HISTORY *of the* BOOK

Chapter 5. The Invention and Spread of Printing
Blocks, type, paper, and markets, contact

Impressions of wood blocks on cloth, or metal stamping in clay, wax, and leather, existed long before the idea of movable type was realized in Mainz. As we have seen, scrolls, tablets, and the bound codex book were all fully developed by the 15th century, and the range of materials pressed into use for writing included palm leaves, bark, walls, and skin in addition to vellum, parchment, papyrus, clay and paper. Of these, paper was the last to be invented, and until the creation of synthetic materials in recent centuries and digital modes of display, paper remained the most important and ubiquitous substrate for written language. And though the use of seals and stamps can be traced almost into prehistory, the idea of printing multiple copies of a text for purposes of distribution to a literate audience is more recent. The first printing for texts was most likely invented in China, with Chinese characters cut in the faces of individual wooden blocks, or whole texts cut in a single block.[1]

But the innovations brought to this art by Johann Gutenberg in the middle of the 15th century changed the scale and scope of printing.[2] Not only was movable type a radical improvement in achieving efficiency for reproduction of multiple copies of a text, but the rationalization of labor that was embedded in this innovative shift created a model that would inform practices well into the industrial revolution hundreds of years later.[3] Literacy, already on the rise in the late Middle Ages in Europe, and integral to certain communities in Asia, the Indian Subcontinent, and Northern Africa, would be fostered by increased availability of printed texts.[4] Controversies would arise as debates about access to religious texts, in particular, would split along fault lines of belief. First, printing would be invented, adopted, spread, and its materials and knowledge about how its technology would be carried throughout Europe and the British Isles, and then further East and North into Scandinavia, Russia, and other geographical domains. Printing would eventually follow colonialization as well. Though it is erroneous to equate the invention of movable type with the creation of printing or invention of the book, it is nonetheless true that the revolutionary impact of this technology can be felt in the standardization of language, relative stabilization of

texts, and dissemination and influence of multiple copies of works of religion, science, literature, philosophy, and every other field of human endeavor or knowledge.[5]

Invention of Printing in the Far East
The invention of paper took place in China around 105 CE, when Ts'ai Lun, an official in the Court of the Emperor Ho-di, made the first sheets.[6] According to legend, the secret of its making was later coerced from a solider captured by Islamic forces at the Battle of Talas in 751.[7] In actuality, knowledge of paper production seeped out of China earlier, into Vietnam, Korea and Tibet. By 900 CE paper was readily available in shops in Baghdad and other areas of the Near East at a time when Islamic military power was at its height. Paper came to the West from the Islamic Empire. The traditions of papermaking, though derived from the single Chinese source, remain differentiated by the use of local materials. Chinese paper was made mostly of mulberry, the same plant whose leaves are used to feed silkworms. Silk had been used as a surface for writing and painting, but was a rare and precious substance. Paper was much cheaper, faster, and easier to manufacture. To make it, the mulberry plants were stripped and shredded, turned into pulp suspended in water and lifted out on screens. The sheets were pressed and dried, and sometimes treated before use (rubbed and polished). In later centuries, the use of hot plates to smooth the surface became widespread, but early paper has considerable texture that varies depending on the fineness of the pulp and toughness of the plant fibers.

Paper was being made in Egypt by 900 CE, in Morocco and Spain in the early 12th century, and in Italy by 1270, when the Fabriano paper company, still in operation, began production.[8] The first German paper making operation seems to have begun around 1390, in plenty of time to supply printers in the next century, but in England paper was not made until after the establishment of printing, around 1494.[9] New world paper production began in Philadelphia in 1690, but the Spanish prohibited the production of paper in their colonies, in part as a way of controlling the population and access to local traditions.[10] However, the Mayan and Aztec people had made paper, which they called amate, from the inner bark of the wild fig tree, perhaps as early as 1000 BCE.[11] Their methods of making and finishing the paper included burnishing with hot stones to create a smooth surface.

Printing in the Far East seems to have begun by using wood blocks for stamping textiles, but printing on paper was achieved by rubbing the back of the sheet to transfer ink from the surface of a block to paper. Writing emerged later in China than in the Near East, but classics of Chinese literature, such as the Confucian *Book of Documents*, were in existence in relatively stable form well before the beginning of the Common Era.[12] Literacy breeds controversy, and that was true in this early period as much as in later times. Tensions between scholars

and political powers brought about tragic events, at least according to some historical accounts, when the first Emperor of the Qin Empire is recorded as having burnt hundreds of books in 213 BCE and buried alive more than four hundred Confucian scholars a few years later.[13] Whether substantive portions of the cultural legacy of ancient China were lost in this event is a matter of debate—many technical books were supposedly spared and copies of many classics were kept in private collections—but China's engagement with the politics of literacy clearly has a long history. The traditions of Buddhist thinking and Confucian philosophy both exerted strong influence, and like the belief systems in the West, they relied upon texts for study.[14] By the 11th century CE, the production of Buddhist texts had become an industry and unauthorized editions and piracy had become a problem. An enormous labor force was engaged in making paper and producing prints as commercial book production soared in the 12-13th centuries, at the same time as manuscript publishing was flourishing in European cities.

