Revolution by the Ream

A History of Paper

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The Paper Trail

paper, one of the most ubiquitous materials in modern life, was invented in China more than 2000 years ago. Nearly a millennium passed, however, before Europeans first used it, and they only began to manufacture it in the 11th and 12th centuries, after Muslims had established the first paper mills in Spain. The German Ulman Stromer, who had seen paper mills in Italy, built the first one north of the Alps at Nuremberg in the late 14th century.

The cultural revolution begun by Johann Gutenberg’s printing press in 15th-century Mainz could not have taken place without paper mills like Stromer’s, for even the earliest printing presses produced books at many times the speed of hand copists, and had to be fed with reams and reams of paper. Our demand for paper has never been satisfied since, for we constantly develop new uses for this versatile material and new sources for the fiber from which it is made. Even today, despite the computer’s promise to provide us with “paperless offices,” we all use more paper than ever before, not only for communication, but also for wrapping, filtering, construction and hundreds of other purposes.

How did paper get from China to Europe? Soon after its invention, Chinese merchants and missionaries transmitted paper, and knowledge of papermaking, to neighboring lands such as Japan, Korea, and Central Asia. It was there that Muslims first encountered it in the eighth century. Islamic civilization spread knowledge of paper and papermaking to Iraq, Syria, Egypt, North Africa and, finally, Spain. This pivotal role is evident in the way we still count paper in units—today they are units of 500 sheets—called reams. That word came into English via the Old French rayme from Spanish resma, which in turn comes from the Arabic rizmah, meaning a bale or bundle.

Most accounts of the history of paper focus either on its origins in China or its development in Europe, and simply ignore the centuries when knowledge of paper and papermaking spread throughout the Islamic lands. Some of this neglect is due to the difficulty of studying Islamic paper, since Islamic papers, unlike later European papers, do not have watermarks (see sidebar, p. 30) and are consequently very difficult to localize and date. Nevertheless, the diffusion of paper and papermaking skill in the Islamic world in the period between the eighth and the 14th centuries wrought enormous changes in such diverse realms as literature, mathematics, commerce and the arts, just as printing with moveable type spurred a conceptual revolution whose effects are still being felt today.

Europeans long debated the origins of paper. Until relatively recently, most people thought that paper derived from papyrus (see sidebar, p. 32) or that Europeans or Arabs had invented it. Indeed, the word paper, attested in English since the 14th century, does derive, via Old French and Spanish, from the Latin word papyrus.
Medieval Muslims, on the other hand, knew that paper came from China. As early as the 11th century, the Arab historian ‘Abd al-Malik al-Tha‘alibi, enumerating the specialties of different lands in his Book of Curious and Entertaining Information, says that “paper is among the specialties of Samarkand, and it looks better and is more supple, more easily handled, and more convenient for writing than papyrus and parchment,” the two major writing materials known in antiquity. According to al-Tha‘alibi, Chinese prisoners captured by the Arab commander Ziyad ibn Salih introduced papermaking to Samarkand after the battle of Talas in 751. (See Aramco World, September/October 1982.) “Then paper was manufactured on a wide scale and passed into general use, until it became an important export commodity for the people of Samarkand,” al-Tha‘alibi wrote. “Its value was universally recognized and people everywhere used it.”

Whether or not one takes al-Tha‘alibi’s account at face value, paper was undoubtedly introduced to the Middle East through Central Asia. Specimens of very old paper have been discovered at various sites in eastern Central Asia, where the extreme dryness of the climate helped preserve them. In 1900, a Chinese Buddhist monk accidentally discovered more than 30,000 paper scrolls in a cave at Dunhuang, in China’s Gansu province. As the cave was first used in 366 and was sealed in the 10th century, the papers—comprising Buddhist, Taoist and Confucian texts, government documents, business contracts, calendars, and miscellaneous exercises written in Chinese, Sanskrit, Soghdian, Iranian, Uighur and Tibetan—must date from this six-century period. In 1907, the British explorer Sir Aurel Stein discovered a group of Soghdian paper documents in a ruined watchtower between Dunhuang and Loulan, farther west. They comprised five almost complete letters and several fragments. The letters, dating from between the fourth and sixth centuries, were found in a refuse heap, and probably represent the contents of a lost or abandoned mailbag. One of the letters was wrapped in silk and enclosed in a coarse cloth envelope addressed to Samarkand, which lay about 2000 miles farther west. The find shows that paper was used by Silk Road merchants throughout the oasis cities of Central Asia even before the coming of Islam.

