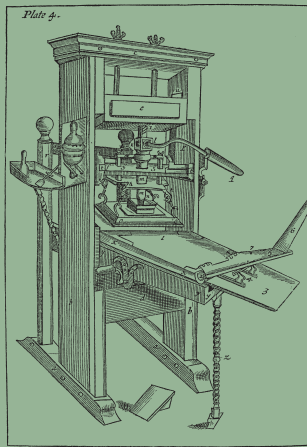


# Six Centuries of Type & Printing



by Glenn Fleishman

**EXCERPT**

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*Dedicated to my mother, Audi Fleishman,  
who encouraged me in all my pursuits*

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Portions of this book previously appeared in earlier forms, including in a six-part series at Medium in 2017, “Letter Rip,” and in *Wired* magazine in June 2017, “How Letterpress Printing Came Back from the Dead.”

This excerpt contains selected passages from the book.

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# Introduction

Johann Gutenberg invented neither printing nor movable type. That honor goes to many artisans across Asia whose work predated Gutenberg by centuries. Gutenberg's achievement instead was creating a rapid, consistent process that scaled with little effort. He spent decades keeping his ideas secret. But once they were observed, others could reproduce them. As infrastructure grew to support printers, printing technology spread faster.

In Western Europe, handwritten manuscripts were in increasing demand toward the 15th century. Production had risen from tens of thousands of copies per century in the 6th to 8th centuries to nearly five million in the 15th century as manuscripts crested their peak.

In the first hundred years following Gutenberg's inventions, however, 100 million books were printed across Europe. During the 18th century, publishers in Europe and Russia produced a billion books. Today, several billion books are printed worldwide every year.

This book traces nearly six centuries of type and printing, from the glimmer in Gutenberg's eye to the current era. The focus is on the initial flood of technological advancement, through the stagnation of 350 years, and then the mad rush from 1800 onward. In the screen-based era, I look at digital technology as it affects putting ink on paper, rather than pixels on screens.

The book is divided into parallel stories of type and printing. Its first part considers type manufacture and typesetting, and the second examines presses and techniques for printing. While the two elements are naturally intertwined, their evolution occurs along different paths.

Much that was invented has been forgotten, even while practices, terminology, and technology remain shaped by it—if you know where to look.

— Glenn Fleishman, Seattle, September 2019

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*A tip about printing the PDF edition: The type is small enough that you may wish to enlarge it on printing. Each page can fit neatly on an 8.5-by-11-inch or A4 sheet at about 140 percent enlargement.*



## The Master Printer

It's hard to understand from a remove of nearly six centuries how revolutionary the set of innovations that Gutenberg linked together were. He moved European society from a state in which books and scrolls were entirely written by hand and unaffordable by most, to one in which mass production was feasible, producing a good that quickly became within the reach of the merchant class.

He is often called the inventor of movable type, but that description covers only a fraction of what he conceived — nor was he the first mover. He spent from the late 1420s to the 1440s thinking about and testing out his ideas. By 1450, he had determined what he needed for a printing workshop, and then had all the pieces manufactured from scratch or adapted from existing parts in Mainz, Germany.

There's no historical record of how he conceived his approach, however, nor of what his tools were. Nearly everything we know about him comes from a handful of court cases; he wasn't necessarily that litigious, but they're the only substantive sources that survived. Any portrait you've seen of him is an invention of a later engraver or painter starting a century after his life. Even his date of birth isn't certain — it's often cited as 1400. We do know he died in 1468.

While Gutenberg is largely known by inference, his works reveal aspects of the methods of printing that were required to make them.

It's only later that printers and others began to document how the art and craft worked, and it's assumed that what they described evolved from Gutenberg's roots.

Historians believe that following decades of tests, Gutenberg rapidly built working presses, found the right ink mixture, and cast metal type. He immediately set to work printing papal bulls, indulgences, and a grammar book before beginning on his well-known Bible. He started printing by 1450 and continued through 1456, when he lost financial control. Despite how new his methods were, by the time he printed his Bible, he could execute it well and make it beautiful.

Gutenberg's approach to printing relied on casting individual pieces of metal type that could be assembled to form words and reused later. Paper, ink, and a press weren't secondary, but their specifics arose from the particulars of his type.

No one is sure exactly how Gutenberg conceived of printing types and printing in multiples, and he may have thought he was first. But antecedents abound across Asia. No later than the 4th century CE, artisans in China carved characters, illustrations, or entire pages or parts of scrolls on wood blocks; the earliest that survives is from the 9th century.

