In 1483 the printer Ripoli...contracted to print a Latin translation of Plato by Marsilio Ficino, charging 3 florins for printing each of the 30 sections, 90 florins in all. Since the whole work was limited to 1,025 copies, each section comprising 4 sheets, the cost price of the paper must have come to 120–160 florins, dearer than the actual printing costs.
—Lucien Febvre and Henri-Jean Martin, The Coming of the Book

The transfer of paper and papermaking technology from the Islamic lands to Christian Europe in the eleventh and twelfth centuries prepared the way for the European print revolution of the fifteenth century. Yet Gutenberg's invention might never have taken off if he and his followers had been limited to printing books on parchment. Gutenberg is thought to have printed 200 copies of his Bible, 35 on parchment and 165 on paper, although only about 40 copies survive altogether. Early printers used movable type to produce editions of one hundred to two hundred, but by 1500 print runs of one thousand or two thousand copies—the print run of modern scholarly titles—were not unusual. Martin Luther's complete German Bible was printed in 1534 in an edition of four thousand copies, and it was reprinted many times. By the seventeenth century most important books had print runs of one thousand to two thousand copies, although editions of popular religious titles regularly surpassed that number. All this printing required enormous quantities of paper, and papermills throughout Europe struggled to meet the demand.

The invention of movable type came almost five centuries after the first use of paper in Europe (sometime before the year 1000). In that time, papermaking spread slowly from the Mediterranean region across the Alps, and written records and other forms of notation came to be used more and more—just as those developments had accompanied the spread of paper in the Muslim world. That Europeans learned about papermaking from the Arabs of Spain, North Africa, and the Levant—and not directly from the Chinese or other East Asians—meant that until the nineteenth century all European paper was made from rags. As paper became an essential commodity in Europe new sources of fiber were sought. Even in the seventeenth century, when Europeans encountered East Asian paper made directly from plant fibers, they did not realize its significance and thought it to be a local variant of the "Western" tradition of papermaking.

The first Christians to encounter paper were probably Nestorians living in Central Asia before the coming of Islam, but their small number made them insignificant so far as any technological breakthrough was concerned. The Christians living under the banner of Islam, however, recognized the advan-
tages of paper as soon as they encountered it. Although Christians, like Muslims and Jews, were initially reluctant to transcribe their scriptures on the new material, the Greek Christian manuscript copied in Damascus in 800 shows that the use of paper was not linked to religious affiliation (see fig. 25). Extensive diplomatic and scholarly contacts in the ninth century between Muslims and Christians—specifically, between the Abbasid capital of Baghdad, where paper quickly became common, and the Byzantine capital of Constantinople—should have made the Byzantines aware of paper at an early date, but they seem to have suffered from a sort of technophobia, so paper was hardly used in Byzantium before the eleventh century and did not become common until the late thirteenth. In contrast to the Byzantine Christians of eastern Europe, the Latin Christians of southern Europe learned about paper from Muslims making it in Spain and Sicily and were actively making it themselves by the twelfth century. From southern Europe papermaking was brought north of the Alps to France and Germany. Western European willingness to embrace and improve on this and other new technologies in the late Middle Ages, as opposed to the conservative Byzantine attitude, would have momentous ramifications in the centuries to come.

BYZANTIUM

There is little, if any, evidence that the Byzantines ever manufactured paper themselves. Until paper began to be used in the eleventh century, Byzantine books were usually copied on parchment codices, and state or legal documents were usually copied on papyrus and, later, parchment scrolls. Most modern scholars believe that Byzantium imported all the paper it used, even after it became popular, first from the Arab lands of West Asia, especially Syria, and then from Christian Spain or Italy. Arab paper was known as bambūkinon or bombúkinon and bagdatikón, names derived from the cities of Mambij and Baghdad, respectively.

