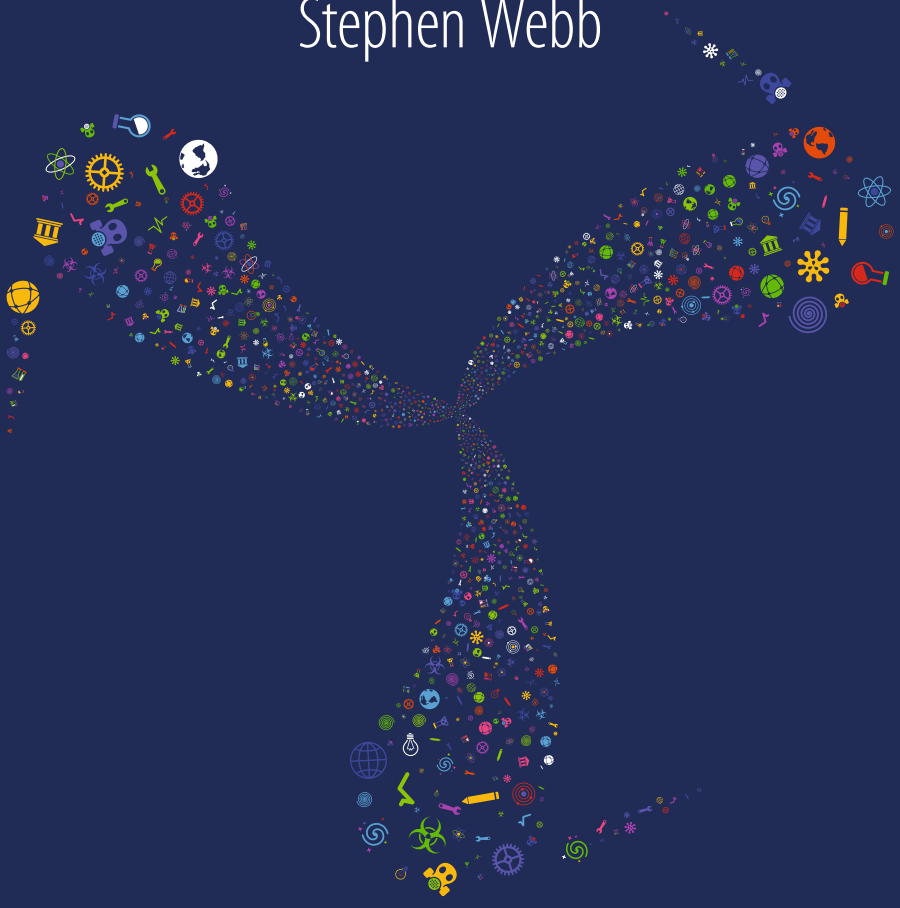
Stephen Webb



CLASH OF SYMBOLS

A Ride Through the Riches of Glyphs

Springer

Clash of Symbols

Stephen Webb

Clash of Symbols

A Ride Through the Riches of Glyphs

Springer

Stephen Webb
Mercantile House
University of Portsmouth
Portsmouth, UK

ISBN 978-3-319-71349-6 ISBN 978-3-319-71350-2 (eBook)
https://doi.org/10.1007/978-3-319-71350-2

Library of Congress Control Number: 2017961109

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my nieces, Emily and Abigail

Acknowledgments

I would like to thank Chris Caron of Springer for his invaluable help and advice in preparing this manuscript for publication.

It has been difficult, given the book's subject matter, to find appropriate fonts. The main body font used is EB Garamond by Georg Duffner; the font used for headings is Source Sans Pro by Paul D. Hunt. Various individual glyphs have been taken from the fonts Symbola (created by George Douras), Quivira (created by Alexander Lange), Junicode (created by Peter S. Baker), Bravura (created by Daniel Spreadbury), and Klingon pIqaD (created by Michael Everson). I would like to thank these talented designers for making their work open source. I created certain other symbols myself, using Theunis de Jong's IndyFont script.

I am grateful to Gary Anderson and Erin McKean for swift responses to requests for permission to use images.

Finally, as always, I would like to thank Heike and Jessica for their patience and support.

Contents

Introduction

Glyph riches and the joy of TEX

Most science students, at one time or another, must have asked themselves or their teachers why we use certain symbols in particular contexts: 'why does *c* stand for the speed of light?'; 'who chose π to represent the ratio of a circle's diameter to its circumference?'; 'what's the deal with using ♂ for Mars and ♀ for Venus?'. And, since bright students are aware that science doesn't act in a vacuum, they are quite likely to ask similar questions of a more general kind: 'why do we use @ in email addresses?'; 'who designed the ♲ sign for recycling?'; 'what's the reasoning behind having a ⌘ key on my computer keyboard?' I wrote this book for the students who ask those sorts of questions.

