



Cultural Diffusion and the Columbian Exchange

Patterns of Trade
From medieval - 1750 C.E.



1

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&
History For Us All

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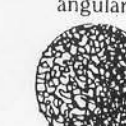









COLUMBIAN EXCHANGE VOCABULARY

Afroeurasia
Cultural diffusion
Perspective
Columbian Exchange
Trade
textile
Trade routes
Migration
Cross culturalism
Voyage
Astrolabe
Monks
Sufi Orders
Missionaries
Islam
Christianity
Judaism
Universal religions
Scholars
Arts
Literature
philosophy
sciences
architecture
natural sciences
regions
origins
Renaissance
global convergence

texture
line
diagonal
horizontal
vertical
perspective
curved line
dimension
dark
light
contrast
rhythm
emphasis
primary colors
neutral colors
velvet
satin
linen
cotton
silk
carpets

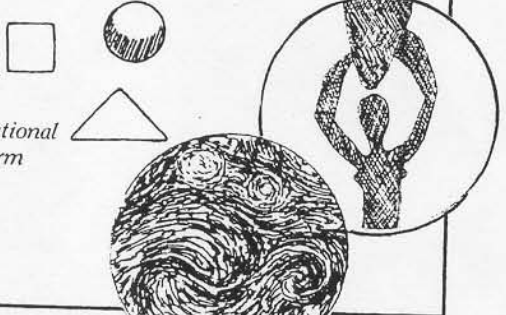
List 1-5 Elements of Art

Line is the path of a moving point. Following are some variations in line:

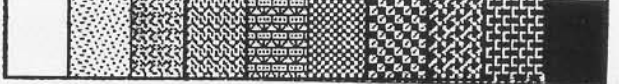
vertical 	horizontal 	diagonal 	curved 	angular 	zig zag 	bent 
straight 	interrupted 	thick 	thin 	parallel 	cross-hatched 	spiral 

Form: 3-D: height, width, and depth
Shape: 2-D: the area enclosed by an outline

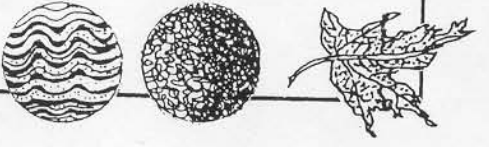
realistic
geometric
abstract form
idealized form
naturalistic
nonrepresentational
amorphous form
biomorphic



Value
Value: differences in a hue or neutral ranging from the lightest to the darkest, for example, white to black.



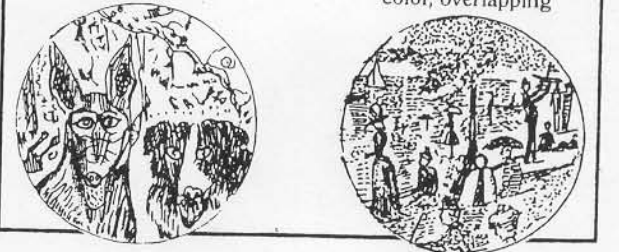
Texture
Real textures: those which can be felt
Implied textures: painted or drawn textures:
 slick, smooth, rough, velvety, satiny, bumpy



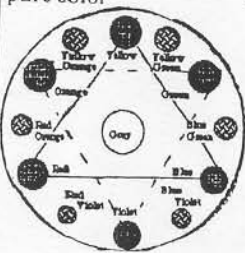
Space
 Space organizes elements in a composition.

shallow:
 little perspective

actual:
 control of size, color, overlapping



Hue
 pure color



Color Wheel
 neutral colors
 gray, black, white, brown

primary colors
 red, blue, yellow

Color
 secondary colors
 violet, orange, green

analogous colors
 side by side

complementary colors
 opposites on color wheel

cool colors
 violet, green, blue

warm colors
 red, yellow, orange

monochromatic
 variations of one hue

Tone
 grayed color

Shade
 hue plus black

Tint
 hue plus white

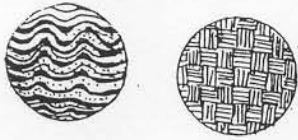
List 1-6 Principles of Design

According to National Visual Arts Standards, the principles of design are: repetition, balance, emphasis, contrast, and unity.