As in the Islamic lands, bureaucrats were the first to use paper. The earliest preserved example of a Byzantine document on paper is a decree in roll form of the emperor Constantine IX Monomachos dated 1052, and at least thirteen other documents on paper survive from the eleventh century. Usually measuring something under 6 ½ feet (2 meters) in length, but occasionally as much as 23 feet (7 meters), these documents were pasted up from sheets measuring 14–16 inches (36–42 centimeters) wide. The format, roughly comparable to that of contemporary Fatimid documents preserved at Mount Sinai, shows that in chancery practice, as in ceremonial practice, the Fatimids and the Byzantines were unusually close. If we can generalize from the nearly six hundred surviving Byzantine documents that date from the eleventh to the fifteenth century, paper and parchment were used in almost equal propor-
tions. Paper, like papyrus, was a luxury product; the conservative imperial chancellery simply replaced the papyrus roll, a commodity imported from Egypt, with paper, a commodity imported from Syria and other Arab lands.

An inventory of the library of the monastery of Attaleiates in Constantinople, written in 1077, lists eight books on paper and six on parchment, indicating that both were used. Contemporaries may have judged parchment to be more durable, for a document written by the empress Irene Doukaina before 1118 states that the original copy of a certain convent’s charter was to be preserved on parchment in the church of Hagia Sophia, and paper copies were to be kept in the convent itself. This evidence is confirmed by a manuscript (Gr. 504) in the Vatican, copied in 1105. It is believed to be the oldest dated Byzantine manuscript on paper, although only parts (folios 5–115 and 157–190) were copied on paper, the rest being copied on parchment. The unusually large size and squarish proportions of the paper sheets (16¾ by 21¾ inches; 42.2 by 55 centimeters), which are unlike those of contemporary Arab paper, are probably due to the mixture of paper and parchment. The size of the more expensive parchment would have determined the shape of the book. The more rectangular sheets of paper would have been trimmed to match, perhaps wasting as much as a third of each sheet.

From the late twelfth century, manuscripts copied on paper became increasingly common in Byzantium, and by the early thirteenth century, they were largely being written on Spanish and Italian papers, indicating new sources of supply. On the one hand, this change can be understood as a general consequence of the Crusades and the constant insecurity in the region, which undoubtedly interrupted Syrian paper production; on the other hand, it can be understood as a specific consequence of the Fourth Crusade, when the Venetians conquered Constantinople, in 1204. European papers became even more common after the Byzantines reconquered the city in 1261. Already in 1260 a Catalan document from Barcelona notes the export of “French cloth, oil, paper and other kinds of merchandise” to Constantinople.

By the second half of the fourteenth century, paper had become the principal material for writing in the Byzantine empire, but now Italian papers dominated the market. Italian commercial superiority and the declining fortunes and diminishing size of the Byzantine empire in the fourteenth and fifteenth centuries made Constantinople an uneconomical place to set up a papermill. This situation changed after the Ottoman conquest of the city in 1453, when the first papermill known of there was established in the suburb of Kagithane (Papermill), and the city, which came to be known as Istanbul, was finally fully integrated into the world of paper. Although chancellery documents, as well as Greek manuscripts produced at the fifteenth-century court of
SPANISH PAPER

Several tenth-century manuscripts from the monastery of Santo Domingo de Silos indicate that paper was available at that time in Spain, although it may not have been made there before the early eleventh century. The characteristic features of Spanish- Arab paper, which have been studied in detail by the Catalan scholar Oriol Valls y Subirà, are long fibers, sizing with starch paste made from wheat or rice, glazing, and zigzag marks. The chain lines, left by the paper molds, are irregularly spaced wavy lines of varying thicknesses, suggesting that the molds lacked ribs to give them dimensional stability. When the unsupported mold mesh sagged with use, it produced sheets appreciably thicker in the middle than at the edges. The laid lines, also left by the molds, are always taut and parallel, however. Apparently, they were produced by hemp threads previously boiled in oil to ensure stiffness; vegetable fibers and horsehair were also used to make the mold mesh. There are normally ten to fifteen laid lines per inch (four to six per centimeter).

The manufacture of paper in Valencia became so important that in 1274, the king, Jaume I, prohibited the sale of rags at fairs to Perpignan merchants, and in 1306, after a disagreement with the king of France, Jaume II placed an embargo on paper.

Mehmed II, were still copied on European, mostly north Italian, paper, Arabic and Persian texts from Mehmed II’s royal library were copied exclusively on paper of West Asian manufacture.