Wood-block printing was also practiced for artwork and a small number of books in the first part of the 15th century in Europe. Both in Asia and Europe, wood blocks were printed by applying ink and then rubbing across paper placed on top. It was time consuming and produced inconsistent results.

Just after 1000 CE, a blacksmith, Bi Sheng, carved and cast type in baked clay in China and printed from it. He could arrange it as desired, fix it into position to make prints, and then reuse it.

Movable type in metal appeared in China by the 12th century, and the first book known to be printed from movable metal type dates to 1234 CE in Korea. One 30-volume work was printed this way. Examples around Asia increase as we approach Gutenberg's era.

It's possible Gutenberg never saw this older technology for making books or printing, even though Mainz was a major trading hub. It's plausible he saw printed works and worked backward to derive their methods and improve upon them.

But regardless of his influences, Gutenberg's work benefited from his apparent genius and from the combination of factors he brought together, as well as from some cultural and typographic distinctions in Western Europe.

Europeans required only a small number of unique characters to represent their written languages. The logographic script originating in China can encompass tens of thousands of characters. At least a few

thousand different ones could be required in a single work.

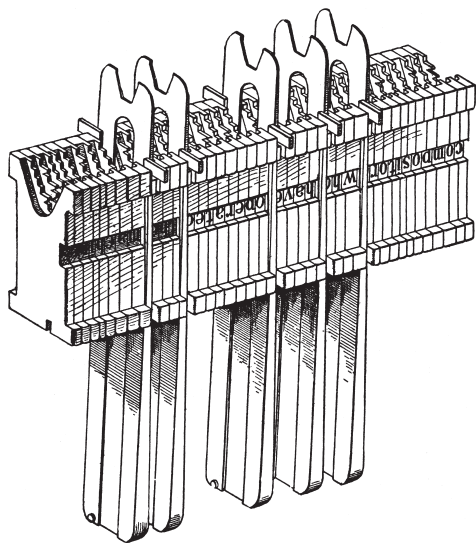
Besides numerals and punctuation, Latin relied on just 23 unique characters, while German and other European languages needed a handful more, plus diacritical marks like umlauts or accents.

Some historians also argue that, at least in China and Korea, governments and courts controlled efforts at printing and they weren't interested in allowing the general spread of printed words. Rather, they wanted to disseminate a few standard texts to ensure religious or regulatory consistency. Otherwise, printing was used for currency and playing cards.

While most of Gutenberg's early works were made under contract for or subscribed to by the local powers in the Catholic Church, he managed his own affairs and owned his business, as did most printers who came after him. He printed the Bible because it was popular and he thought it would be profitable. (He paid the price, though, as he lost control of his workshop by 1456, when he couldn't manage his key investor, Johann Fust.)

It remains a mystery to historians how cultures that were advanced in science, engineering, and the arts elsewhere in the world, and which had modest numbers of characters in their scripts, didn't produce printing types. The Islamic Golden Age, spanning the 8th to 14th, centuries CE, was ripe for such exploration, but it didn't take hold. Cultural impediments may have contributed.

We don't have certainty about what let a German printer spark a revolution. But we do know the centerpiece of his engine of change: the knack of casting well-designed characters over and over again.



## Type Heats Up Information's Speed

Mired in more or less 15th-century methods of composition, publishers couldn't feed a public maw hungry for books and newspapers, and job printers could barely keep up with demand for increased commercial production.

A 1929 US Bureau of Labor Statistics report found that a composing room in 1896 required 40 people to set type and compose pages for a four-page newspaper, which was then printed in an edition of 10,000. About 16 of those people were typesetters, who spent seven hours each edition typesetting and about half that again in distributing type.

The introduction of machine composition, discussed in this chapter, shrank composition staff by 60 to 80 percent, the report said: It multiplied the output of each typesetter and eliminated type distribution. (If you wondered, many workers were rehired quickly due to subsequent growth in typesetting.)

One newspaper grew its daily edition from 12 pages in 1896 to 36 pages by 1926, went from 48 to 60 pages on Sundays, and produced more editions each day — “Extra! Extra!” isn't just a movie newsboy's cry. The number of copies printed went up dramatically as well.

The first attempt at mechanical typesetting wasn't the Linotype, a name you may have heard. But the Linotype machine was the first

that successfully changed and radically sped up the process, requiring new skills and inevitably bringing competitors with distinctly different approaches to market.

It's also where the interests of type manufacture and typesetting collide, to the detriment of type foundries but to the benefit of publishers and readers.