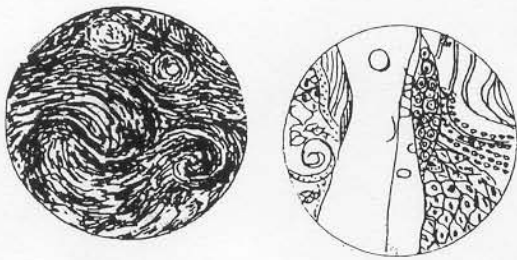
Repetition

Repetition is the use of line, color, or a motif, in more than one place in a composition.

Pattern is created through a repetitious use of the same element to create an overall design.



Rhythm is the repeated use of similar elements such as color, line, or shape—the smooth transition from one part to another.



Emphasis

Emphasis is given to a center-of-interest, which might be the largest, brightest, or lightest subject.



Contrast

Contrast shows differences between the elements of art, which are: line, color, shape, value, space, and texture.

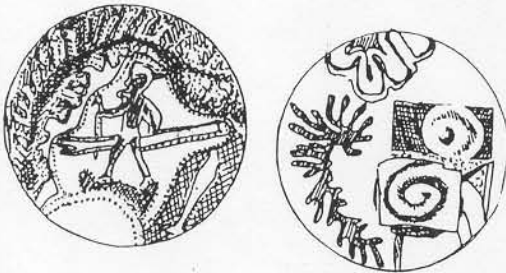


Balance

Balance is the equilibrium of various elements in the work of art.

symmetrical or formal balance. equal balance on each side of an imaginary middle line.

asymmetrical or informal balance. balance achieved through unequal distribution on each side of an imaginary middle line



Unity

Unity is the harmony of all the visual elements in a composition.

Proportion is the pleasing relationship of all parts to each other and to the whole of the design.

Variety consists of differences in scale, surface, line, value, and shape that give interest to a composition.



Lesson 1***Student Handout 1.7—Early Northern Renaissance Genre Painting of a Goldsmith's Shop***

A

Goldsmith in His Shop, Possibly Saint Eligius, 1449

Petrus Christus (Netherlandish, active by 1444, died 1475/76)

Oil on wood; Overall 39 3/8 x 34 3/4 in. (100.1 x 85.8 cm); painted surface 38 5/8 x 33 1/2 in. (98 x 85.2 cm)

Robert Lehman Collection, 1975 (1975.1.110)

www.metmuseum.org

This is one of the earliest genre paintings, which showed detailed portrayals of everyday life. The title refers to St. Eligius, the patron saint of goldsmiths. Art historians note, however, that the man in red probably represents a goldsmith of the Renaissance rather than the saint. The two people with him are a bride and groom in their wedding finery. The goldsmith is shown weighing a gold ring that he is selling to the couple. On the table and on the shelves behind him are many items for sale.

1. Study carefully the objects pictured. With a partner or partners, identify and list as many objects as you can name. Be precise. Also be observant, looking at the fabric materials and their characteristics and small details of the items, clothing, and furnishings.

2. Categorize the items according to various criteria:

- Are they imported or of local origin?
- Were they imported from outside of Europe?
- Are they raw materials or finished goods?
- Are they luxury items or necessities?

Lesson 1

Student Handout 1. 8—A Merchant’s List: Import and Export In Iraq (ninth century)

The variety of items that traveled through the Muslim lands can be seen by reviewing the following list, which was written in the mid-ninth century by Abu Uthman bin Bahr. This list appeared in his pamphlet *The Investigation of Commerce* and gave an inventory of items that arrived in Iraq during his time. It also lists the regions that exported the items.

India	tigers, panthers, elephants, panther skins, rubies, ebony, coconuts
China	silk, chinaware (porcelain), paper, ink, peacocks, saddles, cinnamon, drugs, utensils of gold and silver, gold coins, engineers, agronomists, marble workers
Arabia	horses, pedigreed camels, tanned skins
Maghrib and Barbary (North Africa)	panthers, felts, hawks, salam leaves (used for tanning leather)
Yemen	incense, giraffes, gems, curcuma (used as a dye, condiment, and medicine)
Egypt	donkeys, suits of fine cloth, papyrus, balsam, topaz
The land of Khazars	slaves, coats of mail, helmets, neck guards
Chorasmia (Khwarizm)	musk, ermine, marten, fox and other furs, sugarcane
Samarkand	Paper
Bactria (Balkh)	sweet grapes
Merv	zithers, zither players, carpets, suits
Isfahan	honey, pears, quinces, apples, salt, saffron, soda, syrups, white lead
Kirman	indigo, cumin
Fars	linen suits, rose water, jasmine ointment, syrups
Fasa	pistachios, rare fruit, glassware
Oman and the sea coast	Pearls
Mosul	quails, curtains, striped cloth
Armenia and Azerbaijan	felts, carpets, fine mats, wool, packsaddles