By the time that paper production developed in Ottoman Istanbul, however, papermaking had virtually vanished from its traditional Syrian and Egyptian locales. Although the Ottomans may have already established papermills in such Anatolian cities as Amasya, the closest and most likely places from which Istanbul papermakers could have learned their craft were the Turkmen-held cities of Shiraz, Isfahan, and Tabriz in Iran, which had been centers of papermaking and the arts of the book at least since the late thirteenth century and which flourished under the patronage of the Aqqoyunlu Turkmens in the fifteenth century. From the 1450s, Ottoman calligraphers adopted the Iranian technique of using a harder size (finish) for their paper, rather than the softer size preferred by Arab calligraphers, and Ottoman illuminators adopted the brilliant Iranian style of illumination characterized by a lavish use of gold. It is likely, therefore, that Iranian artisans brought these techniques to the Ottoman court. At exactly this time, scribes from the Aqqoyunlu court came to work for the Ottomans, introducing the distinctive Iranian chancellery script, known as taliq, that the Ottomans assimilated and transformed into their characteristic divan script.

SPAIN

The Christians of the Iberian Peninsula were far more receptive to paper than the Byzantines were, a testimony to the sharing of material and technical culture under the Umayyad caliphate. Spanish Christians became familiar with paper well before the year 1000, almost as soon as Muslims began to use it, and as Christians became masters of greater areas of the peninsula after 1000 they used it more. That the use of paper had expanded in Spain by the twelfth century can be seen in the comment of Peter the Venerable, abbot of the Benedictine monastery at Cluny, in France, after returning from a pilgrimage to Santiago de Compostela in 1141. Peter, who had commissioned translations of five Arabic books, including the Koran, had a remarkable knowledge of Islam. Having seen that the monks of the Cluniac monasteries in Spain used paper, he hyperbolically expressed his aversion to it: "In Heaven [says the Jew], God reads the Talmud. But what kind of book is this? In appearance it is like those that we read every day, which are made from the skins of rams, he-goats, and calves [that is, parchment], or the bark of rushes [papyrus] plucked in the swamps of the East. These [papers], however, are made from scraps of old rags, or, perhaps, from even viler stuff; and they are inscribed in foul ink by means of the feathers of birds or swamp reeds." Peter’s rantings are important early
evidence for the use of paper, but Diderot, in the eighteenth century, considered his comments suspect and erroneously concluded that true paper was unknown in Europe before the thirteenth century.

Fortunately, Peter’s rodomontade had little effect on the use of paper, and in the following centuries it became the material of choice in Spain and elsewhere in Europe, particularly for documents and records, if not for books. The Valencian paper industry, centered at Játiva, flourished until it was overshadowed by Italian production in the fourteenth century. Sheets of Játiva paper typically measured 11 ¼ by 16–19 inches (29 by 40–47 centimeters). Size varied wildly, though; before printed books, there was simply no need to make paper in absolutely standard sizes, so even the "standard" sizes discussed in the classical Arabic sources were only approximations. Certainly every sheet produced from a particular mold would have been the same size, but a variation between individual molds of even as much as several inches appears to have been quite acceptable, and such variations were easily accommodated by scribes and bookbinders. The standardization of paper sizes, which, in turn, standardized the size of the codex and accompanied the development of printed books, lay well in the future.

Spanish paper was sold in sheets, quires, and even bound books and was exported to the whole Mediterranean region, including Majorca, Italy, Morocco, Tlemcen (Algeria), Tunis, Athens, Byzantium, Sicily, and Egypt. The rapid acceptance of paper in the Christian regions of Spain itself is attested by the large number of paper documents preserved in the crown archives of Aragon, one of the largest repositories of medieval European (and North African or West Asian) paper. The earliest datable sheet of paper there is a piece of linen rag paper on which is copied a parchment document dated 1178; hundreds of paper documents survive from after that date.