The Buddhist Diamond Sutra is the oldest existing full text and was printed in China in 868.[15] An earlier, fragmentary, specimen of block printing, also a sutra, dates two hundred years earlier and is printed on hemp paper. Carving a text on a single woodblock makes sense for works that would remain stable and be printed over and over again in significant numbers. Even today the monks in Tibet use their libraries of woodblocks to reproduce certain prayers. In addition to the creation of woodblock printing, the Chinese invented movable type—individual characters carved on blocks.[16] The creation of individual blocks of type for single characters allowed them to be re-combined in multiple texts. In addition to wood used for moveable type from about the 11th century, metal casting came into use in the 12th.[17] Blocks and moveable type moved westward with military activities and trade. The first recorded printing of paper money was in 1294 in Tabriz, a city near the northern border of modern day Iran.[18] The Koreans had a method of casting ceramic type on small blocks of clay, but this did not catch on, and it is hard to imagine the surfaces being standardized enough to print effectively. Wood, like metal, can be cut with fair precision, and the principles of assembling a form for printing require that the individual units fit together perfectly. This requirement determines the aesthetic properties of type as well as the technical ones, as will be apparent.

Chinese traditions keep their distinction well into the modern era, and, as with the textual transmission methods of manuscript and print in the West, so copies of canonical works kept the intellectual legacy intact over millennia. For instance, in the latter half of the 18th century, the Emperor Sik Quanshu, of the Qing dynasty, ordered several hundred scholars to work on copying selected books from the known corpus. [19] About 13,000 texts were collected in the capital, of which about 3500 were selected for copying (others were identified

as contrary to "official thinking" and destroyed). But the Emperor had multiple copies of the classics of Confucianism, history, geography, agriculture, military strategy, law, medicine, records of folklife, science, literature, catalogues of plant and animals, well as Daoist and Buddhist philosophy made and created new libraries to house them. Of these several remain, either as structures or collections, at the Forbidden City in Bejing and Shenyang. Important evidence for the history of the book and literacy in Asia has been brought to light through archaeological means. Discoveries in Dunhuang, for example, had an effect similar to that of the finds of Dead Sea Scrolls in Qumran on knowledge of biblical texts. Some of the fragments recovered in Dunhuang date back to the first and second centuries before the Common Era, and provide an insight into the production and use of texts in this early period and their connection to much longer histories and practices.[20] Also, like their peers in the West, Chinese scholars developed techniques for the study of books. Their tools of bibliography, textual emendation, and the gathering of scattered texts were all formalized into rigorous scholarly methods. Private libraries grew in China in the 12th through 16th centuries as well, and from the remains of these collections the study of various binding methods using bamboo strips, cords, folded paper, and butterfly bindings can be studied.

Taking advantage of local resources is a conspicuous aspect of writing production in every area of the world. Indian scholars used palm leaves to make books using metal pens to inscribe these polished surfaces. Rubbing ink into the lines darkened the text, and the leaves were tied together as a series of flat slats.[21] Paper making began in India in the 13th century, but certain Tamil traditions remain committed to palm leaf production into the presenct on account of traditional associations. The Indians created the earliest known grammar books, and though the common roots of Indo-European languages were not known or understood until the 19th century, the Sanskrit grammar of Panini, the fourth century BCE scholar, provides an exemplary model of the rules of morphology and syntax that govern language. Certain features of his analysis are still used by 20th century linguists because of their sophistication and specificity.

Printing in Europe
The earliest piece of printing in Europe carrying a reliable date is a woodblock print from 1423 of St. Christopher carrying the infant Jesus in his arms.[22] The motifs on the block, and in particular the treatment of the water, make it clear that the artist was influenced in part by Asian or Indian designs.

Though religious images comprised some of the earliest printing in Europe, among the most commonly printed images were playing cards, and their popularity raised concerns about degenerate habits and the vice of gambling. Known as "sheet dice," playing cards originated in China and spread along the same trade routes as paper, spices, and

other commodities and cultural influences.[23] Card playing became so addictive and conspicuous that it was actually subject to prohibition in various European cities. In 1377 an ordinance was passed in Paris forbidding use of cards on workdays. By the 1380s and 1390s, St. Gallen. Augsburg, and Nuremberg all outlawed card playing in the city. Gambling was so rife in the city of Bologna that a figure known as St. Bernardin of Siena preached a lesson encouraging people to burn their decks of cards.[24] The story goes that a printer standing by bemoaned the loss of his livelihood, and the Saint held up an image of the sun with the sacred Christian monogram inside it and suggested that this be printed and sold instead. The point, however, is that card printing was a major industry throughout Europe, with guilds regulating the role of those who made pigments, applied colors, prepared paper, and so on, indicating the level of production involved. Competition for market share in these printed and painted artifacts caused the city of Venice to pass ordinances in 1441 limiting the sale of foreign or imported cards, but also, forcing local printers to display their wares only in their own shops. The business of printing was well-known, therefore, before Gutenberg's innovations.[25] **[Figure 1]**