Source: Ragaie and Dorothea El Mallakh, “Trade and Commerce,” in John Hayes, editor, *The Genius of Arab Civilization, Source of Renaissance*, (Cambridge: MIT Press, 1983), Chapter 9.

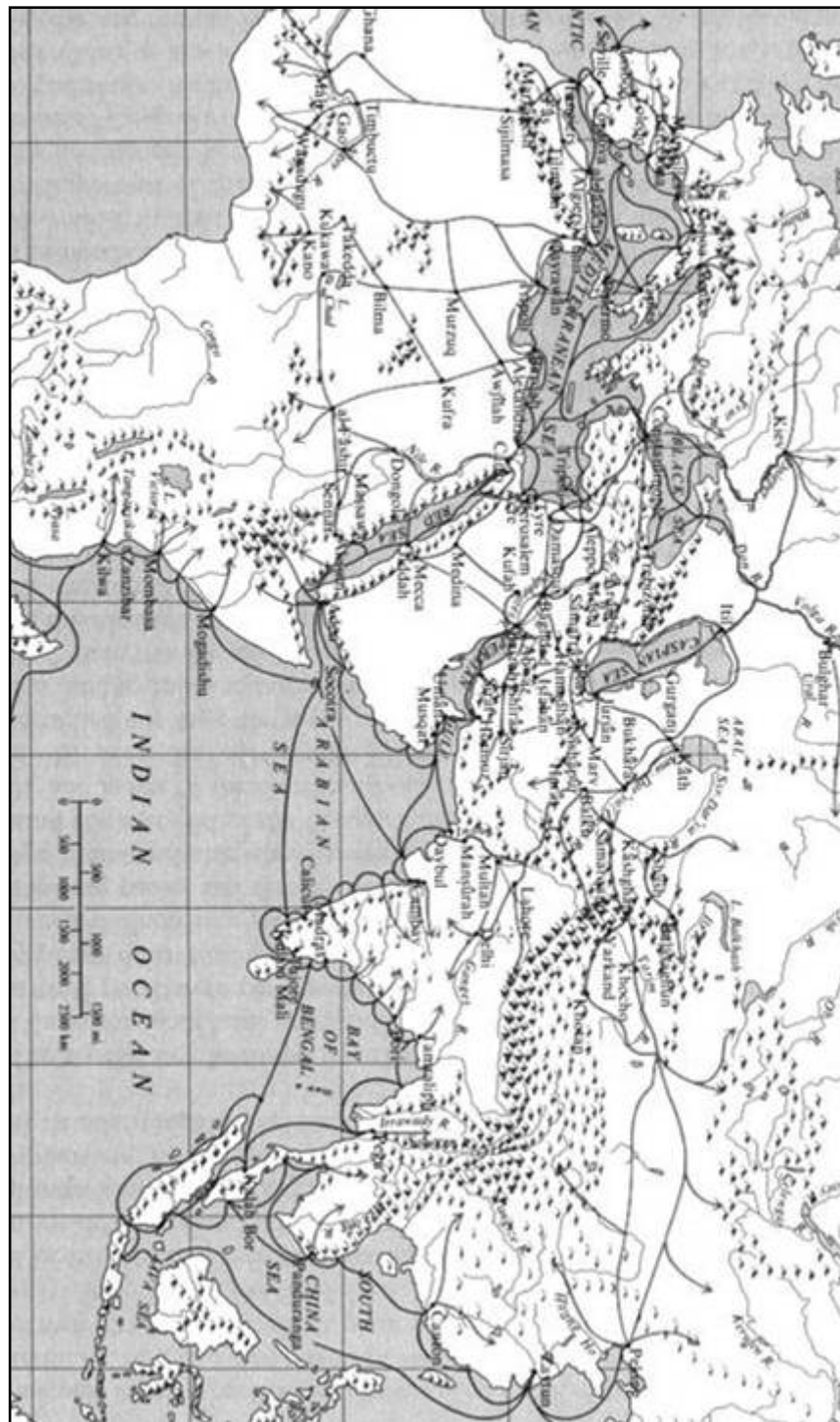
Lesson 1***Student Handout 1.9—Map of the Hemispheric Trade during Big Era Five***