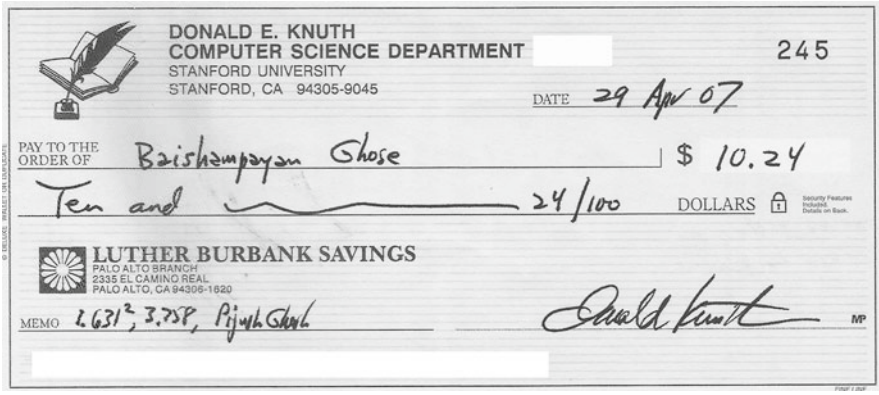
My own interest in symbols came about in a tortuous fashion. In the mid- to late-1980s I was working towards a PhD in theoretical physics. My research involved calculating various quantities of interest using toy models based on quantum chromodynamics (don't ask). Eventually the time came for me to write up the results of all my tedious labour, which meant I had to find a way of putting mathematics down on paper. My calculations didn't employ particularly intricate mathematics, but what I lacked in mathematical sophistication I made up for with sheer volume — I had short equations interspersed in the text itself, important equations that warranted their own lines, and long equations which, when displayed, occupied most of a page. To produce my thesis I was tempted to adopt the simplest approach: use a typewriter to type the words and leave gaps in which I could fill in the maths later by hand. (For younger readers, a typewriter is a keyboard-based device with an extremely low-bandwidth internet connection.) The trouble was, my particular mixture of typewriting and handwritten maths resembled more a late-period Jackson Pollock than a scientific thesis. I wanted my thesis to at least *appear* professional. The geeks in the department suggested I try a variant of a computer program called troff. I did try it, but I lacked the technical proficiency to make it work. Even the geeks who were able to manipulate troff didn't much like using it. And then I discovered the joy of TEX.

TEX (it's pronounced 'tech', with a soft 'ch' as in the composer Bach) is the creation of Donald Ervin Knuth, one of the greatest of computer scientists. Knuth, among his many accomplishments, is the author of the seminal multivolume work *The Art of Computer Programming*. In 1976 he prepared a revised edition of one of the early volumes in the series, a book containing a lot of mathematics, but found himself frustrated by various difficulties in the production process. He therefore decided to develop his own typesetting system, one that would let him typeset further volumes efficiently and to a quality that met his (extremely exacting) standards. The result was TEX. The first release of the software came in 1978; a rewritten version was released in 1982.

I was fortunate in that, just before I began to write my thesis, the departmental geeks installed TEX on the central computers (we didn't have personal computers back then). I instantly found the system simple to use — it was much simpler than troff — and, in addition to handling with ease whatever equations I chose to throw at it, TEX typeset my words beautifully. Me and my fellow students pounced on TEX and soon we were using it to produce all sorts of important documents, my favourite being a party invitation whose words we typeset in the shape of a guitar.

After the PhD was completed I discovered, not entirely to my surprise, that those quantum chromodynamical calculations I'd slaved over were of little use either to me or anyone else. What *did* surprise me was that the TEX skills I'd developed in writing my thesis were in demand — and they remain useful to me to this day. I've used TEX to write academic papers and teaching materials; I've helped deploy TEX systems in science publishers; and TEX remains my favoured option when typesetting my books. TEX is a bullet-proof piece of software — I can't remember it ever crashing — while documents written in TEX possess remarkable longevity: I can typeset documents written more than a quarter of a century ago, on computers whose manufacturers long ago went out of business, and get exactly the same output today as I did back then. Another factor helping to make TEX so attractive was that Knuth offered it up for free — even when I was a penniless student I could always afford TEX.