In 1933, Soviet scholars found several paper documents among 76 Soghdian, Arabic and Chinese texts discovered at Mount Mug, the mountain stronghold, near Pendzhikent in Tajikistan, where Devastich, lord of Panch, had attempted to escape from the Arab invaders in 722–723, some three decades before the battle of Talas. Pendzhikent, just east of Samarkand, is only 500 kilometers (300 mi) from Talas.

This Central Asian diffusion route is confirmed by the first Arabic word for paper, kaghad, and by the Turkish word, kâğıt, used to this day. Both derive from Soghdian and Uighur words, which themselves derive from the Chinese word gu-zhi, “paper made from paper-mulberry bark.” Qiratas, another early Arabic word for paper, was borrowed from the Greek chartes and initially referred to papyrus, was available in Baghdad for bureaucrats to use it for record-keeping instead of papyrus and parchment. According to the great 14th-century North African historian and philosopher Ibn Khaldun, the vizier al-Fadl ibn Yahya introduced the manufacture of paper to Baghdad when parchment was in short supply and he needed more writing materials. The vizier, whose family came from Balkh, now in northern Afghanistan, was probably familiar with paper from his youth. “Thus,” Ibn Khaldun writes, “paper came to be used for government documents and diplomas. Afterward, people used paper in sheets for government and scholarly writings, and the manufacture [of paper] reached a considerable degree of excellence.” Ibn Khaldun did not mention one of the greatest advantages of paper: Since it absorbed ink, writing could not easily be erased from it, as it could from papyrus and parchment. Documents written on paper were therefore more secure from forgery.

Papermaking and stationery were soon significant businesses in Baghdad. Ahmad ibn Abi Tahir (819–893), the teacher, writer, and paper dealer, was established at the Suq al-Warraqin (the Stationers’ Market), a street which was lined with more than 100 paper- and booksellers’ shops. Stationers in Abbasid Baghdad must have functioned somewhat like private research libraries, for the ninth-century polymath al-Jahiz is said to have rented stationers’ shops by the day in order to read the books they kept in stock. Another famous stationer was Abu’l-Faraj Muhammad ibn Ishaq (d. 995), known also as Ibn Abi Ya’qub al-Nadim al-Warraq (“the Stationer”). He used his extensive professional knowledge to compile the Fihrist, an encyclopedia which remains a mine of information about medieval books and writing.

The new availability of paper in the ninth century spurred an extraordinary burst of literary creativity in virtually all subjects, from theology to the natural sciences and belles-lettres. Religious scholars collected and codified the traditions (hadith) of the Prophet, which had been preserved orally following his death in 632, and committed them to ink and paper. New types of literature, such as cookbooks and the tales we know as The Thousand and One Nights, were copied on paper for sale to interested readers. Although earlier caliphs had maintained libraries, it was Harun’s son and successor al-Ma’mun (813–833) who enlarged the caliphal library, which came to be known as the bayt al-hikmah, or “house of knowledge.” (See Aramco World,
Paper in One Paragraph

Paper owes its distinctive strength and flexibility to the way the cellulose fibers it is made of are chemically and physically bound together in the papermaking process. In traditional papermaking, the cellulose fibers are extracted from plants, or from rags made from plant fibers, and then beaten in water to make the fibers swell and bond together into a pulp. This pulp is suspended in water, and a mat of it is then collected on a screen and drained. As the mat dries, the fibers physically intertwine and the microfibrils form physical and chemical links with each other. Paper sheets were at first formed with a floating screen, a primitive type of mould made from a woven cloth stretched on a frame onto which the pulp was poured. The pulp remained on the screen until the sheet was dry. The two-piece mould, in which the screen could be separated from the frame and which was lowered vertically into the vat containing the macerated fibers and then raised horizontally, marked a major advance in papermaking. It allowed the just-formed sheet of paper to be removed from the mould while still moist. Other sheets could then be formed in the mould while the first sheet dried. Moulds were traditionally made of smooth bamboo or flax fibers (or, in Europe, of thin brass wire) held parallel by cross-ties of silk, flax, hair or wire. Whatever the materials, paper made with this type of screen generally displays a distinctive pattern of faint parallel lines called “laid lines,” and European papermakers quickly discovered that they could weave designs into the screen which would leave faint “watermarks” in the finished paper.
Al-Uqlidisi’s new calculation techniques, published around 950, clearly assume the use of paper and ink instead of the familiar dust-board.