During Big Era Five, as in earlier eras, long-distance trade often involved a relay of goods along regional and trans-regional routes. Merchants bought, sold, and re-sold a mix of items—bulky staples as well as lighter, valuable luxury goods. Goods were often unloaded and reloaded among numerous different modes of transportation in the course of their journey from origin to end-user. Different types of transport—pack animals, carts, barges, ships—were used on certain regional routes, either for cultural, technological, or ecological reasons. Match the names of each type of transportation to the icons on this page. Then match each form of transportation shown in the icons to the routes on the hemispheric map of trade (Student Handout 1.10). You may want to make smaller versions and mount them on a classroom trade map

Lesson 1

Student Handout 1.10—Map of Trade Routes

Marshall G. S. Hodgson, *The Venture of Islam, Vol. 2, Chicago: University of Chicago Press, 1974, 75.*



Lesson 1

Student Handout 1.5—From Ibn Battuta, The Rihlah (travels in East Africa, fourteenth century CE)

Background

Ibn Battuta was born in 1304 CE in Tangier, Morocco, to a family of legal scholars. He entered that profession as well, but in 1325, he decided to make the hajj (Islamic pilgrimage) to Mecca (Makkah). This began a remarkable journey that lasted nearly 30 years and covered thousands of miles. His journeys, extending as far north as the Volga River, as far South as the coast of East Africa, and as far east as China, demonstrated the amazing diversity and cosmopolitan unity of the Dar al-Islam (House of Islam) during the fourteenth century. The *Rihlah*, the travel account that was prepared with the help of Ibn Juzayy in 1356, is an excellent historical and geographic source on the period.

We sailed . . . for fifteen nights [from the horn of Africa] and came to Maqdashaw [Mogadishu], which is a town of enormous size. Its inhabitants are merchants, possessed of vast resources; they own large numbers of camel, of which they slaughter hundreds every day [for food], and also have quantities of sheep. In this place are manufactured the woven fabrics called after it, which are unequalled and exported from it to Egypt and elsewhere. It is the custom of the people of this town that, when a vessel reaches the anchorage, the sumbuqs, which are small boats, come out to it. In each sumbuq there are a number of young men of the town, each one of whom brings a covered platter containing food and presents it to one of the merchants on the ship saying ‘This is my guest,’ and each of the others does the same. The merchant, on disembarking, goes only to the house of his host among the young men, except those of them who have made frequent journeys to the town and have gained some acquaintance with its inhabitants; these lodge where they please. When he takes up residence with his host, the latter sells his goods for and buys for him; and if anyone buys anything from him at too low a price or sells to him in the absence of his host, that sale is held invalid by them. This practice is profitable one for them.

Account of the Sultan of Maqdashaw

The sultan of Maqdashaw is, as we have mentioned, called only by the title of ‘the Shaykh’. His name is Abu Bakr, son of the shaykh Umar; he is by origin of the Barbara (Berbers) and he speaks in Maqdishu, but knows the Arabic language. One of his customs is that, when a vessel arrives, the sultan’s sumbuq (patrol ship) goes out to it, and enquires are made as to the ship, whence it has come, who is its owner and its rubban (that is, its captain), what is its cargo, and who has come on it of merchants and others. When all of this information has been collected, it is presented to the sultan, and if there are any person [of such quality] that the sultan should assign a lodging to him as his guest, he does so.