Why did paper and papermaking spread so rapidly in the regions of Iberia then coming under Christian control? As Christian rule expanded over the peninsula, the Muslims now living under Christian rule, who were known as Mudejars, certainly must have practiced their traditional crafts, including papermaking. But this does not explain why papermaking moved into new areas. One scholar, Oriol Valls y Subirà, theorizes that the Almoravids (1056–1147) and Almohads (1130–1269), fundamentalist Muslim dynasties that ruled in the south, persecuted dissident Muslims, including papermakers, and this drove them to settle in the Christian kingdoms of the north. If this argument is correct, the refugees would have established new papermills in such regions as Catalonia and Bilbao as early as the twelfth century. The argument rests on the identification of the many fulling mills—water-driven mills in which woolen cloth was beaten to felt it slightly—mentioned in the sources among other exports. Several late thirteenth-century documents show that paper was exported from Játiva to Sicily, Byzantium, and other destinations, and a thirteenth-century Constantinopolitan manuscript copied on paper marked with the distinctive Spanish zigzag proves that Spanish paper made its way as far as the Byzantine capital.

Toward the end of the thirteenth century there were several changes in Spanish paper: the chain lines became parallel and more regular, indicating that the molds were of better manufacture, and the fibers—basically linen with a small admixture of hemp—became much shorter and better pulverized, indicating that the stampers for beating the pulp were becoming more efficient. The first Catalan watermarks appeared in the late thirteenth century, too, at the same date as the Italian Fabriano watermarks.
as actually being mills for beating pulp, or at any rate mills that were easily convertible for that purpose. But this was not necessarily the case.

Another theory suggests that when King Jaume (James) II of Aragon conquered the province of Valencia and the city of Játiva in the mid-thirteenth century, the expanded bureaucracy in the regions now opened for Christian settlement demanded documentation, meaning a sharp increase in forms and records, presumably on paper, as officials, settlers, and carpetbaggers made their positions and holdings secure. The Muslims of Játiva had run the paper industry as a cottage craft when they were under Muslim rule, but after the Christian conquest the industry progressively fell under direct crown control, or so the theory goes. Under the benevolent patronage of the Christian king, Muslim and then Christian papermakers would have applied new technologies, whether the improved water-driven hammermill to mass-produce more finely macerated pulp or the improved paper mold woven from brass wire to make better and more consistent sheets. The consequent flood of inexpensive paper allowed by the new technologies would have revolutionized crown recordkeeping, for it would have encouraged bureaucrats to file cheap paper copies of the charters that they sent out as more durable parchments.

Unfortunately, neither theory entirely fits the facts. Although King Jaume’s archive undoubtedly reflects the first important government use of paper in Christian Europe, his contemporary King Alfonso the Wise of Castile also used paper, but limited its use to lesser categories of documents, such as commercial permits, routine financial records, broadcast mailings, and passports. Nor can we say for sure that the paper made in Christian Játiva was superior to what Muslims earlier made elsewhere. Most reports and examples over the centuries indicate that Spanish Islamic paper was of consistently high quality (much higher in fact than the problematic treatise of the North African Ibn Badis might suggest; see Chapter 3). Furthermore, water-driven trip-hammer mills were not an invention of Christian Spaniards. Such mills had been known for centuries in the Islamic lands and were probably introduced to the Iberian Peninsula by the eleventh century along with the cultivation of rice, for they were essential to husking the rice without crushing the grain.

Without doubt, however, Europeans—not only Valencians but also Italians and later Germans—harnessed waterpower more efficiently than West Asians and North Africans had, primarily because they used the overshot waterwheel to power their mills. In addition, Europe had a wetter climate and more rugged terrain than most of the Islamic lands, so more water was generally available, and the streams tended to be faster, providing more potential energy to power the mills. Europeans also improved the design of stampers by putting studded iron coverings over the heads of the wooden mallets. Finally,
the marked improvement of the quality of Játiva paper in the thirteenth century was not an isolated phenomenon, but was part of a much broader trend, for the improvement is also apparent at the opposite end of the Mediterranean, where in thirteenth-century Iran, Iraq, and Egypt paper became whiter, finer, and more evenly beaten. That King Jaume of Aragon negotiated an alliance with the Mongols while Genghis Khan was contemplating invading Europe indicates that such far-flung connections are not improbable.