Across the 19th century, many inventors created contrivances that could compose lines with handset type. A number of them involved pressing keys to release type from a *magazine*—a vertical holder divided into channels—sometimes directly into a composing stick. Others required modifications to type to grab the right letters. (Inventors were also in a mad dash at the time to create a typewriter.)

Because women were largely excluded from typographical unions, they were often hired to operate these frequently breaking-down machines, and at much lower wages than men. These type selectors generally neither justified lines nor distributed type, which together could consume 40 to 50 percent of composition.

From accounts at the time, a reader might think early typesetting systems were widely used. Rather, patents abounded, but few of the systems described provided enough advantage to move from prototype to real production. Many had higher throughput than handsetting, but required multiple people to operate! Hardly a savings.

Others, like the Paige Compositor—the machine that bankrupted investor Samuel Clemens (a.k.a. Mark Twain)—could carry out all composition needs, but were too temperamental in operation.

In the wonderful book *A Collation of Facts Related to Fast Typesetting*, written in 1887 by three of the fastest typesetters who ever lived and likely will ever live, the authors noted apropos of many devices then in development, "...what is wanted is a piece of mechanism that can think, and the numerous efforts to secure this phenomenon proves the sure foundation on which the compositor's art is based."

The Linotype arrived in 1886 and didn't yet warrant a mention. While the Linotype couldn't think, it used mechanisms to mimic the hardest parts of typesetting.

Ottmar Mergenthaler designed several models of typesetter at the behest of James Clephane, a celebrity stenographer of the 19th century who was friends with Abraham Lincoln and other statesmen; he developed shorthand systems and was famed as a court reporter.

Clephane beta-tested the typewriter that Christopher Sholes and James Densmore had underway in the 1860s, and destroyed one experimental model after another, sending back detailed, "caustic" critiques. (They persisted, came to market, and sold their production interests to the Remington company.)

The typewriter answered Clephane's need for quick and clean text, but not for copies. He first envisioned typing onto a sheet that could be reproduced by lithography (see "Painting Images with Ink"). Mergenthaler, then working at a machine shop, produced a version, but didn't like it. He moved on to make a device that would punch molds into paper for casting, like stereotyping (see "Copy and Paste in Metal"), and felt that was a dead end, too.

Mergenthaler finally came up with the notion of a keyboard that lined up matrices to set and cast type in hot metal on a single machine. Clephane agreed, and the first model went into a newsroom in 1886. But Mergenthaler still wasn't satisfied. He quit the company that was making his typesetter, redesigned it, and rejoined with a new model that became a juggernaut. (Mergenthaler saw only part of its success: He died, at 45, in 1899.)

The Linotype is an absurdly complicated all-in-one device that was allegedly named after the exclamation that it set a literal "line o' type," called a *slug*. Like a hand-set composing machine, it relied on a magazine. But a typesetter released matrices — not pieces of type — from the magazine when they typed on an attached keyboard.

Matrices drop into the machine's *assembler* one at a time, forming a line with the mold facing away from the operator. The typesetter could spot-check a line by reading the labels printed facing them, however, as well as make corrections or drop in special characters by lifting out and inserting matrices in the assembler.

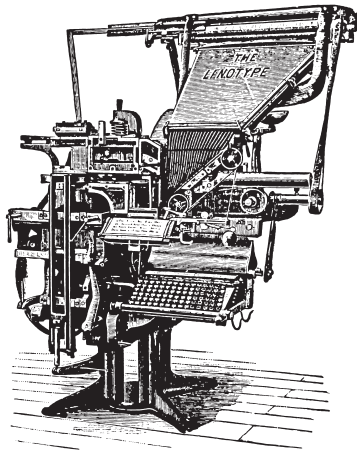
When the line nears its maximum length the operator pulls a casting lever, which shifts the line of type over to a mold disk. Each Linotype had its own heated pot of type metal. In casting, the device pumped metal to fill the matrices for that line of type.

The mold disk then rotates and releases the solid, cooling slug into a galley tray that accumulates lines of type. That injection happens just to the left of the compositor. If something goes wrong, such as the mats not being properly aligned, the machine could produce a *squirt* of hot lead. Most operators wound up with burns and scars.

Slugs are immediately ready to print, and a compositor might cast a few lines at a time or entire stories or book pages.

You might say at this juncture: This is all very slick, but how does it solve justification and distribution?