When I arrived with the qadi I have mentioned, who was called Ibn al-Burhan, an Egyptian by origin, at the sultan’s residence, one of the serving-boys came out and saluted the qadi, who said to him “Take word to the intendant’s office and inform the Shaykh that this man has come from the land of al-Hijaz.” So he took the message, then returned bringing a plate on which were some leaves of betel and areca nuts. He gave me ten leaves along with a few of the nuts, the same to the qadi, and what was left on the plate to my companions and the qadi’s students. He brought

also a jug of rose-water of Damascus, which he poured over me and over the qadi [i.e. over our hands], and said “Our master commands that he be lodged in the students’ house,” this being a building equipped for the entertainment of students of religion. The qadi took me by the hand and we went to this house, which is in the vicinity of the Shaykh’s residence, and furnished with carpets and all necessary appointments.

Later on the serving boy brought food from the Shaykh’s residence. With him came one of his viziers, who was responsible for the care of the guests, and who said “Our master greets you and says to you that you are heartily welcome.” He then set down the food and we ate. Their food is rice cooked with ghee (clarified butter), which they put into a large wooden platter, and on top of this they set platters of kushan. This is the seasoning made of chickens, meat, fish and vegetables. They cook unripe bananas in fresh milk and put this in one dish, and in another dish they put curdled milk, on which they place pieces of pickled lemon, bunches of pickled pepper steeped in vinegar and slated, green ginger, and mangos. These resemble apples, but have a stone; when ripe they are exceedingly sweet and are eaten like other fruit, but before ripening they are acid like lemons, and they pickle them in vinegar. When they take a mouthful of rice, they eat some of these salted and vinegar conserves after it. A single person of the people of Maqdashaw eats as much as a whole company of us would eat, as a matter of habit, and they are corpulent and fat in the extreme.

On the fourth day, which was a Friday, the qadi and students and one of the Shaykh’s viziers came to me, bringing a set of robes; these [official] robes of theirs consist of a silk wrapper which one ties round his waist in place of drawers (for they have no acquaintance with these), a tunic of Egyptian linen with an embroidered border, a furred mantle of Jerusalem stuff, and an Egyptian turban with an embroidered edge. They also brought robes for my companions suitable to their position. We went to the congregational mosque and made our prayers behind the maqsura [area restricted for the ruler]. When the Shaykh came out of the door of the maqsura I saluted him along with the qadi; he said a word of greeting, spoke in their tongue with the qadi, and then said in Arabic “You are heartily welcome, and you have honored our land and given us pleasure.”

Excerpted from *Beyond A Thousand and One Nights: A Sampler of Literature from Muslim Civilization* (Fountain Valley, CA: Council on Islamic Education), 154-155. Reprinted by permission.

Lesson 1

Student Handout 1.6— From Ibn Battuta, The Rihlah (travels in West Africa, fourteenth century)

The date of my arrival at Malli was 14th Jumada I seven hundred and fifty-three [after Hijra 28 June 1352]...I was accompanied by a merchant called Abu Bakr ibn Ya'qub. We took the Mima road. I had a camel which I was riding because horses are expensive, and cost a hundred *mithqals* each. We came to a wide channel which flows out of the Nile [meaning the Niger River] and can only be crossed by boats. The place is infested with mosquitoes, and no one can pass that way except by night. On reaching it I saw sixteen beasts with enormous bodies...so I said to Abu Bakr, "What kind of animals are these?" He replied, "They are hippopotami. . . ."

We halted near this channel at a large village, which had as a governor a negro, a pilgrim, and man of fine character, named Farba Magha. He was one of the negroes who made the pilgrimage in the company of Mansa Musa. . . . We continued our journey from this village which is by the channel and came to the town of Quri Mansa. At this point the camel which I was riding died...I sent two lads whom I had hired for my service to buy me a camel at Zaghari, and waited at Quri Mansa for six days until they returned with it. . . . Thence we went on to Tumbuktu, which stands four miles from the river. Most of its inhabitants are of the Massufa tribe, wearers of the face-veil. . . . From Tumbuktu I sailed down the Nile [Niger] on a small boat, hollowed out of a single piece of wood. We used to go ashore every night at the villages and buy whatever we needed in the way of meat and butter in exchange for salt, spices and glass beads. . . .

I went on from there to Gawgaw [Gogo], which is a large city on the Nile [Niger], and one of the finest towns in the Negrolands. It is also one of their biggest and best provisioned towns, with rice in plenty, milk and fish, and there is a species of cucumber there called inani which has no equal. The buying and selling of its inhabitants is done with cowrie-shells, and the same is the case at Malli. I stayed there about a month, and then set out in the direction of Taghadda by land with a large caravan of merchants from Wuchin, which means "wolf". . . . I had a riding camel and a she-camel to carry my provisions.

