

Archaeology of type

Printing technology co-evolved with the written representation of language.

Blaise Agüera y Arcas and
Adrienne Fairhall

Before the emergence of printing in the mid-fifteenth century, the representation of the written word in Europe was extremely complex. Especially in Germany, Gothic aesthetics and the cost of vellum (made from sheepskin or calfskin) had compressed writing on the page into the densely woven *textura* style. Abbreviated word forms abounded, and the alphabet itself had been expanded with hundreds of space-saving symbols. A few examples, such as æ, œ, and the Spanish ñ (short for 'nn'), survive.

The arrival of paper in Europe removed the economic constraint of vellum. First announced in 105 AD in China, papermaking slowly made its way along the Silk Route, reaching Germany in 1390, when a papermill opened in Nuremberg — less than 200 kilometres from Mainz, where Johann Gutenberg would set up the first European press in about 1450. Printing was soon to play a central role in kindling Renaissance humanism, and in catalysing the Protestant Reformation by bringing the Bible and the tracts of its interpreters to a new lay readership. It is difficult to imagine the Enlightenment and the scientific revolutions of the next centuries without this technology, which allowed ideas to be disseminated quickly, broadly and reliably.

The idea of assembling a composite printing surface from small, reusable (or *moveable*) pieces of type had been developed centuries earlier in the Far East, but unlike papermaking, there is no evidence of a slow diffusion of this technology to Europe. Printing appears to have evolved independently several times; all modern printing, however, derives from Gutenberg. In distinguishing his invention from earlier Chinese and Korean printing, most scholars cite the introduction of the font: the set of unique steel master letters, called punches, used to strike matrices, from which lead letters, or types, were cast in large numbers using an adjustable mould. This underlying multiplicative process, not of printed pages but of metal types, was at the core of typography in the West until the twentieth century.

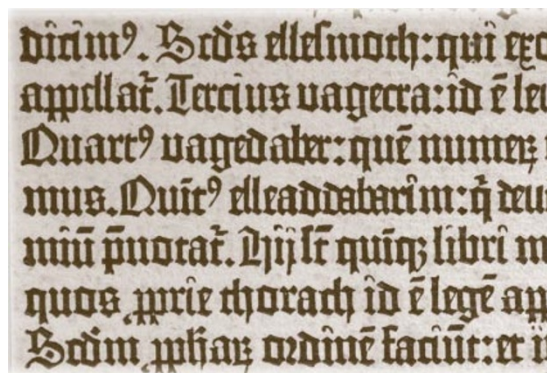
The reproducibility of printing types opens intriguing opportunities for the historian as archaeologist: beneath the abstraction of its textual content, a book can also be studied as a physical artefact. Watermarks and bindings provide valuable information about printer, provenance and

production, and recent advances in digital imaging allow detailed analysis of the printed characters themselves. We can begin to reconstruct the typefaces used in a printshop, trace the patterns of damage and wear to individual types, and study the early development of printing technologies. Were the changes in the look of typographic printing between 1450 and 1500 accompanied by corresponding technological changes? Only the surviving printed documents can answer; early printers left no account of their methods.

Printing drove the simplification of written language. Increasing literacy and the globalization of reading eventually led to standardization in spelling and punctuation, but a more fundamental change in the written representation of language occurred very rapidly in response to the new economics of print. By 1470, the Venetian printer Nicolas Jenson had developed a humanist Roman type, the first font specifically designed for print; by the sixteenth century, printed use of elaborate scribal shorthands was almost obsolete. Unlike modern font designers, however, Gutenberg and other early European printers sought to reproduce the handwritten look of contemporary manuscript. In fact, the Lambeth Palace copy of Gutenberg's famous 42-line Bible was misclassified as manuscript for 200 years.

The initial challenge in the creation of moveable type thus lay less in the aesthetics of the final product than in the segmentation of the written page into reusable pieces. In 1988, Janet Ing Freeman and Paul Needham, of the Scheide Library in Princeton, hand-compiled a set of 204 possible punches used by Gutenberg in his first font. Their source was a 1456 Bull of Pope Calixtus III, announcing the Turkish conquest of Constantinople. About 20% of the identified letterforms were repeats; though slightly different in shape, they had no distinct typographic meaning. This finding posed a minor mystery. Carving a steel punch requires a full day of work by a highly skilled craftsman. Each punch can strike many matrices; each matrix can yield a nearly limitless supply of type. Why would Gutenberg have carved so many unnecessary punches?

Computational analysis of the Calixtus Bull has helped to resolve this puzzle. Clustering all occurrences of a single letter allows



Sed postea quom maior orbis solaris factus esset: ignem in ipso fuisse intrusū. Epicurus Neoclis atheniensis filius maiestati deorū detraheri conatur: nec aliquid ex non ente fieri asserit: ac semper uniuersum finem se habuisse neq; aliquid noui fieri: præter id quod tempore infinito iam factum est: corpusq; esse uniuersū non solum immutabile: uerum et infinitum finem bonorum uoluptatem statuit. Aristippus cyrenaicus uoluptatem bonorū: dolorem malorum finem constituit. Cæteras scientias excludit illud solū esse utile putans: ut quæras si quid domi mali

The Gutenberg Bible (top), printed in 1454–55 and Nicolas Jenson's *Eusebius* of 1470, the first book to show off his humanist Roman type.

us to track type pieces as they are reused throughout the document. Although inking, paper grain and other factors add noise, the impressions fall into distinct clusters, each corresponding to a different type piece. Surprisingly, there are hundreds of versions of each letter. This suggests that Gutenberg did not make his types by the usual mass-production method using punches and matrices. Rather, they seem to have been handmade, one (or, at most, a few) at a time. Similar variability is observed in other Gutenberg printing, and in the work of several of his contemporaries. The inventor of the font is still unknown.

Thus, the Promethean view of the invention of typography as a single great leap must be slightly amended. The transition from manuscript to print was a two-way negotiation between the new technologies of page and type reproduction and the written representation of language itself. Gutenberg began this process by transmuting manuscript into moveable type, with magnificent results. Evolving selection pressures posed new problems for his successors. They needed to reverse the trend of the Gothic, moving towards lean, discrete and pan-European character sets: complex fonts are both costly to manufacture and difficult to typeset. This rebirth of classical simplicity in script had far-reaching repercussions, addressing in advance the challenge of our own transition to purely digital representations of text. ■

Blaise Agüera y Arcas is at the Scheide Library, Princeton University, Princeton, New Jersey 08544, USA. Adrienne Fairhall is at the NEC Research Institute, 4 Independence Way, Princeton, New Jersey 08540-6634, USA.