The oldest surviving dated book copied in Arabic script on paper is generally believed to be a fragment of Abu ʿUbayd al-Qasim ibn Sallam’s work on unusual terms in the traditions of the Prophet. Preserved in the Leiden University Library, and dated to November or December of 866, the manuscript is on dark brown, opaque, stiff paper; it is strong, of medium thickness, and has clearly undergone some polishing on both sides. Thus, we know that paper was used in the Islamic lands for Christian, secular, and theological manuscripts at least from the ninth century.

There seems, however, to have been some resistance to using this new material for transcribing the Qur’an, the most important and popular book in the Islamic lands, which was normally copied on leaves of parchment. Parchment is made from the wetted,
The papyrus plant (*Cyperus papyrus*; its name is the ultimate source of our word paper) is a member of the sedge family which once grew throughout the uncultivated marshes of the Nile. In Egypt, the plant could grow to a height of five meters (16') and its stems reach a thickness of five centimeters (2'), but under less ideal conditions the plant yields only modest stems, so that the manufacture of papyrus was essentially an Egyptian industry. By the 19th century increased cultivation had destroyed the reed’s native habitat, and it had died out in the Nile Valley, although it still flourished in the Sudan. The papyrus strain currently grown in Egypt was introduced in 1872 from the Jardin des Plantes in Paris.

The first-century Roman writer Pliny the Elder described the manufacture of papyrus sheets in his *Natural History*, although his description is difficult to follow and has given rise to varied interpretations. Surviving papyri, however, give some indication of how sheets of writing material were prepared from the plant. (See *Aramco World*, July/August 1973.)

The papyrus stems were cut into manageable lengths and the outer layer removed from the pith. The pith was then sliced or peeled into very thin strips, normally one to three centimeters wide (1/8–1/4'). The resulting strips could be used immediately or dried and stored, in which case the strips were soaked until the fibers loosened. In either case, the strips were then laid parallel, one by one, on a smooth surface, just touching or slightly overlapping each other. Another similar layer, with its strips running at right angles to the first, was laid on top. Pressing or hammering brought the strips together, and the fibers of the two layers intertwined. The whole thus dried into a strong and flexible sheet. Papyrus sheets were pasted end to end with flour paste to form a roll, normally about 20 sheets long. The plant juices remaining in the sheet functioned as a natural sizing, barely allowing carbon ink to penetrate the surface, and erasures could thus be made by wiping or washing away the wet ink, or by using a stone eraser to abrade the dried surface.
The oldest surviving dated book written in Arabic on paper is this partial copy of the grammatical work Kitab Gharib Al-Hadith (The Book of Linguistic Difficulties in the Traditions of the Prophet), completed in late 866.

The sanctity of the holy book and the respect accorded its earthly copies meant that the Qur'an continued to be transcribed on expensive parchment, often in the traditional bold Kufic script, well after paper became widely available.

To make parchment, goat or sheep skin is wetted, stretched and scraped repeatedly. The word probably derives from the name of the Greek city of Pergamon (now Bergama, Turkey), where the techniques that allowed utilization of both sides of the skin were developed in the second century BC.
sold. This suggests that paper had become relatively cheap, although it still wasn’t so cheap that it was easily discarded. Used paper was saved so that the fiber could be recycled into new paper.