We pushed on rapidly with our journey until we reached Taghadda. The houses at Taghadda are built of red stone, and its water runs by the copper mines, so that both its color and taste are affected. There are no grain crops there except a little wheat, which is consumed by merchants and strangers. The inhabitants of Taghadda have no occupation except trade. They travel to Egypt every year, and import quantities of all the fine fabrics to be had there and of other Egyptian wares. . . . The copper mine is in the outskirts of Taghadda. They dig the ore out of the ground, bring it to the town and cast it in their houses. This work is done by their male and female slaves. When they obtain the red copper, they make it into bars a span and a half in length, some thin and others thick. The thick bars are sold at the rate of six or seven hundred to the *mithqal*. They serve also as their medium of exchange; with the thin bars they buy meat and firewood, and with the thick, slaves male and female, millet, butter, and wheat. The copper is exported from Taghadda to the town of Kubar, in the regions of the heathens, to Zaghay, and to the country of Barnu, which is forty days' journey from Taghadda. The people of Barnu are Muslims, and have a king called Idris. . . .

Excerpted from H. A. R. Gibb, translator, *Ibn Battuta: Travels in Asia and Africa, 1325-1354*
London: Routledge and Kegan Paul, 1929, 331-336

Lesson 3

Transfers of Knowledge along the Trans-hemispheric Network Hindi-Arabic Numerals and Paper's Journeys Across Afroeurasia

Procedure

1. Read and study the text and images on Student Handout 3.1. Read the evidence historians give for the transfer of Hindi, or Arabic numerals across Afroeurasia during Big Era Five.
2. Examine the primary source images showing the development and dissemination of Hindi-Arabic numerals. Students should describe what type of sources they are and assess the credibility of their arguments.
3. On the graphic organizer with Student Handout 3.1 students should briefly summarize the evidence used by the writers for the transfer of Hindi/Arabic numerals, the individuals involved in the transfer, the place where the evidence of transfer was located, and the dates of the evidence. Note the languages and religious affiliation of the participants in this transfer.
4. Use Student Handout 3.2 to trace the path of diffusion of this important innovation by locating the place of transfer, the date, and the type of evidence cited, and then write this information on the outline map using boxes, talk balloons, or other methods.
5. Discuss the complexity of the paths by which this technical and scientific innovation moved across the hemisphere, and the number of different societies involved. Discuss also the time factor in its transfer and make hypotheses about the rate and time periods in which the numerals' movement accelerated. What might account for this acceleration? What types of people were involved in the transfer?
6. Make copies of Student Handout 3.3 for individual or group work to help students understand paper-making technology, its uses, and its social and economic effects. Make additional copies of Student Handout 3.2 to use with Student Handout 3.3 to locate and date diffusion points for the spread of paper.

Lesson 3

Student Handout 3.1—Hindi-Arabic Numerals and their Journey across Afroeurasia

Read the evidence the historians below give of the transfer of Hindi, or Arabic numerals across Afroeurasia during Big Era Five. Note the evidence used by the writers for the transfer, the dates of the evidence, and the individuals involved in the transfer. Also notice the languages and religious affiliation of the participants in this transfer. Finally, use Student Handout 3.2 to trace the path of diffusion of this important innovation by locating the place of transfer, the date, and the type of evidence cited.

Excerpt 1: Seyyed Hossein Nasr, *Islamic Science: An Illustrated History* (London: World of Islam Publishing, 1976), 77-79.

The major sources for Islamic mathematics were Greek, as well as Persian and Indian. . . . The Persian sources reflected mostly the Indian ones and were embedded in astronomical treatises. . . . The Muslims originally used finger computation before learning of the Indian numerals and the “dust-board” system early in the [8th century] from Indian and Persian sources. . . . It is known that the Muslims gradually developed the ‘Arabic numerals’ from the Indian numerals they had learned from Sanskrit sources early in the Islamic period in Persia and other eastern lands of Islam The newly developed system spread to the Maghrib [North Africa and Spain] and from there to the West..