The open nature of TEX, its stability, high quality and low price point (it's always difficult to argue with free) led to the development of a worldwide community of practitioners. And as I began to make more use of TEX myself I learned of people who were using it to typeset not only math-


DONALD E. KNUTH
COMPUTER SCIENCE DEPARTMENT
STANFORD UNIVERSITY
STANFORD, CA 94305-9045

245

DATE 29 Apr 07

PAY TO THE ORDER OF Baishampayan Ghose $ 10.24

Ten and 24/100 DOLLARS

LUTHER BURBANK SAVINGS
PALO ALTO BRANCH
2335 EL CAMINO REAL
PALO ALTO, CA 94306-1620

MEMO 2.631², 3.758, Pijush Ghosh

Donald Knuth

The longevity and stability of TEX has much to do with the fact that Knuth made the source code freely available for the community to study, analyse, and improve. If you spot a coding error in TEX (or simply an error in one of his books) you can write to Knuth and receive one of his famous reward cheques, as shown above. The cheques are typically for small dollar amounts, but are much prized in the community. There's a programming quotation that goes 'Intelligence: finding an error in a Knuth text. Stupidity: cashing that $2.56 cheque you got.' With so many eyes having scanned its source code for errors, TEX is rock solid. (Credit: Baishampayan Ghose)

heavy texts but also critical editions, chess commentaries, general magazines... all manner of publications. In order to facilitate their work these practitioners often developed TEX packages and, in the same community spirit that fired Knuth, they made their work freely available. It was when I dipped into these packages that I began to discover a world full of unfamiliar, oddly shaped glyphs — or characters or symbols; call them what you will. Those packages sparked an abiding interest in glyphs. (Incidentally, many of the glyphs I pondered over were generated by a computer program called Metafont, which is yet another of Knuth's creations.)

Someone went to the bother of creating TEX commands for the production of symbols such as ſ, Ï, ǫ. But why? What was ℘ used for? What did ⅂ mean? What did ᖷ stand for? Come to think of it, what was the story behind all those symbols that I *was* familiar with — punctuation marks such as ! or mathematical symbols such as ∞ or astronomical signs such as ♓? Where did *they* come from?

Those questions — and similar ones asked of me by students over the years — led to this book, a collection of stories relating to one hundred

glyphs. (Actually, a couple of them — the barcode and the QR code — aren't strictly glyphs. But we see them so often I felt their inclusion was appropriate.) I've chosen to split the book into five equal parts, with each presenting the stories behind 20 symbols.

Part 1, called *Character sketches*, looks at some of the glyphs we use in writing; part 2, called *Signs of the times*, discusses some glyphs used in politics, religion, and other areas of everyday life. Some of these symbols are common; others are used only rarely. Some are modern inventions; others, which seem contemporary, can be traced back many hundreds of years.

Part 3, called *Signs and wonders*, explores some of the symbols people have developed for use in describing the heavens. These are some of the most visually striking glyphs in the book, and many of them date back to ancient times. Nevertheless their use — at least in professional arenas — is diminishing.

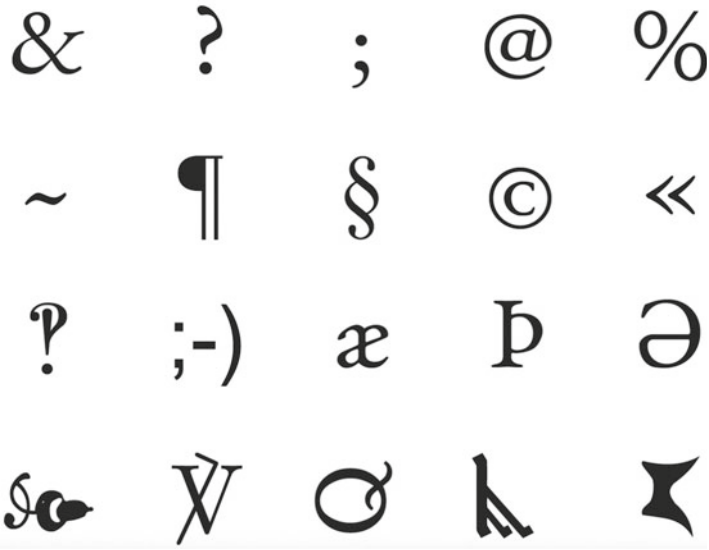
Part 4, called *It's Greek to me*, examines some symbols used in various branches of science. A number of these symbols are employed routinely by professional scientists and are also familiar to the general public; others are no longer applied in a serious fashion by *anyone* — but the reader might still meet them, from time to time, in older works.

The final part of the book, *Meaningless marks on paper*, looks at some of the characters used in mathematics. I hesitated before including these symbols since they might seem off-putting to any lay readers of this book. On the other hand, it was the appearance of symbols such as ℵ, ∃, and ζ that got me interested in glyphs in the first place. And surely the stories behind mathematical symbols deserve to be told just as much as the stories behind punctuation marks, say, or political signs? Besides, one can appreciate the history of the symbols with only a basic knowledge of mathematics.