Like Central Asia’s, the extremely dry climate of Egypt is ideal for preserving organic materials, and several great caches of ancient papyri and medieval papers were discovered there in the 19th century. In 1877 archaeologists found more than 100,000 papyrus and paper documents at Akhmin, Arsinoë, and Ashmunayn, including important historical and economic documents from the Islamic period. Most were acquired by Archduke Rainer of Austria in 1884 and formed the basis of the great Vienna Papyrus Collection at the Nationalbibliothek. At approximately the same time, workmen discovered some 300,000 more documents, dating mainly from the mid-10th to the mid-13th centuries, in a storeroom (known in Hebrew as a geniza) of the Palestinian Synagogue in Fustat. The geniza documents include trousseau lists, commercial documents and personal letters relating to the Jewish community; they had been placed in the storeroom in anticipation of proper disposal, but were forgotten for centuries 7.

Mostly in Judeo-Arabic—colloquial Arabic written in Hebrew characters—they have become an essential source for reconstructing daily and economic life in the medieval Islamic lands, as well as for the history of spoken Arabic. They also show how paper had become an indispensable medium of communication in this commercial society, where bills of exchange, orders of payment, and similar documents, most of them written on paper, were regularly sent back and forth between trading communities located as far apart as Spain and India.

The Zipidi prince-al-Mu’izz ibn Badis, who ruled in what is now Tunisia and eastern Algeria from 1016 to 1062, included a brief account of medieval papermaking in his book, ‘Umudat al-Kuttab (The Support of Scribes), the only medieval work on the arts of the book to survive. However, the process of making paper from raw flax on a floating screen, as Ibn Badis described in detail, had been superseded for centuries throughout the Islamic lands, where papermakers had adopted more advanced techniques, using waste rags and old rope as the primary source of fiber, and dipping the paper mould in a large vat of pulp suspended in water. It is possible that Ibn Badis’s sources did not wish to share the real secrets of papermaking with him. The rest of his account refers to the sizing of paper with equal quantities of chalk and starch, or with rice starch, and dyeing paper different colors.

Oddly enough, the one manuscript known to have been copied and illuminated during Ibn Badis’s lifetime is a copy of the Qur’an transcribed on parchment, not paper, in 1020. According to the Geniza documents, Tunisia and Sicily were great centers for leather production, and private letters and documents from that region were still written on parchment well into the 11th century. But papermaking nonetheless spread

7 Nearly all of the approximately 200,000 medieval documents found in 1896 in the geniza of the Palestinian Synagogue in Fustat (Old Cairo) were written on paper; they are evidence of the wide availability of inexpensive paper in the Islamic lands. Many were written in Arabic using the Hebrew alphabet, like this letter of thanks.
By the mid-14th century, North African chanceries had begun to use Western papers.

Throughout North Africa and Spain, Fez was already an important papermaking center in the 11th century, with 400 paper mills reported by the end of the 12th century, and the first Spanish paper mill is documented at Játiva in 1056. Here too there seems to have been some reluctance to use paper for manuscripts of the Qur’an, even after it had become acceptable in the east. Paper manuscripts of the Qur’an began to appear in the western Islamic world in the 13th century, but parchment ones continued to be produced well into the 14th century.

Ibn Badis’ description of colored papers is confirmed by North African documents surviving in European archives, where some are on papers varying in color from red or vermilion to purple or pale pink. These documents are known by the generic term nasri, after the Nasrid dynasty of southern Spain, which ruled from the Alhambra in Granada. (See Aramco World, March/April 1999.) Perhaps the most striking example is in the Aragonese archives, a blood-red paper made of linen and hemp. Its text is a furious letter written in 1418 by Muhammad VIII of Granada to Alfonso V, protesting that his representative at Alfonso’s court had arrogated undue powers to himself; the vivid color may have been intentionally chosen to symbolize the wrath of the writer.

Paper began to be used in Italy at the very end of the 11th century, first in Sicily, where the Normans followed Arab custom, and then in the northern trading cities. In the first half of the 13th century some paper was briefly made near Genoa, probably following Spanish techniques, but the major center of Italian paper manufacture developed after 1276 at Fabriano, in central Italy. The Europeans’ ability to harness water power to run paper mills made their product cheaper, if not initially better, than that available in North Africa and Egypt, and imported Italian paper soon began to supplant local production in North Africa and Spain. By the mid-14th century, North African chanceries had begun to use Western papers. A letter dated December 8, 1350 from the Sultan of Tunis to King Peter IV of Aragon-Catalonia is on
paper bearing a griffin watermark, which shows that it had been exported from Italy. At much the same time, Egyptian papemakers also began to face serious competition. In addition to better-quality papers from Fabriano and Treviso, cheap papers “of the worst kind”—in the estimation of the 14th-century Egyptian writer al-Qalqashandi—were also imported. Although some paper continued to be made in Egypt until the 17th century, French and Italian papers were dominant in Egypt from the 16th century.