The work in which Indian numerals were used and transmitted to the West for the first time is *Addition and Subtraction in Indian Arithmetic* of Muhammad ibn Musa al Khwarazmi [died 840 CE], the original of which is lost. The Toledan [Spain] translation of this work known as *Algorismi de numero indorum* ” had a profound effect on the West...In the 10th century Abul Hasan al-Uqlidusi wrote his *Book of Chapters Concerning Indian Arithmetic*, in which he applied Indian schemes of calculation to methods of finger-reckoning and tried to change dust-board methods so as to make them applicable to ink and paper.

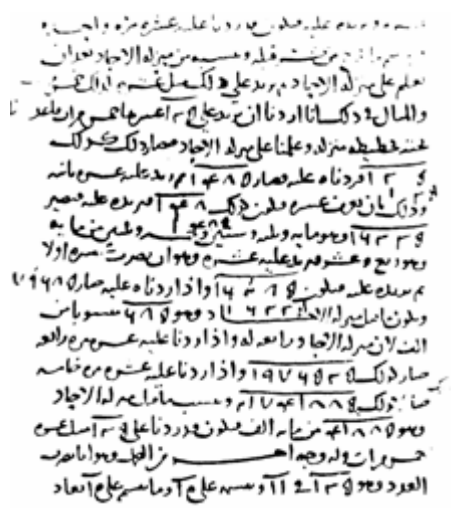
Contemporary with him Abu’l Wafa freed Indian numerals from the dust-board techniques, while in the following [11th] century Abu’l Hasan al-Nasawi wrote another important treatise on Indian numerals entitled *The Satisfying Book on Indian Arithmetic*, first in Persian and then in Arabic. By the 11th century, therefore, the decimal system and the two methods of reckoning connected with it had become fully established among Muslims and through them had reached the West, bringing about a transformation which influenced nearly all aspects of life and thought from pure mathematics to commerce and trade.”



Page from the first Arabic work on the decimal system with Hindi

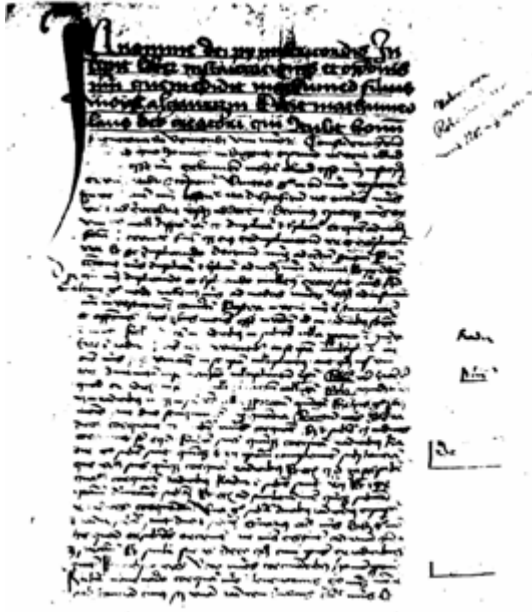
Excerpt 2: Jonathan M. Bloom, “Revolution by the Ream - A History of Paper,” *Aramco World Magazine*, Volume 50, No. 3, May/June 1999, 26-39.

The new availability of paper also encouraged new approaches to old subjects. At the same time that paper was being disseminated across the Islamic lands, the Hindu system of reckoning with decimal place-value numerals--what we call "Arabic numerals"--was spreading westward from India. Before the Hindu system was introduced, people in the Islamic lands, as elsewhere, did their calculations mentally and recorded intermediate results either on a dust-board--which could be repeatedly erased as they performed successive additions or subtractions--or by the position of their fingers ("finger-reckoning"). The first manual of Hindu reckoning in Arabic was written by Muhammad ibn Musa al-Khwarizmi (ca. 825), whose name has given us our word algorithm, meaning the sequence of steps followed to solve a type of problem. According to al-Khwarizmi's treatise, the fundamental arithmetic operations are performed by placing the numbers one above the other; the process begins on the left. Numbers are erased and shifted, clearly implying that the operations were still meant to be performed on a dust-board. A century later, however, the mathematician Abu al-Hasan Ahmad ibn Ibrahim al-Uqlidisi ("the Euclidian") altered the Indian scheme of calculation in his mathematical treatise, composed at Damascus in 952-953, to suit the use of ink and paper. Although al-Uqlidisi's scheme allowed neither shifting nor erasure of numbers--not possible on paper--it did permit far greater flexibility in calculation.