So: here are the stories behind one hundred glyphs. A century might appear to be a surfeit of characters, but there are countless others I could have chosen to discuss. In recent years the computing industry has developed Unicode — a standard for encoding, representing, and handling text in most of the world's writing systems — and it currently contains more than 135 000 entries. Take a brief stroll through Unicode and you'll meet many characters that will delight the eye and, if you research their history, lead to some fascinating insights.

1

Character sketches



Take a glance around you. If your environment is anything like mine your gaze will take in a plethora of characters. As I sit here in my office I can see letters, punctuations marks, and numerals everywhere I look. Characters cover the numerous papers, magazines, reports, and articles littering my desk; they run down the spines of the books and folders poking out from my overcrowded bookcase; they fill the assorted fliers, maps, and listings I've pinned to a corkboard in the hope one day they'll prove useful. And characters don't appear just on matter made from dead trees, of course: they fill most of my computer screen. If I turn and look out through my office window I catch sight of a variety of characters stencilled on an information board to provide visitors with directions; a different set of characters painted onto the tarmacced courtyard in order to indicate who owns which car parking bay (a source of huge contention in a university setting); and yet another set of characters on traffic signs. If I look down I see characters labelling the keys on my computer keyboard, the keys on a desk phone (it's a newly installed high-tech phone, possessing functions that

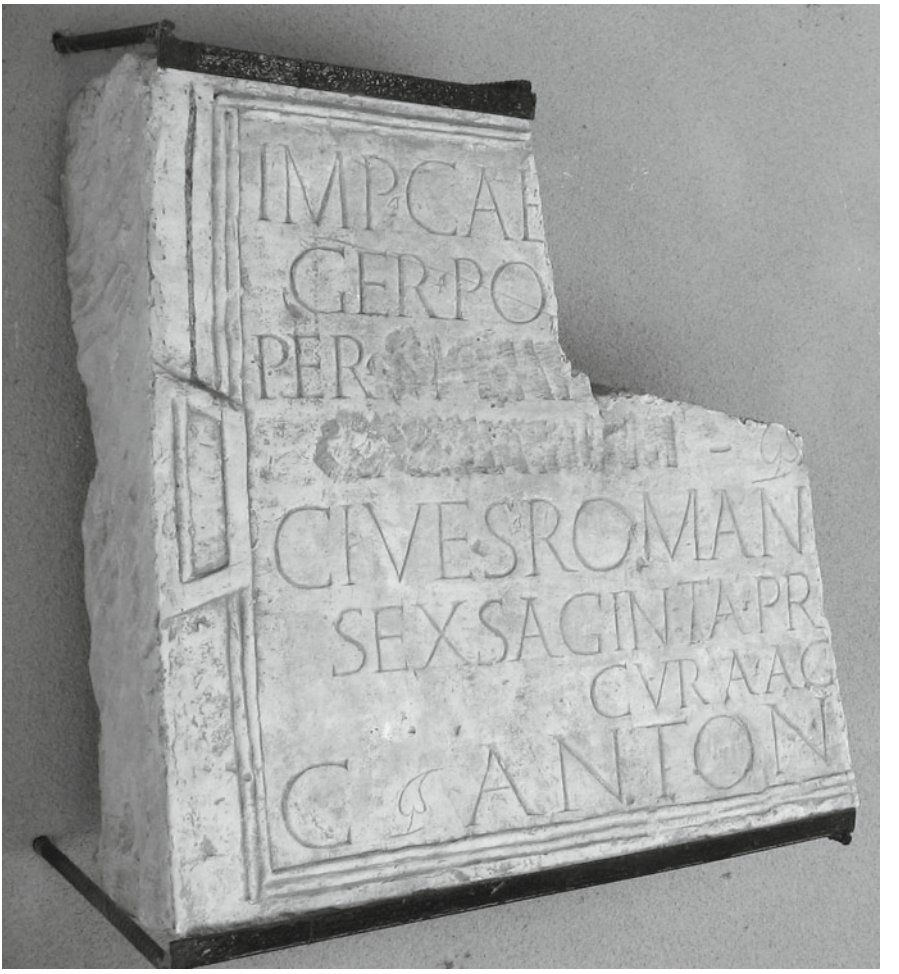
S. Webb, *Clash of Symbols*, https://doi.org/10.1007/978-3-319-71350-2_1

frankly baffle me), and the keys on an old-fashioned electronic calculator. Furthermore, and to add to the interest, the characters appear as glyphs in an incredible variety of fonts and styles: the letter A, for example, might appear as A, 𝔸, 𝐀, or in a thousand other different ways. The *character* A carries meaning, but has no intrinsic appearance; the *glyph* A has no intrinsic meaning, but can possess distinctions in form. Glyph riches add to the lavish mix of characters we all interact with every day.

Letters and punctuations marks, numerals and symbols — they might surround us but we seldom stop to think about their origins.

