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Abstract: This article focuses on the printing press invented by Johann Gutenberg. While working at the mint, Johann Gutenberg was struck by a new idea. Perhaps, he thought, books could be created mechanically. Such machine technology would allow multiple copies of a book to be printed at the same time instead of being hand-copied laboriously one by one. Gutenberg began experimenting with a bookbinder's metal punch, a long metal rod with a raised letter at one end that was used to punch single letters into the cover of a book. Gutenberg planned to create sets of letter punches that he could place in a frame. He could then press the frame onto a sheet of parchment to create a printed page. This technique would allow printers to produce hundreds of books in the same time it took a scribe to make just one copy. (Copyright applies to all Abstracts)

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CHAPTER ONE: Johann Gutenberg and the Printing Press

The first revolution in human communications was the invention of writing. This event dates back many thousands of years to the ancient kingdoms of the Middle East. The written word allowed rulers to publish declarations, merchants to keep track of their trade, and storytellers to record their myths and tales.

Humans first engraved their texts by hand in stone. Later, they wrote on long scrolls of parchment made from animal skin that was stretched and scraped to make a thin writing surface.

The craft of printing did not begin until the eighth century A.D. in Asia. In ancient Japan, Korea, and China, the first printers carved characters into wooden blocks, spread them with ink, and then pressed the blocks down on paper or fabric. In the 1040s, Pi Sheng also experimented with movable type by carving the characters into blocks that could be arranged for printing.

Although most Chinese continued to create and copy their literary and scholarly texts by hand or with wooden blocks, thirteenth-century Koreans began to replace woodblock

printing with movable type, which by the fifteenth century became the primary form of printing in that country.

Europeans, however, knew nothing about these developments in the Far East. While Chinese and Korean artisans were creating methods for printing books with machines, copyists in Europe continued to reproduce manuscripts by hand. Many of these scribes were monks who lived in isolated communities and spent their days laboring at small desks, writing out religious texts, hymns, and prayers. Using quill pens, they had to copy a text word for word on a piece of stiff parchment. Bookbinders then secured the individual pages of each manuscript between a set of wooden or leather covers.

Making books by hand took a long time--often several months or more. As a result, they were rare and expensive items that only a few people could afford. Even if the Europeans had developed movable type at the same time as the Chinese, the cost of parchment would still have made books unattainable to most people. While kings and popes owned large libraries of books and wealthy landowners had small collections, most Europeans owned no books and could not even read.

In the late thirteenth century, the process of making paper was brought to Europe. Although this process made the materials for books much less expensive, books were still rare in Europe when Johann Gensfleisch was born 100 years later in the German city of Mainz. Very little is known about the life and work of Gensfleisch, the man whose invention made such a significant impact on world history.

The aristocratic Gensfleisches were part owners of the Mainz mint that produced official coins, medals, and jewelry for the city. One of the family mansions was called Hof zum Gutenberg, and young Johann began using "Gutenberg" as his last name when he entered school.

Johann's father, Friele Gensfleisch, owned a private collection of expensive books, and young Johann may have spent much of his time browsing through his family's library. While still a boy, he also began working at the mint. Johann may have learned the trade from his uncle, who at one time was the master of the mint. Soon, Johann could cut precious stones, coin money, and create jewelry. In time, he became a skilled metalsmith.

While working at the mint, Johann Gutenberg was struck by a new idea. Perhaps, he thought, books could be created mechanically. Such machine technology would allow multiple copies of a book to be printed at the same time instead of being hand-copied laboriously one by one.

Gutenberg began experimenting with a bookbinder's metal punch--a long metal rod with a raised letter at one end--that was used to "punch" single letters into the cover of a book. Gutenberg planned to create sets of letter punches that he could place in a frame. He could then press the frame onto a sheet of parchment to create a printed page. This technique would allow printers to produce hundreds of books in the same time it took a scribe to make just one copy.

Gutenberg made letter punches by melting down lead and pouring it into a mold. But the letters were unusable because they had so many imperfections. They formed uneven rows in the frame. And when pressed against the parchment, the punches left dark blotches of ink in some places and blank spots in others because the surfaces of the letters were not flat.

In 1428, during a revolt by the citizens of Mainz, Gutenberg fled to Strasbourg. There he set up a workshop outside the city walls and spent long days and nights trying to invent a more efficient and precise way to make letter type.

Gutenberg quickly ran out of money because the materials he needed were expensive. In 1436, he took on three partners--Andreas Dritzehn, Hans Riff, and Andreas Helimann--who invested money in three secret processes Gutenberg was developing. One was a new method of polishing precious stones, another was a way to manufacture mirrors--and the third was a printing press.

