm.

Yet a serious lack of manpower existed for producing the kind of cartography required, given that the Russian population was largely illiterate and innumerate, with little formal schooling of any sort, including mathematics, available at any social level (Cracraft 2004, 195–96). Peter I therefore created new institutions for specialized cartographic training that were to endure through the century. As a focus on systematic surveying and measurement, the Shkola tsifiri i zemlemeriya, a school of arithmetic and land measurement, was organized under the auspices of the Pushkarskiy prikaz in 1698, but it burned down in 1699. By 1701, Peter I had founded the Moskovskaya matematiko-navigatskaya shkola, the school of mathematics and navigation in Moscow, which provided the first systematic training for surveyors (geodesists) both on land and at sea; it later relocated to St. Petersburg as the Morskaya akademiya, the naval academy. These two institutions, until the academy's closure in 1752, trained almost all of the Russians skilled in surveying, cartography, marine charting, and geodesy (Cracraft 2004, 80–87).

Members of these institutions produced the earliest Russian textbooks and teaching aids on cartographic subjects and offered courses on elementary surveying, trigonometry, navigation, keeping a ship's log, and practical astronomy (Sergeyev 1954). The Moskovskaya matematiko-navigatskaya shkola's first chief instructor

(*facing page*)
FIG. 736. WILLIAM ROY, *TO PRINCE FERDINAND OF BRUNSWICK, THIS PLAN OF THE BATTLE OF THONHAUSEN* [MINDEN] . . . *TAKEN FROM AN ACTUAL SURVEY*, 1760. Surveyed and drawn by Roy, engraved and published by Thomas Major, London, 29 February 1760, ca. 1:35,000.
Size of the original 59.0 × 66.5 cm. © The British Library Board, London (Cartographic Items Maps *30520[1]).

was the Scot Henry Farquharson, supported by two students from London's Royal Mathematical School at Christ's Hospital, Stephen Gwyn and Richard Grice; they ran a curriculum of topography and surveying based on Western European techniques and instruments (Goldenberg and Postnikov 1985), though some aspects of the training were similar to the compass route surveys commonly used in traditional Russian geographical drawings, giving Russian field cartographers a ready framework for assimilating new methods. The mathematics of projections and incorporation of longitude and latitude into mapmaking also entered the curriculum. In 1721 the senate produced regulations on how to compile maps, the "Punkty kakim obrazom sochinyat' landkarty," which combined these older methods of surveying and mapmaking with the curricula of the new schools (Goldenberg and Postnikov 1985).

The Petrine reforms also shifted map production from manuscript to print, increasing public accessibility. Peter I's personal interest in printing techniques stemmed from his engraving lessons in Amsterdam in 1697 with Adriaan Schoonebeek, whom he brought back to Moscow to become Russia's first professional engraver (Kokkonen 1997, 46). Publication of Russian maps began in 1698, and by the early 1700s Vasiliy Onufriyevich Kipriyanov in Moscow became the primary map printer in Russia. Among the significant printed works were senate secretary Ivan Kirilovich Kirilov's *Atlas vserossiyskoy imperii* (1731–34), with thirty-seven maps, only twenty-eight of which are known to have survived in four known copies (fig. 737). The crowning achievement of printed Russian geography was the *Atlas Rossiyskoy* (1745), published by the Akademiya nauk and based on the Petrine surveys from 1720 to 1744, which became a widely known source of Russian cartography in Europe (see fig. 316).

Imperial ambitions dramatically influenced charting efforts, for which it is virtually impossible to identify links with earlier Russian mapping traditions. One part of Peter I's newly established navy descended the Don River in 1696 to lay siege to the Ottoman town of Azov to give Russia a foothold on the Black Sea; the mapped result was the *Nauw-keurige Afbeelding vande Rivier Don, of Tanais, de Azofsche Zee / Prilezhnoye opisaniye reki Donu ili Tanaisa Azovskovo morya* (1703), engraved and published in Amsterdam from manuscripts supplied by the Dutch admiral in charge of the expedition, Cornelis Cruys. The Great Northern War with Sweden (1700–1721) encouraged a flow of Swedish maps into Russian ministerial archives; twenty-one of the twenty-nine Russian navigational atlases published in the eighteenth century were devoted to the Baltic (Postnikov 2000, 81). Peter I's southward expansion also promoted the mapping of the Caspian Sea (see fig. 524).