European papers also began to make their way east, although they faced stiffer competition from the local product there. A single-volume manuscript of the Qur’an in the Nour Collection, for example, was transcribed on Italian paper datable to the 1340’s. Heavily watermarked with a double-key design surmounted by a cross, the paper is almost identical to examples from Arezzo and Torcello near Venice. The European paper confirms that Genoese and Venetian merchants like Marco Polo had carried Italian goods, including paper, to Iraq and Iran, where they may have traded them for carpets, silks, and spices to bring home.

The appearance of European paper at this date in Iran and Iraq, in contrast to North Africa and Egypt, is all the more surprising because local production was then at its apogee. From the 13th century, the availability of large sheets of locally manufactured fine white paper in Iran had spurred a second revolution in the Islamic book, the effects of which would continue to be felt for another two centuries there and in Egypt, India and the Ottoman Empire. Before the 13th century, most books written on paper had usually been small, normally no bigger than a sheet of modern office paper, implying that the sheet of paper from which they had been made was about twice as large. A sheet of this size was made in a mould that could easily be held in the papermaker’s hands. Larger sheets of paper were more difficult to make and consequently too expensive to use freely. Even when caliphs and sultans needed long scrolls for documents and decrees, they were made from smaller sheets pasted together.

From the 13th century, however, the size and quality of paper available in Iran for books and other uses increased dramatically, but the causes of these changes are not immediately apparent. One possibility is increased contact with China—where papemaking techniques had continued to develop—during the period when Mongol dynasties ruled China, Central Asia, Southern Russia, Iran, and much of the Middle East. (The Mongol rulers of Iran briefly, and disastrously, introduced printed paper currency there in 1294.) It is also possible that techniques for grinding and processing the pulp improved. Whatever the causes, the results of this change can be seen in the great number of large luxury volumes that have survived from this period.

As always, the Qur’an continued to be the most important and popular text, and famed calligraphers penned splendid large copies. Ahmad al-Suhrawardi, for example, completed transcribing a 30-volume copy of the Qur’an at Baghdad in 1307 (see p. 26). The pages measure 500 by 350 millimeters (19 9/16” x 13 6/16”), implying a sheet size of at least 500 by 700 millimeters (19 9/16” x 27 6/16”). The brilliant white paper was beautifully sized and polished so the calligrapher’s pen
Larger sheets of paper allowed larger and more monumental examples of the calligrapher's art, but also allowed use of more and larger illustrations.

was able to glide effortlessly over its smooth surface. Even larger is the dispersed 30-part manuscript of the Qur'an copied for the Mongol sultan Öljeitü between 1306 and 1309 and bequeathed to his mausoleum at Sultaniyya. The pages measure a whopping 720 by 500 millimeters (28 1/8" x 19 1/2"), implying that the sheets of paper from which the folios were made measured approximately 1100 millimeters (43 1/4") in their long dimension. The manuscript has only five lines of text per page, so the entire set of 30 volumes would have comprised over 2000 folios. Monumental calligraphy was indeed appropriate for a volume meant to be read publicly in a mosque.

Larger sheets of paper allowed larger and more monumental examples of the calligrapher’s art, but they also allowed production of books with increased numbers of larger illustrations, and from the early 14th century the illustrated book became a major form of art in the Islamic world. In previous centuries several types of books had been illustrated with relatively small drawings and paintings to clarify specific points in the text. Thus, books on astronomy would have been practically useless without small diagrams of the constellations, and books on pharmacology might have been dangerous without small illustrations of the useful plants the author discussed. In the 13th century, a few literary works began to be illustrated, but in the 14th century larger books, such as Rashid al-Din’s Compendium of Chronicles—the first truly universal history of the world—and the great copy of the Shahnamah (The Book of Kings), the so-called Great Mongol Shahnamah, copied for the Ilkhanid rulers, were prepared with paintings as large as 250 millimeters (10") on a side. In contrast to earlier illustrations, these images do not simply illustrate the text but also elaborate on it in new and dif-
The paintings included in the "Great Mongol Shahnamah," a large-format, 14th-century manuscript of the Book of Kings, were among the first to go beyond mere ornamentation of a narrative text to elaboration of it. Some scholars attribute a political subtext to the illustrations and see the manuscript as a work of propaganda intended to legitimate Mongol rule of Persia.
Different ways, using complex and deep landscapes and facial expression and gesture to portray human emotions. (See Aramco World, July/August 1997.) Although such paintings are called “Persian miniatures” today, in their own time they must have seemed quite monumental. Persian painters did not continue to use these pictorial devices in later centuries, but the ideal of the luxury book copied on large sheets of exquisite paper lived on for generations.