When an operator needs a word space, they press a space bar, which releases a *spaceband*, a special expanding wedge. When a line is complete and shifts to the mold disk, it's held within vise-like jaws, which are set to the desired width of the line. A *justification block* pushes up from beneath, driving the spacebands, which expand until they fit the space snugly. Because the spacebands are wedges and pushed with equal pressure, each resulting space is identical.



After a line is cast, the Linotype raises the matrices via a mechanical elevator to a *distributor* above the magazine. Each Linotype matrix has a unique pattern of teeth jutting out from a V-shaped slot on the side opposite to its mold. This is effectively a 7-bit binary code allowing for up to 128 combinations.

The *distributor bar* carries matrices along until the right set of missing teeth are encountered — one of as many as 124 channels, as four codes are reserved — and it drops back into place. (Later machines could handle several magazines and two characters per matrix, allowing access to up to 850 unique characters.)

Yet distributing matrices isn't really distribution — it's more like sorting. Distribution wasn't required at all. Linotype slugs were largely used for perishable work, like newspapers, and immediately melted after printing.

The Linotype's keyboard, casting, and justification sped up composition by an extraordinary amount. A trained operator was required to compose at a minimum of about 5,000 ems an hour in standard sizes under the rules in many composition rooms, or at least five times that of a skilled handsetter. However, speeds above 10,000 ems an hour were common.

The Linotype also never ran out of type, didn't require storage of expensive type bought in advance, and eliminated distribution. An operator needed training, but far less apprenticeship than a handsetter. Not inconsequentially, typesetters lived longer on average after the Linotype's advent, meeting the national average of around 50 years by 1905.

What Linotypes did need were matrices, and in vast quantities. The first Linotype went into use in 1886 at the *New York Tribune*; dozens

followed in the next two years, and then hundreds after Mergenthaler developed his improved version. Each magazine required hundreds to thousands of matrices.

Mergenthaler and associates began by using electroformed matrices, excellent for casting a lot of type, but a slow method to make a mass number of matrices. The company quickly switched to steel punches and struck its matrices. But punch cutting is a slow business, and punches are subject to break.

Even with six or seven punchcutters on staff at the Linotype company by 1890, it could barely keep up with the matrices needed for the machines in use. Some critics said it was noticeable when punches were replaced, seeing variations even in a single line of type depending on when each matrix was made.

This cycles us back to the pantograph. Benton designed his pantographs to cut punches in soft type metal for electrotyping matrices. But could he cut in steel instead? In 1884, before the first Linotype went into production, the company's patent attorney visited Benton's foundry to ask that question. (There's some dispute about whether it came this early.)

Benton quickly proved it could. His firm made punches for the Linotype company under contract for a few years, and agreed to lease his machines. Perhaps due to the work of getting the Linotype into full production and repairing those in the field, the first engraver wasn't delivered until early 1889.

The quantities required were staggering. In a 1919 publication, what was then the Mergenthaler Linotype Company said it offered 250,000 unique characters for its machines worldwide, and produced one million matrices a week.

Without Benton, the Linotype would have stalled. As De Vinne wrote in *Plain Printing Types*, "The success of the Linotype...composing machine is largely due to the accuracy of the matrices made from Benton machine punches." The patent on Benton's equipment expired around 1900 in the US and UK, allowing Linotype and others to manufacture punch-cutting pantographs.

Linotype didn't exist in a vacuum, however. Patents allowed the company to keep direct competitors out until the Intertype arrived in 1917 with innovations of its own.

But Linotype didn't have a monopoly on hot-metal type. Within just a few years, it was joined in the market by a company that took a different tack, aiming for a slower-speed and more diverse market than that of newspapers.

## Coda: Letterpress Abides

Every November since 2008, hundreds of letterpress aficionados and designers gather for a *wayzgoose*—an annual printer confab—at the Hamilton Wood Type & Printing Museum in Two Rivers, Wisconsin.

Attendees hear lectures about history, design, and current practices, and take workshops on printing, paper marbling, and wood engraving. *Wayzgoose*-goers swap tales and letterpress prints over meals and pints. There is also bowling.

Since its founding in 1999, the museum has survived funding crises, a flood, and the loss of its location within the old confines of the historic wood-type manufacturer for which it's named, which was torn down in 2015. Its story is the story of letterpress: Despite many losses and near misses, it survives.

This resembles in spirit the runaway train that type and printing became across the 19th and 20th centuries as methods were discarded almost as quickly as they were invented. Printing shifted from artisanal by nature to commercial by demand.