Books printed from blocks, in particular a genre known as the *Ars Moriendi*, or "Art of Dying," precede those printed from metal type by just a few years.[26] An edition of this work was printed in the Netherlands in 1450. Block books were, in essence, early graphic novels. They used visual storytelling in sequences to provide instruction, in this case on the art of dying in such a way as to achieve redemption. The story is straightforward, and the moral issues clear—resist the temptation of the devils and demons, confess, and accept the last rites. But the graphical treatments gave artists full license to imagine devils quite imaginatively–angels rather less so. Block books would be a staple of the publishing world as printing from metal type came into use, and woodblock images, which are printed relief in the same way as type, could be used in the same printing forms. Images, initial letters, borders, and other graphical elements thus found their place in early printed books.

The innovation brought to the arts of printing by Johann Gutenberg was a technical invention as well as a conceptual leap.[27] Metal punches for doing leather work, tooling, and stamping in gold on book bindings were in use, and metal casting was a craft with a long history in jewelry-making as well as tool production. But the design of metal type for printing required that letters be cast in an efficient manner, making multiples of each character, and that these small cast objects be perfectly rectangular. Typecasting is demanding and highly skilled work. Each letter is initially carved on the end of a steel punch, a thin stick of hard metal whose end is fashioned into a letterform in reverse.[28] Every letter begins this way, and until the 19th century, this process of punch cutting could not be automated. Once punches are cut, and refined, they are used to make brass matrices. These are in

Figure 1. Francesco Marcolini, *Le ingeniose sorti / composte per Francesco Marcolini da Forli, intitulate Giardino di pensieri*. Venice: Fra[n]cesco Marcolino da Forli (1550).
* Z233.I8 M333gi 1550
Whether used for gambling or divination, playing cards were some of the most commonly distributed items during the spread of early European printing. This text by Francesco Marcolini displays hundreds of woodcut images depicting various card combinations and their fortuitous implication, as well as numerous narrative vignettes of virtues, muses, and philosophers.

turn fitted into a mold into which molten lead and alloy are cast. The letters are released from the mold, cleaned up and trimmed, and then are distributed into cases for setting. Gutenberg invented a mold for casting that had variable width to it, allowing for letters like "i" and "m" to be accurately placed on the "body" of the metal letter, and for sizes of type in fonts to be cast consistently.[29] This improvement in casting techniques is the main invention made by Gutenberg, but the print shop also became a place of specialized tasks and segmented production. This division of labor had been implemented by scribes and illuminators, but in the print shop the tasks of typecasting, setting, inking, printing, and redistributing had to be tightly coordinated. Modern labor practices are thus inaugurated with the segmentation and coordination of printing.

Gutenberg's earliest book production was a 42-line bible, named for the number of lines in each of the two columns of text on its pages.[30] Six presses were used for its production and the edition contained vellum and paper copies. The presses were versions of bookbinding presses, similar to those used for making olive oil or other products. Thus the printing press was a modification of existing technology, rather than a radical invention. These presses were made of wood and consisted of a screw mechanism for lowering the platen onto a form which slid in and out along the track of the press bed.[31] Metal presses were only invented in the very beginning of the 19th century, and with their increased strength, the size of printed forms increased. But in many ways, the technology of Gutenberg's shop remained unchanged for more than three hundred years, and only industrialization advanced printing beyond its earliest techniques. **[Figure 2]**

In addition to the bible, Gutenberg printed Indulgences. These were sold by the Church, and could be bought as a way to pay penance for sins, thus reducing the time to be spent in purgatory after death. These were a major source of revenue for the Church, and sold in its precincts. They had been issued in manuscript form, and were now printed in multiples that included an expiration date for sales. The 36-line bible followed in 1460, and its text was copied directly from that of the 42 line version, thus incorporating many errors. The number of punches required for production of all the many ligatures and variant forms of letters in Gutenberg's fonts exceeded that of the alphabet. A total of about two hundred and ninety different letter forms have been inventoried. Ink that was suited to a metal surface had to be refined as well, since the absorptive properties of wood are so different that older inks were not suitable. Gutenberg's original goal was to produce about two hundred copies of the bible, and forty-eight copies of the 42-line version have been identified, twelve of which are on vellum. Gutenberg ran into business difficulties, and his shop and materials were put into the hands of Johann Fust, who had originally lent him the funds. Another partner, Peter Schoeffer, married Fust's daughter and the two men went into the printing business together,
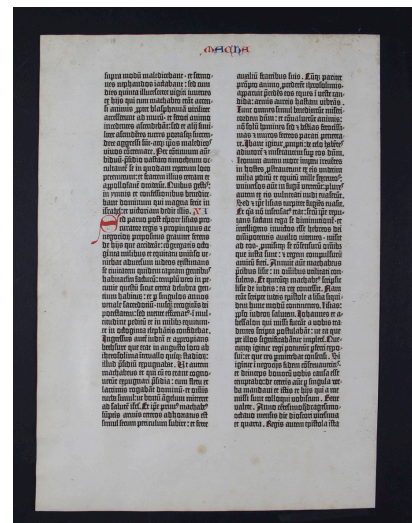