The increased availability of paper from the 13th century also spurred another artistic revolution in the Islamic lands. Architects and artists began to take advantage of the medium to work out designs before the work of art was actually executed, and for transmitting designs from one place to another. The most obvious new role for paper was in architectural plans.

Builders in antiquity had, of course, sometimes used plans and drawings, and there are occasional references to plans in the first seven centuries of Islam, but most construction was based on empirical knowledge transmitted by the spoken word, by gesture, and by memory from one builder to another and from one site to another. From the 14th century, however, builders in the Islamic lands increasingly took advantage of plans and drawings to supplement their traditional skills. Within each cultural orbit, the result was an increased uniformity in architecture, as the new method of representing architecture allowed someone working in the capital to design a building for a provincial city he might never have visited. The clearest example of this new approach comes from the Ottoman Empire, where, after the conquest of Constantinople in 1453, the office of the chief court architect in Istanbul became responsible for designing buildings, bridges, and aqueducts for sites throughout the realm, to be constructed by local workmen. Ottoman architects were thereby able to achieve an impressive uniformity in their work, and the Ottoman presence in a particular region was immediately visible as hemispheric lead-covered domes and pencil-thin minarets defined the skyline.

The increased availability of paper in the Islamic lands also spurred a change in the other arts, such as metalwork, ceramics and particularly textiles, as artists increasingly created designs on paper that artisans applied to their work. In traditional craft practice throughout the first centuries of Islam, the artisan had also been the designer, working out the design of the finished piece from memory or creating it as he or she went along. A metalworker, for example, would draw out the design on a brass tray before scraping away parts to be inlaid. A potter might practice his decorating on the backs of tiles before beginning to decorate an important plate, but the design on the finished piece came out of his head. A weaver would pattern her carpet with designs she had learned as a child from her mother, never with ones she had seen in a book.

Now the increased presence of designs on paper led some artisans to work in different ways: Potters learned their designs from pattern books and weavers learned to follow the encoded instructions in large cartoons or smaller graphs. Not only did this development signal a split in the traditional unity of artist and artisan, but it also meant that old and new designs were free to be attached to whatever medium the artisan chose: Similar designs, for example, might now appear on textiles, ceramics, metalwork and in book illumination.

In both China and Europe, the start of paper manufacture was quickly followed by the development of printing, first with wooden blocks and then with moveable type. Block printing was also known in the Islamic lands, perhaps as early as 10th-century Egypt, where it was used for decorating textiles and producing inexpensive amulets, but it seems to have died out in the 14th century. Why was the idea of printing books or literary texts not seriously entertained in the Islamic lands until the 18th century? It was difficult to design a complete font of Arabic type, since some 600 sorts, or separate pieces of type, might be needed, as compared to 275 for a European language, including italics, points and figures. Furthermore, typeset Arabic would inevitably compare unfavorably with the fluid handwork of a calligrapher—indeed, it is still considered inferior today. Finally, traditional Islamic society accorded great respect to calligraphers and their work.

Thus printing came late to the Islamic lands. The first book printed in Arabic script was printed in Europe, and is believed to be the edition of the Qur’an that Paganino de’ Paganini printed in Venice in 1538, of which a single copy was discovered in 1987. (See Aramco World, March/April 1992.) Only in the 18th century were the first presses established, with European help, at Aleppo and Istanbul. Knowledge had thus come full circle: Having given paper to Europe, the Islamic lands learned printing from Europe.