Some rebelled. The Arts and Crafts movement of the late 1800s was in part a response to the quality, nuance, and aesthetics lost when printing grew into an industrial operation. A century later, typographers and printers pursued fine-art letterpress printing of ephemera and books, even as the commercial side crashed and was replaced by offset lithography.

Universities, design schools, and art nonprofits helped keep the fire alive as well. Some institutions—like my alma mater, Yale—kept letterpresses turning, while others stowed their gear, and retrieved it from storage when interest picked up. Many nonprofits that taught silkscreening, lithography, and similar forms added letterpress, too.

As a result, thousands of people a year take an afternoon workshop or an entire course in letterpress. Some of them start their own presses. Thousands of little presses and some medium-sized ones dot America and other countries, some saved from decades past and many newly founded for side hustles, art, or teaching.

But Martha Stewart gets some credit, too. She loved letterpress when others had forgotten it, and featured relief printing in her flagship magazine. She favored a style in which the type bites down deeply, or is heavily *debossed*—shades of hand-press days and dampened paper. Traditional letterpress printers mostly prefer a *kiss* impression that lightly touches the paper with a taste of the type.

Nevertheless, Stewart elevated letterpress, making the method a popular choice for high-budget events, like weddings and arts fundraisers. But these printed works aren't typically set in metal or wood type. Instead, they're printed from plastic!

That's plastic in the form of *photopolymer plates*, a resin-coated raw material in sheets that—just like offset—hardens on exposure to light. But where offset is flat, photopolymer produces a relief. It's used extensively in the packaging industry for *flexography* to print plastic films, wallpaper, and stuff that won't work with offset's flat method.

To make one of these plates, a digital file is output as film from an imagesetter. The film is exposed to the plate material, which then gets an ultraviolet light treatment, and is finally scrubbed down. The remaining raised material is suitable for letterpress. Some flexographic platemaking devices skip a stage by using a laser to engrave plates. This is likely the future, as imagesetters are now endangered species.

Photopolymer has distinct echoes back to the start of stereotyping. Then, type was expensive and composition slow. Pairing letterpress with fast digital composition and an infinite supply of characters and typefaces seems a natural progression, but carries a historic echo.

Digital typefaces aren't designed for the characters of impression and ink spread in relief printing, so there can be a mismatch between the two. And some printers challenge themselves to find ways to use only traditional printable materials.

But there are growing options even for traditionalists in using digital technology to revive old methods as well as produce entirely new forms of printing surfaces.

It's increasingly common in the late 2010s to find a mix of type and images: old and new pantograph-cut wood type as well as that made by 2D laser engravers and cutters or output from 3D printers. CNC routers—which drive cutting tools from a digital plan—are often used to make patterns for pantograph-cut wooden type and to make some larger wood type.

And there are always inventors who experiment like Bruce, Barth, Benton, Mergenthaler, and Lanston. A few designers around the world have tested digital tools to produce fresh matrices for electrotyping and for casting on Monotype composition and Super Casters.

Watching a volunteer at Hamilton cut wood type with a pantograph using training she received from her father, once a Hamilton wood-type carver, I realized that the difference between tracing a wood template to make type and designing on a computer to have a laser accomplish the same is more one of time than necessarily of craft.

To preserve letterpress, some aspects of the past have to adjust to keep it going. But that's always been the case with printing, a malleable art and craft that never stops changing.

## COLOPHON

The print edition of this book was set by Nick Gill at Effra Press in North Yorkshire, England, on a Monotype Composition caster in Monotype Bembo. That edition was printed by Phil Abel at Social Enterprise Printing in London using a letterpress Heidelberg on Mohawk Superfine White Eggshell. Binding by Buchbinderei Spinner in Ottersweier, Germany.

This ebook edition was designed and composed by the author in Adobe InDesign, and set in Cardo, a typeface designed by David Perry especially for the use of classicists, and which has a similar feeling as Bembo. Cardo is available under an Open Font License.

## ABOUT THE AUTHOR

Glenn Fleishman trained as a typesetter in the late 1980s and earned a degree in graphic design from Yale University. He has spent his working life as a journalist, often writing about graphic communication and, in more recent years, printing and type history.

In 2017, he was the first designer in residence at the School of Visual Concepts in Seattle, and printed a book there by letterpress of his writing, *Not To Put Too Fine a Point on It*. In 2018, he wrote *London Kerning*.

This book is part of Glenn's 2019 project, the Tiny Type Museum & Time Capsule, a mini-museum of type and printing artifacts, modern and historic.

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## ILLUSTRATION CREDITS

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