Figure 2. *Biblia Latina* (known as the Gutenberg Bible), leaf 509. Mainz: Johann Gutenberg and Johannes Fust (ca. 1454). ** A1 .B47l 1454
The Gutenberg Bible is the first Western book printed with moveable type. Although printing was used in Europe to reproduce images and block books prior to Gutenberg's work, his development of techniques for lead typecasting and setting revolutionized the way books were produced and consumed. Gutenberg altered the labor practices surrounding book production from scribal work into a highly refined, tight coordinated series of production steps.

producing a Psalter in Mainz in 1457 using the equipment from Gutenberg's shop.[32] Knowledge of printing and ability to replicate the technology could not be controlled, however, and printing began to spread rapidly. **[Figure 3]**

In the decades after Gutenberg printed his first bibles, print shops were established all over Europe and even beyond. In the 1460s, presses appeared in Cologne, Strasbourg, Bamberg, Augsburg, Subiaco and Rome, giving evidence of the rapid transfer of knowledge and dissemination of skill.[33] These establishments did not make use of materials from Mainz, but instead, spread knowledge of making molds, punches, and presses. In the 1470s print shops were established in Paris, Lyon, Barcelona, Frankfurt, and in the decades that followed the technology spread to Constantinople, Lisbon, Stockholm and Vienna. In each environment, local handwriting styles were copied into metal. For instance, Konrad Sweynheym and Arnold Pannartz, who set up shop in the Benedictine monastery in Subiaco in 1465, absorbed the design lessons of their scribal predecessors, and created a font based on a highly distinguished Italian round hand.[34] Their first printed volume, Cicero's *De Oratore*, is not only exemplary for its elegant design and execution, but as the sign of the humanist revival that would drive the migration of the classical corpus into printed form in this period. The humanist script they used embodied these values as well, and would serve as a model for the renowned Venetian printer Nicolas Jenson's elegantly refined typographic designs. Printers in the north used textura fonts, dense blackletter designs, for their types while William Caxton, setting up his shop in England, created an English blackletter for his types. These designs conformed to expectations of readers familiar with certain versions of letterforms, and are a continuation of the scribal traditions of national and local hands.[35]

Demand for books had already increased, and manuscript production could not keep pace. In addition to students and teachers in Universities, a readership grew among the expanding class of merchants and civil servants. Each type of book had its format: academic text books were usually printed two columns to a page, humanistic texts such as classics, poetry, and philosophy were often issued in quarto or smaller, as were popular books for the lay and religious communities. All of the features of manuscript books, such as paragraphs, initial capitals, rubrication, and illumination were adopted for printed works. Within a few decades hand-finishing diminished and press runs increased. The content of books in the late fifteenth century was broadening, but classics like Virgil and Cicero remained constants of the publishing industry, as did editions of the great modern writers—Boccaccio, Dante, Petrarch, and Chaucer, and of course, the writings of Church Fathers, such as Thomas Aquinas and Augustine.[36] Interestingly, reports on current events, such as the broadside of Sebastian Brant on the fall of a meteorite, which occurred in 1492, began to appear as well.
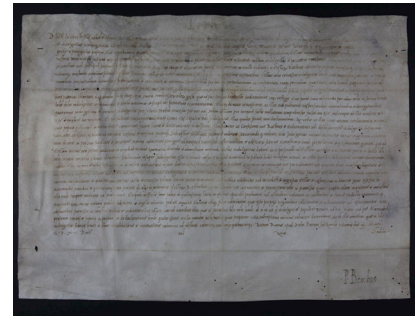

Figure 3. Pope Leo X. Indulgence granted to the Annonciades of Bourges and Albi. Rome: (1515).
*** Z233.I8 C28i 1515
According to the traditional Catholic doctrine, sins accrued during one's life result in a specific amount of time in Purgatory, the intermediary purification space between Earth and Heaven. Indulgences were sold by the Church as a way to forgive sins and alleviate the length and severity of posthumous punishment. Given this tempting presentation, it is easy to understand how indulgences were a major source of revenue for the Church.

Works of literature and law, and text books for grammar, rhetoric, music, and dialectic were in constant use. Titles in the sciences—math, geography, physic and optics—were often more difficult to print on account of the diagrams and images required, as were herbals and works in medicine. Editions of heraldry, as well as military strategy, history, and biography appeared in print along with standards of philosophy. Religious titles, bibles, psalters, and books of hours, remained popular, but in literature non-religious texts outstripped religious ones. By the end of the 15th century the notion that one might read to learn, rather than merely learn to read, had taken hold and with it came a flood of books on decorum, cook books, and political life. Niccolò Machiavelli's famous work of political theory, *The Prince*, was originally published in 1532, though it may have circulated in manuscript somewhat earlier.[37] Offering a justification for royal princes to use immoral means to further their own power and survival, the book, written in Italian vernacular, was both controversial and popular, an example of changing attitudes towards reading among emerging audiences. **[Figure 4]**