The characters we use most often are, of course, the letters of the alphabet. The origin of the uppercase letterforms of most Western and European languages lies thousands of years ago; proof of this lies in the fact that we can quite easily recognise the letters inscribed in stone on Roman buildings. Indeed, we still call the set of these letters the Latin or Roman script. (The Latin script derived from a version of the Greek alphabet used by the Etruscans; so the letters we use now date back to glyphs that people scratched on stones and etched on pottery at least 500 years before Christ. The very word 'glyph' is from a Greek word meaning 'carving'.) However, although the letters of the alphabet are the most important characters we encounter, I'm much more interested in all those other characters appearing on the printed page and elsewhere. On my keyboard, for example, I see § and @ and % sharing space with the Latin letters of the alphabet; you won't find *these* characters chiselled into a Roman column. Where did such characters originate? Well, with some them we know the precise date and time of creation; the history of some others remains hazy. In this section of the book I take a look at the stories behind a dozen of the most well known symbols — the three I've just mentioned (§, @, and %) and others such as ¶, ©, and &. I also sketch the background of several characters you are unlikely to encounter, unless you happen to working in a field in which they are used — characters such as Þ, ə, and Ỿ. (In one case I cheat: an emoticon such as ;-) is really three characters treated as one. But I'm in good company in bending the rules this way: in 2015 the prestigious 'word of the year' honour from Oxford Dictionaries went not to a word but to 😂 — the face-with-tears-of-joy emoji.)

There's no pattern, incidentally, to this array of characters I've opted to sketch. A random stroll through the more than 135 000 characters in the Unicode standard provides encounters with a bewildering range of sym-



An inscription from the Roman fortress Sexaginta Prista in Ruse, Bulgaria: the uppercase or capital letters are clearly recognisable. The Romans borrowed from even earlier scripts so, with the exception of a few letters added by medieval scribes, the orgin of our letterforms lies in Antiquity. Lowercase letters, on the other hand, have evolved in response to developments in writing technology — as pens and parchment replaced stones and slate, for example. (Credit: Rossen Radev)

bols; in the currency section alone, for example, you'll find ¥, ₫, and ₴, to pick three at random — and I'm sure they all have a fascinating backstory. But since I can't write about them all I've had to make a choice. This is my selection of character sketches.

AMPERSAND

&

Of all the characters in common use the ampersand surely presents font designers with the most scope for demonstrating their art. In a sans serif font (such as Source Sans Pro, used for section headings in this book), the ampersand is typically no-nonsense: &. In Garamond, the font you're looking at right now, the ampersand has a traditional vibe with just a hint of flair: &. The particular Garamond version I'm using also contains variants that have a rather baroque touch — *&* and *&* — a feature shared by fonts such as Baskerville Italic. But the ampersand is not only a lovely, expressive glyph — it has managed to retain its original meaning, a shorthand for the word 'and', for almost two millennia.

The symbol & was originally a ligature — a joining of two letters into a single glyph. (Old English contained several common ligatures such as æ and œ, which I discuss later in the sections on ash and thorn, but modern English typefaces typically only contain ligatures where it's difficult to kern, or space, particular pairs of adjacent letters. The ligatures tend to involve the letter f: 'fi' rather than 'f i'; 'ff' rather than 'f f'; 'ffi' rather than 'f f i'; and so on. A number of other Latin alphabets use special ligatures, and many non-Latin scripts also employ them.) The & was a ligature of the letters e and t — *et* — referring to the Latin word 'et' meaning 'and'. Nowadays, in English, we usually pronounce & as 'and', but traces of its origin can be found when people write &c — which is pronounced 'et cetera'. Roman scripts from almost two thousand years ago can be seen to contain the ligature, and even today you can see traces of 'E' and 't' in some representations of the symbol: you can make out the letters in the Garamond variant of the ampersand *&*, for example. And because the

ampersand dates back to Roman times, its use is widespread; it crops up in many languages that use the Latin alphabet.

The ampersand was, until relatively recently, part of the English alphabet — a letter, just the same as a, b, and c. The influential Benedictine monk Byrhtferth, who lived at Ramsey Abbey in Cambridgeshire around the turn of the first millennium, wrote a textbook called *Enchiridion* or *Manual* and on page 203 of his manuscript he presented an ordering of the English alphabet as he thought it should be: & came after Z, and before Anglo-Saxon additions to the alphabet such as thorn (Þ) and eth (Ð). Even as late as 1857, & was printed in some early-reader books as the 27th letter of the alphabet. And it is the ampersand's status as a letter that gave it the name by which we know it today, a name that first appeared in English in about 1835.