The earliest Italian paper to appear in the Aragon archives dates from 1291, only a short time after Italian production began in earnest, and the tremendous flowering of the Italian paper industry rapidly brought about the decline of both Iberian and North African production. By the mid-fourteenth century, complaints surfaced about the precipitous decline in the quality and the size of Játiva paper in comparison with the Italian product, but by this time it was too late to improve the situation, and the brief heyday of the Spanish paper industry was over. The word *ream*, which derives from the Arabic word for “bundle” and which entered European languages via the Spanish *resma*, remains a legacy of the important role that Spain played in the history of papermaking.

**ITALY**

Paper was introduced in Sicily by the late eleventh century, but the major centers of Italian papermaking developed elsewhere in the following centuries. Sicily had shared a cultural heritage and government with North Africa from 827, when the Arabs conquered the island, until 1061, when the Norman conquest was complete. Even after the Normans had established themselves, many Sicilians still regarded the Arab-Islamic culture of North Africa as worthy of emulation. Although North Africans were slow to accept paper, by the late eleventh century they had brought paper to Sicily. The first extant paper document is an order of Adelaide, the widow of the Norman king Roger I, which is dated 1109 and written in Greek and in Arabic. The document shares the format of contemporary Arab paper, indicating that the paper was probably imported from North Africa.

Adelaide’s order cannot have been the first use of paper in Sicily, however, because slightly earlier and contemporary documents—dated 1097, 1102, and 1112—were written originally on paper, although they were transcribed onto parchment for safekeeping in 1145 on the orders of Roger II. Nearly eighty years later, in 1222, King William II also had paper documents dated 1168, 1170, and 1187 copied onto parchment, again for safekeeping. In 1231, Frederick II, king of Naples and Sicily, went so far as to prohibit the use of paper for public documents in Naples, Sorrento, and Amalfi because of its perishable nature. Like the Byzantines, the Sicilians did not make paper, but imported it...
from North Africa, Islamic Spain, or Valencia. In fact, paper was initially known in Latin as *carta cuttunea*, "cotton papyrus," probably a mistranslation of the Byzantine Greek *charta bombycina*, for Norman Sicilian culture was also heavily dependent on Byzantium. From the second half of the eleventh century Iberian paper, distinguished by its format and by the presence of zigzags, was used in Sicily and southern Italy for copying manuscripts written in Greek.

As far as we can tell, the inhabitants of central and northern Italy did not use paper before the mid-twelfth century, when Genoese notaries started to record their official acts in registers made from paper. With the commercial and legal renewal of the region, the institution of the notary, which had disappeared from northern Italy and southern France since Roman times, was revived, along with the principles of Roman law. Oaths, wills, judicial procedures, and commercial, financial, and marriage contracts were increasingly "notarized." For notaries, paper was a relatively permanent material on which to write; it was also cheaper than parchment and easier to file for reference, presumably because the sheets lay flatter and more compactly. A new system of registering notarial records that developed in twelfth-century Italy contributed to the increased use of paper there. The gradual replacement of parchment by paper, which was more fragile, also caused the disappearance of the lead or wax seals that had been affixed to documents by cords or ribbons threaded through pierced holes. Instead, all but the most important state documents came to be sealed with affixed lumps of wax impressed with a signet.

The most famous register to survive from this period is that of the notary Giovanni Scriba, which, with some gaps, covers the decade from December 1154 to August 1164. The paper he used was probably imported from Spain or possibly North Africa. Paper was cheaper than parchment, but it still was not cheap, for the last folios of Giovanni's register are the remains of an Arabic roll with Latin translations that had already been cut into sheets and reused by a contemporary notary. Although the format is similar to that of sheets used earlier, certain technical characteristics have led scholars to suggest that these somewhat finer sheets were made either in the eastern Mediterranean or in the region corresponding to modern Tunisia.

Other notarial registers from the late twelfth century are on sheets of slightly larger format, and the presence of zigzags suggests that the paper was made somewhere in Spain. This hypothesis is supported by numerous medieval documents mentioning shipments of paper from Barcelona and Valencia. Although the Genoese probably imported their paper from some western Mediterranean port, their strong diplomatic and commercial ties with Byzantium, where paper had been used in the chancellery since the mid-eleventh century, may also have contributed to the increased use of paper in
Genoa over the course of the twelfth century. Genoa entered into commercial relations with Byzantium in 1142, and in 1155 a formal alliance was concluded between the city-state and the empire.