Spread of print

By the end of the 15th century, more than 29,000 different titles (or editions) had appeared in print and though many books were issued in runs of 200-300 copies, this still represented an exponential increase in the number of books available for readers before the invention of printing with movable type.[38] An estimated 10 million books may have been produced in less than fifty years. Certain titles were extremely popular. An edition of Pliny's *Historia Naturalis (Natural History)*, printed by Nicolas Jenson may have been produced in more than a thousand copies.[39] Quite a few of these copies were illuminated by hand, with elaborately ornamented borders depicting species described in the text. The work of the charismatic preacher, Savonarola, is believed to have been issued in an edition of between 2000-3000 copies. Presses sprang up all over, and in Venice, the vibrant port city with its multicultural population and place in the center of trade routes, more than 200 presses were established before 1500. Not all thrived and survived, but among them was the first to cast Hebrew type: the editions of Daniel Bomberg's printing house are considered milestone works. In addition, in these early decades, type was cast in Arabic, Armenian, and Greek, as well as the Latin alphabet.[40] In Venice printers were not organized into a guild, and so anyone with sufficient means and skill could set up shop. Of the incunabula editions, however, nearly three-quarters were in ancient languages, with the vast majority of these published in Latin, then Hebrew, Greek and Church Slavonic in descending order. The modern languages were also represented, particularly German, French, and Italian, with smaller numbers of titles in Dutch, Spanish, English, Czech, Swedish, and Portuguese. The publication of titles in English began with the work of William Caxton, and with his aptly named apprentice, Wynken de Worde, Caxton set
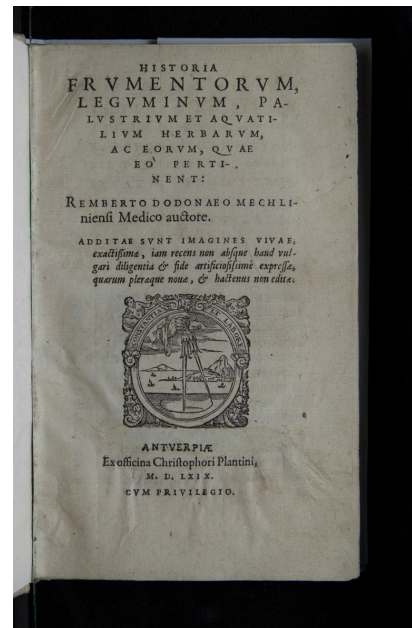

Figure 4. Dodonaeo Rembert, *Historia frvmentorvm, legvminvm, palvstrivm et aqvatilivm herbarvm*. Antwerp: Christophe Plantin (1569).
Barcode:G0000308676
European exploration and imperialistic expansion resulted in the collection of new biological specimens. This proliferation of information—coupled with a humanist desire to learn from observation—resulted in the printing of numerous botanicals. Some, such as this volume published Christophe Plantin, retain their original monochromatic appearance, while others have been hand-colored by their owners.

out to put the existing canon of English literature into print. In his shop near Westminster Abbey, Caxton printed such classics as the *Morte d'Arthur*, *Recuyell of the Historyes of Troye*, and the *Canterbury Tales*.[41]

Scholar-printers were a common feature of the times, but among them, the exemplary figure of Aldus Manutius stands out.[42] Manutius was a scholar before he became a printer-publisher, and his knowledge of Greek and Latin classics was extensive. He saw the potential of printed works to provide convenient, portable, and inexpensive editions, and thus created a pocketbook format for his publications. Working with his punch-cutter, Franceso Griffo, he produced a compressed font known as *italic*, and the term is still in use today. Manutius had a large enterprise, with apprentices, journeymen, and masters, many of whom lived in an environment described as a cross between a school, a sweatshop, and a boardinghouse. Literacy was essential for many of the tasks in the print shop—setting type, proofing pages, and distributing type—even if presswork and inking could be undertaken with skill and strength.

The question of whether print makes texts more stable, whether print technology is one of fixity or fluidity, cannot be answered without taking into account the ways that errors, editing, copying, circulation, and use all factor into the way a text is produced and received.

Elizabeth Eisenstein's milestone 1980 publication, *The Printing Press as an Agent of Change*, made an argument for the revolutionary impact of print.[43] She suggested that printing had brought about major social effects and might be in part responsible for the Reformation, advances in scientific knowledge, and shifts in political thought. Patterns of knowledge, she said, were changed by the shift from scarcity to wide availability and access in the change from "manuscript culture" to "print culture". Literacy requires education, not just access, and the criticisms of techno-determinism that have been leveled at her book suggest that a more complex social process is at work, not merely technical innovation, in the transformations of knowledge production in early Renaissance Europe (beginning in the 15th century). The mere fact of the number of books in print, their relative inexpensiveness compared to manuscript copies, and wide circulation supports many aspects of her arguments. But textual stability is probably not one of them, since not only do editions vary one from another according to editorial choices, errors, or omissions, but even within a single edition, changes occur from copy to copy as the forms are altered throughout a press run to correct errors.