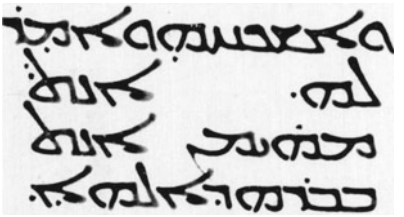
When children recite the English alphabet today, they end it by saying 'ecks, why and zed' (or 'zee' in America). Previous generations would have performed the same recitation, with two differences. First, if a letter could form a word by itself — letters such as A and I, for example — then the children were taught to preface it with the short Latin phrase 'per se', which means 'by itself'. This was useful when learning how to spell, where a word might be repeated after spelling. Second, the alphabet had & (in other words, 'and') as the final letter. So a child would end the alphabet by saying 'why, zed and per se and'. It's not surprising that the mouths of children would slur the words into a single mush: 'ampersand' was the result. There were inevitable variations: a 1905 dictionary of slang records 19 different names for this end-of-alphabet character, including 'Ann Passy Ann' and 'and pussy and', but it was ampersand that won out. (A physicist friend of mine once argued that the name comes from the famous French scientist André-Marie Ampère; it was *Ampère's and*. It wasn't. The & has nothing to do with Ampère.)

The ampersand throughout history. 1: 131 AD; 2 & 3: mid-4th century (and note the Garamond italic ampersand in the caption here); 4: early 6th century; 5: 7th century; 6: 810. (Credit: Johan Winge)

QUESTION MARK

The earliest writing systems didn't need much in the way of punctuation: the use of marks to clarify the meaning of written material became necessary only when that material reached a certain level of sophistication. Playwrights, for example, would need punctuation marks in order to instruct their actors when to pause between sentences and within a sentence. The same playwrights would also face the problem of conveying *how* a sentence should be spoken. Consider the short sentence *He's here*. Its meaning depends, at least in English and similar languages, upon whether the intonation rises or falls. If the intonation falls, then the sentence is a statement of fact. (The precise intonation, coming from the mouth of a skilful actor, could of course convey much more information than the face value of the words — perhaps, depending upon the context, that 'he' is unwelcome or five minutes late or the target of an assassin.) If the intonation rises, on the other hand, then the sentence becomes a question. That guide to intonation requires a punctuation mark — a question mark.

In 2011, Dr Chip Coakley, a manuscript expert at the University of Cambridge, identified what appears to be the earliest known example of a question mark. The mark resembles a colon, of the double-dotted rather than the intestinal variety, and it appears in a Biblical manuscript of the 5th century written in Syriac — a Middle Eastern language that flourished until the rise of Islam, and that developed a large Christian literature. Scribes put the vertical double-dot, also known as a zagwa elaya, near the start of a sentence in order to indicate that a question followed. (Of course it was unnecessary to add the double-dot if the sentence began with an interrogative such as 'who'.)



Syriac is an ancient language of the Middle East. This Syriac manuscript contains two dots indicating a question, though it's unclear whether the dots mark grammar or instruct those reading aloud to modulate their voice. (Credit: British Library Board)

The Syriac question mark seems to have had little or no influence on the development of a similar symbol for Latin script, but the need for a standardised system of punctuation in Latin became pressing when copyists started to produce the Bible in large numbers: a monk reading by himself, in silence, would need some guidance on how the text ran together, where to pause or to stop, how to hear the 'music' of the verses. Without such guidance, a monk reading a Biblical chapter for the first time would surely encounter the same sense of disorientation I often feel when reading modern poetry.

According to scholars it was Alcuin of York who introduced a question mark to the western world. Alcuin was born around 735. He was celebrated by Einhard, the servant and biographer of Charlemagne, as 'the most learned man anywhere to be found'. Alcuin rose to become one of the leading intellectuals at the court of Charlemagne, and in his writings he developed something called the 'punctus interrogativus' to signal an inflection at the end of a sentence. The symbol looked something like a tilde over a dot, like so: ⸮ (though in handwritten manuscripts the tilde has much more of a flourish). The punctus interrogativus was used quite liberally at first, but by the 13th century scholars began to standardise punctuation and Alcuin's symbol was chosen to represent purely interrogative statements. At the same time the tilde was tilted upwards — it was recognisably the modern question mark.

Many languages use this curving, hunchbacked symbol to indicate a question. But there are some variations. Spanish, for example, employs opening and closing question marks, with the opening mark being an inverted version of the closing mark (¿Where are you?). This seems to me to be an eminently sensible system: it tells you at the outset that a sentence is a question. Arabic, Persian, and Urdu use a mirror version of the question mark (؟) and some languages go their own way: in Armenian you put the symbol ՞ over the final vowel of an interrogative.