Gutenberg had developed a way to cast type. Using a metal punch, he made an impression of a letter in a copper or brass bar. He then set the bar, called a matrix, at the bottom of a wooden mold and poured melted metal into the mold. When the metal cooled and hardened, Gutenberg took apart the mold and removed the raised letter. With the mold and the metal matrix, Gutenberg could create many identical letters more reliably than by casting different metal punches.

To produce a document, Gutenberg first cast and set the type. Then he placed the type in a composing stick, which contained all the letters of a word. The composing stick was put in a wooden frame, known as a chase. Finally, the inventor spread ink on the rows of type.

Gutenberg used a press to make an impression of the text on parchment. The press was a large wooden machine that was similar to the presses used to extract oil from olives or juice from grapes. When Gutenberg pressed a sheet of parchment firmly against the type in the chase, the result was a mechanically printed page.

THE BREAKTHROUGH
Gutenberg worked several years to devise a new metal alloy for his type. To create many identical versions of the same letter, the alloy had to resist shrinking as it cooled from a hot liquid state. At some point, probably in the mid-1430s, Gutenberg found that a combination of lead, tin, and antimony (a metallic element used to harden other substances) worked best. For the printing ink, he mixed linseed oil and lampblack (a kind of fine soot). This combination provided ink that would adhere to the edges of the type, allowing the letters to print clearly. Gutenberg also replaced parchment with paper. In addition to being cheaper than parchment, paper had a smoother surface and, as a result, reproduced letter type more evenly.

Gutenberg kept his type and his press in the home of one of his partners, Andreas Dritzehn. In December 1438, Dritzehn died. Fearing that his former partner's relatives would claim Dritzehn's investment as their inherited property and make his invention public, Gutenberg ordered two of his assistants to go to Dritzehn's house to destroy the presses and type molds.

Unfortunately, Andreas's brothers, George and Nicholas, had already stolen some of Gutenberg's equipment from the house. Worse, Andreas had not bothered to sign a partnership contract before his death, so the brothers were quick to bring a lawsuit against Gutenberg. The suit claimed a share of the partnership and challenged Gutenberg's right to exclusive use of the printing process. In court, Gutenberg managed to avoid giving testimony that would make his printing process public knowledge, but defeating the suit was costly.

During the 1440s, Gutenberg returned to Mainz, which was again at peace, in the hope of gaining support for his project there. Gutenberg was probably the Mainz printer who in the 1450s brought out a classic Latin grammar book by a scholar named Aelius Donatus.

By this time, word of Gutenberg's printing process had spread. Several other European inventors were designing mechanical presses, and Gutenberg found himself in a race against these competitors. In 1450, he asked Johann Fust, a wealthy Mainz businessman, for money to continue his work. Fust agreed to lend Gutenberg 800 guilders (more than $20,000 in today's money), and the inventor put up his presses and printing materials as collateral for the loan. The money allowed Gutenberg to buy paper, parchment (for higher -quality editions), ink, and the metals he needed to print a Bible.

With his assistant, Peter Schoffer, Gutenberg spent months building frames and preparing type for the first printing of the book. Each frame held 42 lines of type in two columns for a single page. Gutenberg wanted the letter type to be perfectly flat and all the type to be absolutely regular so that, for example, each "s" was identical to every other "s." Since certain letters, such as "i," take up much less space than others, such as "m" or "w," he had to adjust the spacing between the letters carefully. In addition to the letter spacing, the rows and columns had to be perfectly straight.

In 1454, Gutenberg and Schoffer finally began printing. Workers operated two or three presses at one time, while compositors prepared the type and laborers hung the printed sheets up to dry. The work progressed slowly because Gutenberg rejected many pages he examined for imperfections.

Then disaster struck. Although Fust had given him an additional loan of 800 guilders, Gutenberg again ran out of money. Demanding repayment, Fust took Gutenberg to court. Because he was aware that the new process was valuable and that he could make a profit by selling the printed Bibles, Fust may have planned to seize the books as soon as they were printed. The court decided in Fust's favor and allowed Gutenberg to keep only a single set of his metal type. He lost his printing workshop, the rest of his type, and the rights to his 200 printed Bibles.

After taking possession of Gutenberg's work, Fust hired Peter Schoffer (who would soon become his son-in-law) as his partner. Schoffer completed the printing of the two-volume Bibles, which carried no dates or printers' names. With the money earned from the sale, Schoffer founded a printing business under his own name.