Peter I's death in 1725 did not mark an end to the cartographic reforms; his initiatives continued under his successors throughout the century, especially under Catherine II (r. 1762–96). For example, while military mapmaking developed the training of army officers in topographical mapping and fortification design through a series of artillery and engineering schools established by Peter I (Cracraft 2004, 132–32), it would be institutionalized further with the establishment of the General Staff of the Russian Army in 1763.

Detailed cadastral mapping began under the general land survey, General'noye mezhevaniye, inaugurated in 1765 by Catherine II. To give the project coherence, the state once again standardized methods and instruction. In 1767, a school was founded in St. Petersburg to train surveyors and draftsmen for work on the general survey, with another set up in Moscow in 1779. While some earlier surveying methods persisted, these large-scale (1:8,400) surveys mapped landscape details much more thoroughly than previous general surveys intended to map the country's regions. Government surveyors prepared thousands of estate plans and many regional atlases, with information on the terrain, population, agriculture, and industry. Most of these remained in manuscript, and only the *Atlas Kaluzhskago namestnichestva* (1782) was published (see fig. 687). Cadastral mapping benefited from Russia's relationship with Sweden and Finland: the creation in 1775 of district-level surveyors resembled provincial land surveyors in Sweden, and the survey of "Old Finland," performed between 1798 and 1804, relied abundantly on the work of Finnish surveyors, work later drawn upon in general maps of Russian Finland (Postnikov 1993).

The maps produced by the General'noye mezhevaniye promoted growth in small-scale mapmaking. Under the aegis of the Geograficheskiy departament of the St. Petersburg Akademiya nauk, astronomical expeditions in the 1770s and 1780s yielded data for small-scale maps covering vast territories. Between 1766 and 1786, the Geograficheskiy departament published 148 maps, including a general map of Russia (1:7,227,000) by Jacob-Friedrich Schmidt and Ivan Truskott to commemorate the Akademiya's fiftieth anniversary in 1776 (Postnikov 1996, 77, 88–89 [fig. 59]). This was followed in 1786 by the same two authors and Fëdor Ivanovich Shubert with the three-sheet *General'naya karta Rossiyskoy imperii* (1:5,250,000) for the establishment of governor-generalships across the realm.

Catherine II established a Geograficheskiy departament as part of her cabinet in 1786, under whose aegis Aleksandr Mikhaylovsky Vil'brekht compiled the *Rossiyskoy atlas iz 44 kart* (1792), which offered detailed classifications of populated areas into ten gradations, with engravings illustrating the ethnography

FIG. 737. *GENERAL'NAYA KARTA ROSSIYSKOY IMPERII / IMPERII RUSSICI TABULA GENERALIS*, 1734. The first general map of the Russian Empire, compiled by Ivan Kirilovich Kirilov and published in the so-called Kirilov atlas. Scale: 1:10,500,000, map on two sheets. Size of the original: 55 × 89 cm. Image courtesy of the Universität Bern, Zentralbibliothek, Sammlung Ryhiner (MUE Ryh 5902 2).

and occupational status as design elements. With the General'noye mezhevaniye data to hand, Vil'brekht continued this thematic approach in the *Carte des environs de S^t^. Petersbourg* (Russian edition, *Karta okrestnostey Sankt Peterburga*) (1792, 1:189,000), which showed the fifty-kilometer radius around St. Petersburg and included ten types of settlements, three categories of roads, industrial plants (foundries, smelters, wineries, quarries), mills (textile, saw, flour), and natural features (forests, parks, rivers, canals, lakes, marshes, and plowed land) (Postnikov 1996, 77–78, 85 [fig. 57]).

The near completion of the General'noye mezhevaniye by the end of the eighteenth century (in some regions it continued up to the 1820s) suggested to government officials that state-run cartographic activity had run its course. Paul I (r. 1796–1801) undertook an administrative reorganization of Russia in 1796, but it only produced a new edition of Vil'brekht's 1792 atlas. Early in the eighteenth century, Russian exploration in the Far East and northern Pacific added to geographic knowledge of the empire. The maps produced by these expeditions incorporated local information supplied by Siberians and local traders and hunters (*promyshlenniki*). For example, the inhabitants of Chukchi spoke of a "Great Land" lying across the ocean, providing further impetus for scientific expedition, carried out in the First (1725–30) and Second (1732–42) Kamchatka Expeditions, led by Vitus Bering and Aleksey Il'ich Chirikov, and the voyages to the Bering Straits and northern Alaska by Mikhail Spiridonovich Gvozdev and Ivan Fëdorov (1732). The Second Kamchatka Expedition produced nautical charts that displayed European cartographic traditions acquired by the expedition leaders in the Siberian schools of navigation (the first one opened in Okhotsk by Bering's order). Government-sponsored expeditions of 1768–69 and 1785–95 produced detailed surveys of the southern coast of the Alaskan Peninsula and Aleutian Islands, confirming Russian claims to these territories (Postnikov and Falk 2015). Native information was highly prized, and from the 1760s official instructions charged surveyors with collecting and preserving native places-names on Russian maps.