A decline in the quality of paper used in the Genoese archives suggests that paper was first made in northern Italy in the early thirteenth century. The paper used from around 1215 was like Spanish predecessors in many ways, but the pulp is less well beaten, the laid lines are thicker and unevenly spaced, and the sheet is rougher. By the middle of the century, the sheets had become larger, whiter, and somewhat finer, so whoever was making it was improving rapidly in technique. The only region in northern Italy where paper is known to have been made before 1250 is the Ligurian coast near Genoa. In a contract dated 24 June 1235, a certain Gautier "the Englishman" agreed to make paper with one Mensis of Lucques and promised to teach no one else the technique. Twenty years later, on 18 May 1255, Michele Traverso of Milan and Giovanni of Sant' Olcese (a village near Genoa) also began a paper business.

Ligurian production was short-lived, however, for by the mid-thirteenth century the town of Fabriano, in the Marche of Ancona, in central Italy, was successfully making paper: paper is still being made there more than seven centuries later. A document of 1264 discovered in the archives of the nearby town of Matelica confirms that paper was made and sold there by that date. The first attempts at making paper in Fabriano were probably inspired by Ligurian production, but the Fabriano papermakers appear to have used a somewhat different technique. Fabriano paper is closer to that made by Arab papermakers in the eastern Mediterranean, and production was probably developed through direct contact with that region during the Crusades.

Following the success at Fabriano, papermaking centers developed in such other regions as the Veneto. The eastern Mediterranean origin of the papermaking technique—as opposed to an Iberian origin—is confirmed by the words used for paper in Latin or in the dialects of the Veneto and central Italy, which follow Byzantine Greek usage. In Padua paper was called carta bambacina, in Modena cartas bambari, in Bologna charta de bambare, in Pistoia carta de bambacia, and in San Gimignano carte bambagie. Nowhere was it known as shabti, the common term used in Spain.

By the end of the thirteenth century, paper made in the Fabriano region was used in Naples, Sicily, and the Balkans, across the Adriatic Sea. Fabriano paper soon dominated the Mediterranean market. By the mid-fourteenth century it competed with Spanish paper even in Spain, causing the decline of the industry there. The instant success of Italian papermakers at making and exporting their product is evident from the fourteenth century. Not only did they take advantage of technological know-how to make large quantities of diff-

chain lines. In addition, if a mold had supplementary ribs, the ribs occasionally interfered with the depositing of fiber when the mold was pulled from the vat. This slight unevenness, known as rib shadow, can sometimes be seen against the light. To localize and date paper made before the invention of watermarks or where watermarks were not adopted, scholars must rely on such features as the size of the sheet, the distinctive arrangement and spacing of laid and chain lines in the paper, and the presence or absence of rib shadows.

All European paper until the eighteenth century displayed a laid pattern of faint parallel lines left from the wires of the mold. In 1756 the English papermaker James Whatman was the first European to produce a perfectly even "wove" paper using a mold of woven wire, and the Birmingham printer John Baskerville used Whatman's paper the following year to print an edition of Virgil. Because of the even surface that readily accepted the impression of type, wove paper quickly became popular among printers and has remained so ever since.
Different qualities of paper suitable for many uses, but they also understood how to market their product at home and abroad. In Egypt, they sold Italian paper cheaply at first—perhaps even below the cost of production—to increase market share and destroy the local competition. In addition to al-Qalqashandi's disparaging remarks about Italian paper in Egypt (see Chapter 2) and certain North African letters in Spain, we have as evidence a single-volume manuscript of the Koran in the Khalili Collection (see fig. 24). It was transcribed, probably in Baghdad, on Italian paper datable to the 1340s. The paper, heavily watermarked with a double-key design surmounted by a cross, is almost identical to examples made in Arezzo and Torcello, near Venice, which suggests that Genoese and Venetian merchants carried paper on their trading missions to buy textiles and spices in Iraq and Iran. The trade is confirmed by the appearance of Italian, particularly Venetian, papers in Arabic, Persian, and Armenian manuscripts of the fourteenth century copied in Georgia and the Crimea.