The Geniza [Cairo] 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 (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.

Excerpt 3: Francis and Joseph Gies, *Cathedral, Forge and Waterwheel: Technology and Invention in the Middle Ages* (New York: Harper Collins, 1994), 225-227, 246.



Page from the Latin translation of al-Khwarizmi's work on arithmetic

Around the year 1180, a Pisan [Italy] merchant was appointed to the post of customs official, or consul, of the Pisan community in Bougia, Muslim North Africa. After settling there, he sent for his son Leonardo Fibonacci, who was still in his boyhood, to complete his education, 'with a view to future usefulness,' a commentary on the new attitude toward Islam developing among the European business class. In his new home, Leonardo made the discovery of Hindu-Arabic numerals.

Adelard of Bath's [1075-1160 CE] translation of al-Khwarizmi had expounded the Hindu notation, but only to a very limited circle even among the mathematically literate. Leonardo [Fibonacci] perceived its enormous potential value and in 1202 undertook its wider diffusion by writing what proved to be a seminal book in the history of mathematics and science the *Liber Abaci* (*Book of the Abacus*). The book began: 'The nine Indian figures are 9 8 7 6 5 4 3 2 1. With these nine figures and the sign 0, any number may be written,

as is demonstrated below.

For a time businessmen were wary of the new numerals, partly out of general conservatism, partly because it was felt that they could be more easily altered by the unscrupulous, and finally because they necessitated memorizing tables of multiplication and division. But by the late 14th century, Hindu numerals were displacing both Roman numerals and the calculating board [abacus] in European commerce."

Excerpt 4: Lisa Jardin, *Worldly Goods: A New History of the Renaissance* (New York: Doubleday, 1996), 320-323.

In 1473, at the age of fourteen, Jakob Fugger was sent by his father to the German business house in Venice . . . where the family held a warehouse, to learn ‘Italian accounting,’ commercial reckoning with Arabic numerals, and double-entry bookkeeping. Within a generation, however, the printed book had made such trips largely unnecessary—an explosion in publication of manuals of technical commercial expertise (how-to books for merchants) had made it possible for merchants to learn their trade closer to home. . . . The author of the first book of commercial arithmetic published in Portugal in 1519 advised his readers, . . . I am printing this arithmetic because it is a thing so necessary in Portugal for transactions with the merchants of India, Persia, Arabia, Ethiopia and other places discovered by us.’ He had in mind the need to know how to reckon and account in Indo-Arabic numbers, rather than Roman numerals, for transactions with regions used to dealing with Muslim merchants. . . . The earliest printed commercial arithmetic, the *Libro de Abacho* [Fibonacci’s *Book of the Abacus*], published in Venice in 1478, is packed with . . . the kind of commercial problems that merchants are regularly required to solve [like these]:

If one yard of crimson is worth 5 ducats, what will 85 yards be worth?

If 1000 pounds of pepper are worth 80 ducats, 16 grossi and $\frac{1}{4}$, what will 9917 pounds and $\frac{1}{2}$ be worth?

Two merchants, Sebastiano and Jacomo, have invested their money for gain in a partnership. Sebastiano put in 350 ducats on the first day of January 1472, and Jacomo 500 ducats, 14 grossi on the first day of July 1472; and on the first day of January 1474 they found they had gained 622 ducats. Required is the share of each.

Images from Nasr, Sayyed Hossein. *Islamic Science, An Illustrated History*. Westerham, Kent: World of Islam Festival Publishing., 1976.

Excerpt 5: John Hale, *The Civilization of Europe in the Renaissance* (New York: Atheneum, 1994), 574-575

The practical role of mathematics . . . is more typically represented by the Englishman Robert Recorde. His first book, on arithmetic, was revealingly called *The Grounde of Artes*. Published in 1540 and six times reprinted by 1561, it reflected . . . the subjects he had taught at Oxford and Cambridge. . . . He was the first English writer to mention Copernicus. In 1557 he published the first English work on algebra, further popularizing the use of Arabic numbers for calculation and the symbols for plus, minus and equals.