Initial reception of printing was not uniformly positive. When Johann Fust arrived at a Paris book fair to display his editioned works, he found them condemned by the local police as devils' works that must have been achieved by supernatural intervention. But familiarity with the new invention soon displaced fearfulness, and the obvious advantages of making multiple copies of a work outstripped any hesitations.
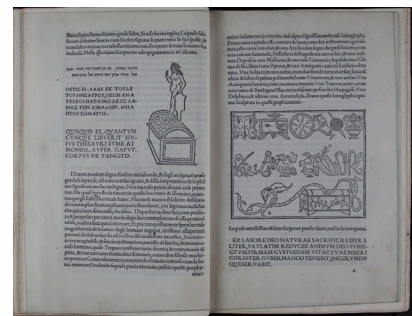

Figure 5. Francesco, Colonna. *Hypnerotomachia Poliphili*. Venice: Aldus Manutius (1499).
* A1 .C71h
Hypnerotomachia Poliphili follows the main protagonist Poliphilo through a dream-like landscape in search of his lover Polia. First printed by Aldus Manutius in 1499, the integrated layout unites image and text in a sophisticated manner and demonstrates the speed in which printing became valued and refined in the incunabula period.

Xylographic books, those printed exclusively from woodblocks, continued to be produced in this period, but more common were letterpress books illustrated with blocks. The skills of engravers intensified rapidly, and the work of Albrecht Durer, to take an outstanding example, made woodblock art into image making of a very high order.[44] Skill at observation and representation of the natural world improved the accuracy of herbals, anatomy books, and other illustrated texts.[45] Woodblocks for religious themes, such as meditations and devotionals focused on the life of Christ, abounded, but so did illustrations for Dante and Aesop, books of astronomical and astrological observation, geometry and arithmetic. One of the finest books ever designed is the *Hypnerotomachia Poliphili*. Printed by Aldus Manutius in 1499, it contains elegant images carved to accompany the text of Francesco Colonna, an enigmatic tale of a dream, part allegory and part surrealist drama. The book is considered one of the masterpieces of incunabula, and the match of text and image is harmonious and elegant. The achievement of such refined design shows how quickly printing became a fine art. **[Figure 5]**

Some discrepancy arose between audiences (actual readers) and publics imagined by the publishers. A glut of books flooded the market by the end of the 15th century. Andrew Pettegree has pointed out, in *The Book in the Renaissance* (2010), that there were a considerable number of remaindered volumes by 1500, indicating a faltering industry from this overproduction.[46] The situation would soon right itself, but the point is well taken. Printing created new communities and users, but as with many inventions, its place in the larger ecology of culture took time to become established and integrated. The Frankfurt Book Fair, still in existence, was one site of diffusion of printed material and knowledge. Books were not put into final bindings by their printer-publishers, just collated with serviceable cords holding the signatures together until their owners had them bound to fit into their private libraries. Business models came to include promotion and advertising, and printers' marks created a brand identity for a publisher's imprint. Among the renowned printers of the incunabula period, are Manutius, Jenson, and Caxton, already mentioned, and the Nuremberg printer/publisher Anton Koberger, whose *Liber Chronicarum* provides a history of the world from creation to the publication date, 1493.[47] Authored by Hartmann Schedel, with illustrations by Michael Wolgemut and Wilhelm Pleyenwurff, it is another of the monumental achievements of the incunabula period. One of its distinctive features is that it uses woodblocks repeatedly for different purposes—thus the city of Jerusalem might be shown using the same image as the one depicting Rome. The idea of visual specificity was not developed, instead, images served an iconic purpose, showing a type of person, place, or thing, not a particular city or individual. By contrast, herbals on which medical or scientific activity depended, strove for a high degree of specificity in their illustrations. **[Figure 6]**

Figure 6. Hartmann Schedel, *Liber Chronicarum* (known as the Nuremberg Chronicle). Nuremburg: Anton Koberger (1493).
** A1 .S3ll c. 1
These woodcut illustrations of so-called omens and human monsters are some of the most recognizable printed images of the incunabula period. The text of *Liber Chronicarum* connects biblical narrative to the histories of various cities (including where to find these fantastical creatures)—however, the woodcut illustrations provided to represent specific cities are frequently duplicated. While perhaps strange to modern readers, it was not odd in this early period of European printing to find the same woodcuts used to represent different geographical locations.

Aesthetics of print

Though many finely made books were created in the incunabula period, the aesthetic specificity of metal type and printed books began to mature only in the first decades of the 16th century. In addition, copperplate engraving was invented, and the possibilities of image refinement expanded through the detail of line work and possibilities of tonal value range.[48] Copperplate is an intaglio process, and its plates must be printed separately using a different press than the one for the letterpress type used for text.