In general, the cartography produced in Russia during the long eighteenth century was promoted and organized by the state through its ministries or the Akademiya nauk with little private initiative either in original survey work or in commercial publishing. An exception was the Nerchinsk Expedition of 1797–1800, privately funded by the Kolyvano-Voskresenskiy mining factories in Altai, which surveyed territory around Lake Baikal and adjacent river basins. In the last quarter of the century, the establishment of up to ten private printing presses in Moscow and St. Petersburg proved to be a short-lived exercise, as all were closed by senate decree in 1796. Nonetheless, Russian cartography during the European Enlightenment demonstrated that concerted deployment of state resources could produce cartographic results that competed with its European peers in terms of quality and reliability.

ALEXEY V. POSTNIKOV

SEE ALSO: Academies of Science; Administrative Cartography; Boundary Surveying; Geographical Mapping; Map Collecting; Map Trade; Marine Charting; Poland-Lithuania, Partitions of; Property Mapping; Thematic Mapping; Urban Mapping

BIBLIOGRAPHY

Appleby, John H. 2001. "Mapping Russia: Farquharson, Delisle and the Royal Society." *Notes and Records of the Royal Society of London* 55:191–204.

Bagrow, Leo. 1975. *A History of Russian Cartography up to 1800*. Ed. Henry W. Castner. Wolfe Island: Walker Press.

Cracraft, James. 2004. *The Petrine Revolution in Russian Culture*. Cambridge: Harvard University Press.

Fel', S. Ye. 1974. "Russian Cartography of the 18th Century as a Synthesis of Astronomic-Geodetic and Graphic Processes." *Canadian Cartographer* 11:15–23.

Goldenberg, L. A. 2007. "Russian Cartography to ca. 1700." In *HC* 3:1852–1903.

Goldenberg, L. A., and Alexey V. Postnikov. 1985. "Development of Mapping Methods in Russia in the Eighteenth Century." *Imago Mundi* 37:63–80.

Kivelson, Valerie. 2006. *Cartographies of Tsardom: The Land and Its Meanings in Seventeenth-Century Russia*. Ithaca: Cornell University Press.

Kokkonen, Pellervo. 1997. "Practice of Marine Cartography and the Russian Representation of the Baltic Sea in the Eighteenth Century." *Fennia* 175:1–96.

Polnoye sobraniye zakonov' Rossiyskoy Imperii, C 1649 goda. 1830. Vol. 6. N.p.: Tipografii II Otdeleniya Sobstvennoy ego Imperatorskago Velichestva Kantselyarii.

Postnikov, Alexey V. 1989. *Razvitiye krupnomasshtabnoy kartografii v Rossii*. Moscow: "Nauka."

———. 1993. "Contact and Conflict: Russian Mapping of Finland and the Development of Russian Cartography in the 18th and Early 19th Centuries." *Fennia* 171:63–98.

———. 1995. *Geograficheskiye issledovaniye i kartografirovaniye Pol'shi v protesse sozdaniya "Topograficheskoy karty Tsarstva Pol'skogo" (1818–1843 gg.)*. Moscow: Vserossiyskiy Institut Nauchnoy i Tekhnicheskoy Informatsii.

———. 1996. *Russia in Maps: A History of the Geographical Study and Cartography of the Country*. Moscow: Nash Dom–L'Age d'Homme.

———. 2000. "The Russian Navy as Chartmaker in the Eighteenth Century." *Imago Mundi* 52:79–95.

Postnikov, Alexey V., and Marvin Falk. 2015. *Exploring and Mapping Alaska: The Russian America Era, 1741–1867*. Trans. Lydia Black. Fairbanks: University of Alaska Press.

Sergeyev, V. K. 1954. "Moskovskaya matematiko-navigatskaya shkola." *Voprosy Geografii* 34:150–60.