SEMICOLON

Some punctuation marks are trouble makers, with the worst offender surely being the apostrophe. An apostrophe that lurks illegally in the vicinity of a terminal letter s — a situation often seen on the chalkboard signs written by purveyors of fruit and veg — has the capacity to drive otherwise placid individuals apoplectic with rage. Personally I've seldom been lured inside a greengrocer's shop in the expectation of seeing a banana in possession of £2 (you don't make that mistake often) so I tend to be quite forgiving of such grammatical lapses. I suppose it's less acceptable in serious writing to misuse the apostrophe; as Kingsley Amis pointed out, there really *is* a difference between the statement

Those things over there are my husband's

and the statement

Those things over there are my husbands.

Even with formal writing, though, I'm happy to cut the author some slack since slips like this can happen easily enough. What really riles *me* is the misuse of the semicolon — and boy is it easy to misuse. Perhaps the main problem with the semicolon is that it's a mixture of two other punctuation marks. As the lexicographer Eric Partridge pointed out: 'by its very form (;) it betrays its dual nature: it is both period and comma'. Another difficulty is that, in principle, an author can always replace a semicolon with another form. Furthermore, some high-profile voices have criticised the mark. Kurt Vonnegut advised against using semicolons on the grounds that 'all they do is show you've been to college'. And Samuel

Beckett has an alter-ego say 'how hideous is the semicolon' (immediately after Beckett himself uses one in the text). So there's a feeling out there that semicolons are stuck-up and somehow ugly. Except they aren't, they really aren't. Semicolons certainly draw attention to themselves when authors abuse them. Some authors employ the semicolon as a fancy way of setting apart two phrases when a dash would work better; others use them interchangeably with colons; a few authors seem to use them whenever the fancy takes them — Herman Melville threw them around like confetti at a wedding. But when used properly, when a semicolon joins two linked ideas together, it works beautifully. Thoreau once wrote that 'if a plant cannot live according to its nature, it dies; and so a man.' Try expressing that sentiment without the semicolon. You can't. Without that mark of punctuation Thoreau's sentence falls flat on its elegant face.

But where does this strange combination of comma and period originate? Well, the Venetian publisher Aldus Pius Manutius is generally credited with a few firsts. The familiar curved appearance of the comma was one of his ideas, as was the use of the slanted type we now call italic (the first italic type itself was cut by Francesco Griffo). Manutius was also the first to use the semicolon in the way we do today: in the 1490s he published copies of various Greek and Roman classic works in which the semicolon appears. The semicolon gradually spread into English from there, with the first appearance being in a chess guide published in 1568. Shakespeare would presumably have grown up without seeing a semicolon, although the typesetters of his First Folio certainly used them.

So the semicolon has a long history. When used correctly it is a beautiful, fluid punctuation mark. Do use them. Do respect them. You could even try joining the Semicolon Appreciation Society.

The Semicolon Appreciation Society tells us: 'The semicolon is not used enough; the comma is used too often.' You can find these words of wisdom on T-shirts, coffee mugs, caps, earrings... visit the Society's website for more details. (Credit: Semicolon Appreciation Society/ Erin McKean)

AT

The symbol @ is one of the most widely used in the modern world. If you use the internet you can hardly avoid it seeing it. For such a common symbol it's surprising that many languages lack an official name for it. Spanish and Portuguese possess a formal term: the symbol is called *arroba*, which is the same word that's used for a pre-metric unit of mass or volume. (The word ultimately has its origin in an Arabic term relating to the load that a donkey could carry.) In French it's called the *arobase*, presumably from the same root. But several other languages give it a playfully descriptive name. The Dutch for example call it *apenstaartje*, which translates roughly as 'little monkey-tail'. The Hungarians call it *kukac* ('maggot') and the Danes *snabel-a* ('elephant's trunk a'). But in English it's just the plain old 'at sign' or sometimes the 'commercial at'.

It's not at all clear where the at sign originates. Its earliest known appearance is in a 1345 Bulgarian translation of a manuscript by Constantine Manasses, a 12th century Byzantine chronicler (the manuscript itself is now in the Vatican library), where @ appears instead of the letter 'A' in the word 'Amen'. Bulgarian historians suggest the symbol was merely an ornamentation. Researchers have spotted the @ sign in Spanish documents dating from 1448, Italian documents dating from 1536, and French documents dating from 1674. So the at sign has a long history — but the origin of the commercial aspects of @ remain a matter of speculation.

One idea is that the symbol arose in medieval manuscripts, not as an adornment as in the Bulgarian example mentioned above, but simply as a shorthand for the Latin preposition *ad* when next to a number. If the variant ∂ were used for d (see the section on partial differentiation for more

about ∂) then it's easy to see how this might have morphed into @. The word *ad* appears often, so it's a type of shortcut that might have developed.