Several figures made major contributions to the design of printed books in the early 16th century. Henri Estienne, a French printer/publisher, and his three sons, founded a dynasty that continued the family business for five generations.[49] These printers embodied the Renaissance, with its commitment to humanist values. Like other early printers, they were scholars, trained in Greek and Latin, committed to the classical tradition and its production in print, and not only printed, but edited, and even wrote, major treatises on a wide variety of topics: diet and classification of foods, geographical guides, dictionaries, a rural encyclopedia, and diseases of horses. Their circle included other famous French printers and typographers, such as Claude Garamond, who also tutored the Estienne children. When Henri died in 1520, his widow married Simon de Colines, a printer whose border designs and typefaces take advantage of the capacity of metal to produce fine, delicate, patterns.[50] Medieval hand-illumination was finally displaced by these elegant metal borders, which could be printed efficiently, but also, suited the typography they were designed to accompany. Colines worked with the artist and font designer Geoffroy Tory, whose principles of proportion were derived from those of human anatomy, figures, and faces. Tory's own book, *Champfleury*, published in 1525, is a masterly treatise on typographic design that embodies the spirit of the period in its execution as well as content.[51] These human references at the core of systems of proportion are characteristic of the Renaissance, with its emphasis upon humanity, rather than the cosmological hierarchies that had pervaded medieval conceptions of the universe. The recovery of Aristotelian thought, through translations of texts from Greek and Arabic, had a profound influence on making observation as important in understanding the natural world as the ideal forms of Plato inscribed in medieval diagrams of the universe had been for medieval cosmographers. **[Figure 7]**

These humanist principles found their way into medical texts and botanical ones. The copperplate engravings in Andreas Vesalius's De Humani Corporis Fabrica, published in 1543, and engraved by a student of the painter Titian, advanced the understanding of the systems of the human body—muscles, blood, digestion, skeleton, and nerves.[52] The images are deeply human, with the flayed figures striking poses of thoughtfulness, reserve, and/or defeat. This expressiveness endows the dissected corpses with spirit and inner life, in spite of their condition.
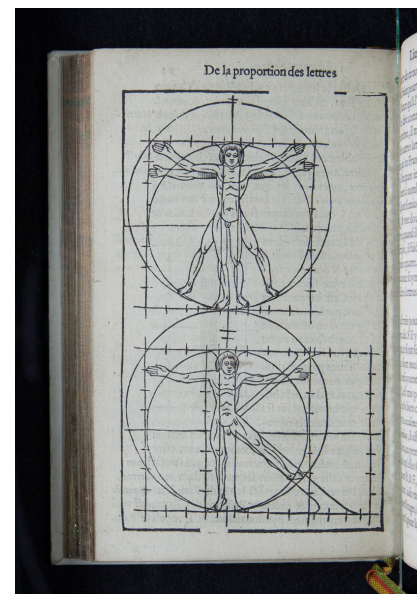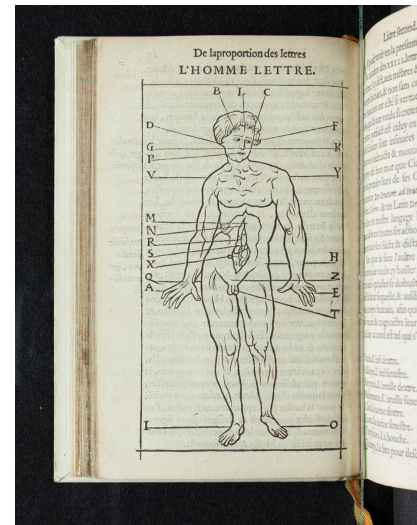

Figure 7. Geoffroy Tory, *Champfleury*. Paris: Viuant Gaultherot (1549). NK3615 .T63c 1549
In *Champfleury*, one of the most well-known examples of Renaissance letterform theory, Tory's defends an innate connection between Roman letters and human proportions. Although this anatomic, anthropometric argument had been proposed by others, in his three-part treatise Tory goes further than most of his predecessors and contemporaries, drawing connections between letterforms and the divine to present complex allegories that connect Roman capitals to gods, Muses, Renaissance cosmology, and Classical myth.

Copperplate engraving found its way to Antwerp, where it fostered transformation of mapmaking. The accuracy of information from observation, combined with new methods of creating projections, reflected changes in knowledge of the world. The voyages of Columbus and other explorers had altered Western Europeans' understanding of the globe, and the many motives that prompted exploration included religious zeal, profiteering, adventure, and conquest in varying combination (as will be clear in Chapter 6). Belief about the natural world were being challenged constantly by principles of observation, and visual representations of knowledge were changing in relation to these shifts. **[Figure 8]**