Europe North of the Alps

Papermaking was significantly slower to take hold north of the Alps than in Italy. The oldest documented use of paper in Germany is dated 1246–47: the dean's register from the cathedral of Passau, which was written on Italian paper. Over the course of the thirteenth century, paper became commoner, particularly in the Tyrol, the Alpine region closest to Italy, which was crossed by important trade routes. Ulman Stromer (or Stromair), a merchant trading in Italy, established the first documented papermill north of the Alps at Gleismühle, near Nuremberg, in 1390. Stromer had apparently seen the craft practiced in Italy and hired Lombard artisans to work at his mill, which was represented several decades later in Hartmann Schedel's woodcut view of the city (see fig. 1).

Stromer's enterprise was followed by others at Ravensburg (1393–94), Chemnitz (1408–25), Strasbourg (1445), and Basel (mid-fifteenth century). The first papermill in Austria was established in 1498. Papermills had already been established in Brabant and Flanders by the late fourteenth century and were established in the Netherlands in the sixteenth century.

Before Johann Gutenberg invented printing with movable type and produced the Bible at Nuremberg in the 1450s, the expansion of paper was generally slower in Europe than in the Muslim world. Although paper was cheaper than parchment—at Bologna in 1280, sheets of paper were six times cheaper than equal-sized sheets of parchment—parchment was still moderately priced and relatively abundant in some regions. Paper was sold by mercers in the fourteenth century and by apothecaries in the fifteenth.
Naturally enough, paper spread more quickly in some regions than in others. In Catalonia, Tuscany, and the south of France it spread rapidly. Italian merchants used paper registers at the Champagne fairs between 1277 and 1282. In France, as in Genoa, the use of paper went hand in hand with new notarial practices and brought notaries a new clientele of more modest means. One clerk from Ghent bought "writing paper" when he passed through Montpellier in the 1270s. In Castile, a region known for its many sheep, paper came into use at a later date than in other regions of Spain. The adoption of paper in England may have been retarded for similar reasons. The oldest paper fragment found in the Public Record Office in London dates from around 1220, but papermaking did not begin in Britain until the very end of the fifteenth century, and even then it was a hit-and-miss operation.

Other arts developed in northern Europe with the increasing use of paper, paralleling the course of their development in the Islamic lands, although paper itself was not widely available north of the Alps until the fourteenth century. Throughout the Romanesque and early Gothic periods, builders normally erected churches without using preliminary drawings. A few architectural drawings on parchment survive from the mid-thirteenth century, but more are associated with the masons' lodges of northern Europe in the late Middle Ages. The most profound changes occurred in the second half of the fifteenth century, however, when increased production of paper, undoubtedly a by-product of the print revolution, encouraged greater freedom in design and drawing methods, with communication between architect and builder coming gradually to depend less on verbal instructions and more on notation.

The triumph of paper over papyrus and parchment in Europe was due not only to the relative cheapness of the final product but also to the availability, as well as the low cost, of the raw materials from which it was made. In other words, enough paper could be made to meet the demand. That demand grew dramatically in the wake of Gutenberg's invention. But if the papermaking industry had not been poised to meet the demand for printed books, Gutenberg's invention would have failed in its effect. Thus, the availability of paper allowed the production of books on a previously unknown scale. It is for this reason that we can talk of a paper revolution following the invention of printing with movable type.

Gelatin, unlike starch, also inhibited the growth of microorganisms on the paper. The first dated paper sized with gelatin is a document of 1264, although many papermills continued to size with starch after 1300.

Italians also mechanized the pulping process. As in Spain, the papermakers harnessed the power of the faster and more abundant local streams to power their stampers, an advantage they had over papermakers in the Islamic lands, who usually had to make do with sluggish rivers. Italian papermakers also innovated by arranging their stampers in batteries, so that the rags, passing successively from one stamper to another, were pounded into a finely and evenly beaten pulp. As a result, paper of high quality could be produced cheaply and quickly.