Despite the many years he had spent perfecting the printing process, Gutenberg earned nothing from his efforts. There is evidence, however, that Gutenberg again received financial assistance, this time from Mainz citizen Konrad Humery, and that he went into a partnership in Bamberg with a printer named Albrecht Pfister. Gutenberg was probably the printer of a new, 36-line Bible, published in about 1458, that was easier to read than the earlier 42-line edition. Later, Gutenberg printed a Catholicon (a huge dictionary of Latin) and an astronomical calendar.

THE RESULT
Within a few years after the appearance of the 42-line Bible, other printers had established shops in the German cities of Strasbourg and Cologne. In less than a day, they could produce mechanically the same manuscripts that had taken months to copy laboriously by hand.

Printers from Mainz traveled to other German cities and to neighboring Switzerland and northern Italy, carrying the knowledge they had gained from Gutenberg and his assistants. These artisans took with them only the printing molds and matrices they used to cast type. When a printer established a shop in a new city, he had to cast a new set of type.

In Mainz, Fust and Schoffer began printing broadsides--single sheets of paper with type on one side. Predecessors of the modern newspaper, these broadsides carried news, declarations, and proclamations authorized by the city's ruler.

Gutenberg's invention is the single most important development in the history of communications technology. His discovery enabled printers to reproduce thousands of books in the time that scribes once took to transcribe a single manuscript. By making books more widely available, the printing press ushered in an age of wider literacy in Europe. People no longer had to depend on their rulers or the church for information, and a growing class of scholars and writers began to explore revolutionary new ideas in philosophy, language, history, politics, and religion.

In an effort to protect his invention from others, Gutenberg had worked for many years in secret. As a result, many historians have given other early craftsmen credit for the invention of printing. People of Gutenberg's time, however, referred to him as the first printer, and eventually most historians and scholars came to recognize him as the true creator of the mechanical printing process.

Despite his legal and financial problems, Gutenberg achieved renown in his birthplace of Mainz. In 1465, the archbishop of Mainz appointed him a nobleman and provided space for the printer to set up a workshop. Gutenberg continued to improve his printing process and train apprentices until his death in 1468.

Printing technology--and the market for books--has changed drastically since Gutenberg's time. In the nineteenth century, machines made printing more efficient by mechanizing all stages of the printing process--from linotype and monotype machines that cast and set type to cylindrical presses that printed on rolls of paper. Now computers are used to set type and create a book's layout and design, and modern printing presses print texts, usually from photographic plates of the manuscript, onto rolls of paper fed into huge machines. Complex automated machines bind the printed sheets into books.

Today, people increasingly depend on sophisticated computer technology for sharing information and retaining knowledge. But the book and other printed texts remain the most commonly used and accessible forms of communication.

According to the Bible, Moses received the Ten Commandments on stone slabs--the writing tablets of biblical times.

Because the Chinese language is written with 2,000 or more characters to represent various words, it was impractical to continue mechanical printing using separate blocks for each character.

Even though Marco Polo wrote about the wonders of China in the late 1200s, the Chinese invention of movable type remained unknown in Europe.

Because books were so valuable, they were often chained to the shelves of libraries to prevent theft.

Historians of printing can identify the printer of an early book by the type used to print the text.

Printed books sold for about one-tenth the price of hand-copied books.

Type refers to the letters that are formed, or cast, from metal and used to print text.

alloy: a mixture of two or more metals

compositor: a person who sets written material into metal type; a typesetter

PHOTO (BLACK & WHITE): Johann Gutenberg (ca. 1400-1468) holds emblems of his printing craft--a letter punch and a piece of metal that has been stamped with the alphabet.

PHOTO (BLACK & WHITE): Clay stamps had been used since ancient times to mark messages with imprinted wax seals, but the Chinese were the first to reproduce documents and books by using interchangeable wooden blocks to press characters onto paper.

PHOTO (BLACK & WHITE): When monks copied religious texts, they often added their own thoughts in the margins. Scholars now read these comments as carefully as the original manuscripts.

PHOTO (BLACK & WHITE): In the late 1200s the first European paper mill was established in Italy. The process of making paper had been invented by Ts'ai Lun of China over 1,000 years earlier, in about A.D. 105.

PHOTO (BLACK & WHITE): This portrait shows Johann Gutenberg using the old form of communication: writing by hand with a quill pen.

PHOTO (BLACK & WHITE): In Gutenberg's device, the press (the flat piece) was screwed down tightly so the paper received the best possible imprint from the type placed in the chase below it. The four boxes in the chase each contained a page of type so that four pages could be printed at one time.

PHOTO (BLACK & WHITE): Gutenberg inspects a printed page as a worker waits to turn the screw on the press.

PHOTO (BLACK & WHITE): The surviving copies of the Gutenberg Bible, printed in Latin, are now among the most valuable books in the world.

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By Thomas Streissguth

Source: Communications: Sending the Message