In Europe, printing became a vital industry, producing prosperity as well as benefitting from it. One example is Christopher Plantin, a French printer, who moved to Antwerp in the 1550s (his religious beliefs put him at risk in France, where a printer had been burnt at the stake for printing heretical material).[53] A bookbinder by training, he took with him a set of punches purchased from the expert type designer, Claude Garamond. The cutting of punches was the most demanding skill for a printer, and in the period before type foundries were established to supply metal type for printers unable or unwilling to do this work themselves, having punches made was the first step in establishing a shop. In Antwerp, Plantin went into business with a local partner, Jan Moretus, and in 1569 they published a polyglot bible with Hebrew, Greek, Aramaic, and Latin fonts and translations for the Old Testament, and Syriac, Greek, and Latin for the New. The daunting problems of design and layout for texts in multiple languages that will always be of different lengths were handled with expert mastery. The Plantin-Moretus shop became an enormous establishment, with dozens of presses and enormous numbers of skilled workers.[54] In the course of his career, Plantin produced almost 2500 different volumes, or approximately seventy titles a year. To do this, his shop had to employ and coordinate an army of typesetters, printers, and other trained craftsmen. He was a prolific printer and the sheer volume of output of his press is unparalleled anywhere in the world in the period. **[See Figure 4, above]**

One final note is in order with regard to the practices of written literacy in the 16th century, which is that it remained a vital period for writing masters. Handwriting would continue to be an essential cultural form for several centuries, but in the 16th century the practice of creating specimen books with copperplate engravings allowed the elaborate flourishes and arabesques and font designs of Ludovico Arrighi, Giovanni Palatino, Giovannantonio Tagliente, and others to be widely disseminated.[55] The use of these books as instruction manuals, examples to copy and imitate, made them highly popular. But the use of writing for different purposes and occasions, once in the hands of scribes working for church or civic institutions, became more widespread. Gentlemen and noble women knew how to
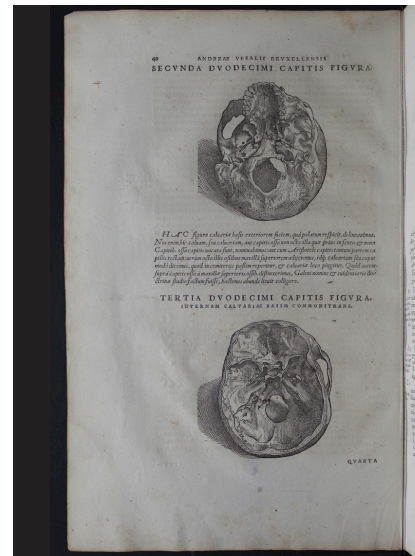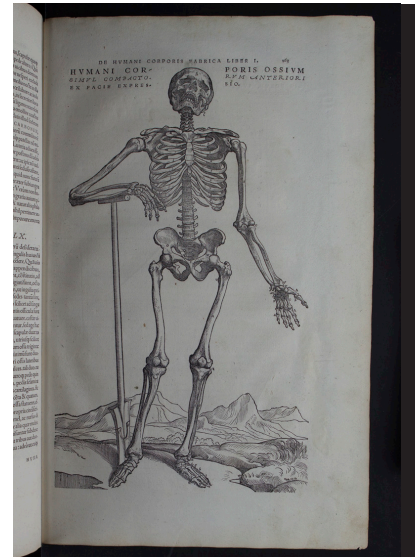

Figure 8. Andreas Vesalius. De Humani Corporis Fabrica. Basileae (Basel): Andreas Vesalius (1543).
** QM21 .V428 1543
Humanist interest in anatomy, coupled with advances in observational drawing and reproductive printing processes, provided the necessary artistic and intellectual environment for detailed anatomical texts, such as Vesalius'. His direct observation and examination of human corpses resulted in more accurate illustrations and descriptions than previous available, as well as provided evidence to refute false information provided by Greek physician and philosopher Galen.

write, and to make use of a range of serviceable, conventional, and distinctive hands. Though at first it is counter-intuitive to imagine that handwriting becomes more refined and its models more developed in the first century of printing, on reflection, it is clear that each literacy technology is part of an ecology in which its identity participates in the whole, rather than existing in isolation.

Conclusion

Printing in the Far East and in the West made use of certain common technological inventions, but they also differed in their use of materials (wood vs. metal) and engagement with a press (essential to European printing, while Asian printing remained a handcraft). The impact of printing registers within an already receptive and literate environment, but the availability of a massive number of new works, in relatively inexpensive formats, and across an increasingly varied range of topics and genres, created new reading publics for sacred and secular texts in classical and modern languages. The rationalization of labor that the print shop practices embodied would serve as a model ahead for the transformation of other industries into their increasingly modern form, anticipating some of the modularity reinforced by 19th-century industrialization. The aesthetics of metal type came into their own, supplying new designs and forms of letters that were not entirely dependent on scribal models, though in the first decades of print, all features of the books and artifacts that were printed borrowed from manuscript traditions because these were the models in place, ready to be imitated. By the 16th century, issues of control and censorship were starting to be felt, and the risks associated with printing, and books as sites and instruments of contestation, would alter the stakes of print publication. Book culture also had an impact in the New World, both for its shaping of missions and attitudes and also for the way print became integrated into emerging cultures in zones of contact and (often troubled) exchange, as will be evident in the next chapter.

Figure captions and research in this chapter are the work of Carlin Soos; all other text is by Johanna Drucker.

All images are from book in the Charles E. Young Research Library at UCLA, unless otherwise noted.

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