Another idea is that merchants in Northern Europe developed @ as a shorthand for 'each at' — and I suppose the symbol does vaguely resemble the letter e with the letter a inside its counter. The argument goes that @ is sufficiently different from a (which was often used to stand for 'per' or 'at') for there to be no confusion. The distinction between 'each at' and 'at' is critical. If a merchant wrote '10 doodahs @ £1' then the cost for the doodahs would be £10; if the merchant wrote '10 doodahs a £1' then the cost would be £1. An @ or an a is the difference between profit or penury.

Yet another idea is that @ is a quick, handwritten form of á, which is the French for 'at'. Try writing á and you'll see that you can't do it without lifting your hand from the paper; in contrast, you can write @ in one flowing symbol. A number of other ideas have been floated for how @ originated, none of which I find particularly compelling. In whichever way it started, though, why did a symbol used mainly in the not terribly exciting world of accounting come to be ubiquitous?

In 1971 the American engineer Ray Tomlinson implemented an email system. It was the first such system that could send messages between users on different hosts connected to ARPANET, the progenitor of today's internet. (In mid-1971, ARPANET had 23 hosts — mostly US university and government institutions. Today there are about a billion hosts.) In order to separate user names from machine names Tomlinson needed a symbol that appeared on a keyboard but wasn't widely used: the @ symbol fitted his requirements perfectly. The exponential growth of email means that you, Gentle Reader, almost certainly have an email address and the @ symbol separates your chosen name from your email provider. (Incidentally, no one remembers the content of the first email message. Tomlinson died in 2016 but in an interview before his death he noted that 'the test messages were entirely forgettable and I have, therefore, forgotten them.')

In recent years, the microblogging service Twitter has generated huge amounts of internet traffic. Twitter launched in 2006, and six years later it was generating 340 million tweets every day from roughly 500 million users. Thus there are about half a billion Twitter user names, each starting with @ (and, if you wish, please feel free to follow @stephenswebb).

The humble @ sign, for so long the province of merchants and accountants, has conquered the world.

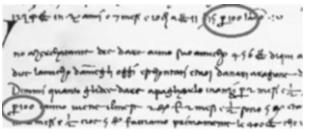
PERCENT

%

Even before the decimal system came into widespread use, people would often choose to perform calculations based upon multiples of one hundredth (1/100). Consider the case of the Ancient Romans, for example. They had a system for arithmetic that's about as unwieldy as it's possible to invent (and, if you don't believe it, try multiplying 32 by 23 using Roman numerals — XXXII × XXIII). Even they were aware of percentages, however: the Emperor Augustus levied a tax on goods sold at auction, and the tax was measured in so many hundredths of the value of the goods sold — in other words, it was a tax of so many percent (although Augustus didn't use the term 'percent' itself). The idea of percentages thus goes back a long way. But how do we get the modern symbol for percent, %, a symbol that sits above the numeral 5 on our computer keyboards?

Fast forward 1500 years or so from Emperor Augustus. The Roman Empire is long gone, but Italy has become a global trading centre. Commercial transactions involving significant quantities of money are commonplace in cities such as Venice, Milan, and Genoa. Merchants and bankers begin to appreciate that the number 100 is a useful base for the many common mathematical operations that are required to operate efficiently within the emerging financial environment. Since 'per cento' is the Italian for 'of hundred' Italian scribes find they are writing these two words with increasing frequency. Not surprisingly, they soon start using abbreviations — 'p cento', 'per 100', 'p 100' and so on. Anything to save ink and time.

In 1425, in a manuscript written by an anonymous author, a new abbreviation makes its first appearance: 'pc' with a small loop placed over the c. (Placing a small loop over a number was a relatively common device in



Part of a facsimile of a 1339 Italian arithmetic text. (The text was reproduced in the 1898 book Rara Arithmetica, by American mathematician David Eugene Smith.) The percentage sign as it appeared in 1339 is circled: the scribe wrote 'p 100'. (Credit: William Cherowitzo, text author unknown)

those times. A loop over the number 1 signified 'first', a loop over 2 signified 'second', and so on.) This new abbreviation is shorter and therefore better than the earlier attempts and it catches on. Gradually, over a period of 250 years or more, the unknown scribe's handwritten abbreviation evolves into something more closely resembling our present symbol with a 'loop' above and below a horizontal bar.

The modern symbol for percent, with zeros either side of a tilted bar, was certainly being used in 1836: it appears in an invoice written by a German merchant with the name of A.F. Höschner. The symbol % was therefore presumably in use in the early decades of the 19th century. Soon after Herr Höschner's usage it was used pretty much everywhere in the world when a writer wanted a symbol to express 'percent'.

A couple of close relatives of the % sign are of much more recent origin. The abbreviation permille refers to one part in a thousand, or 0.1%. The symbol for permille is ‰, with an extra zero added to the bottom of the percent sign. The term is not widely used in English, but it's quite common elsewhere. Perhaps the main use for ‰ is to express blood alcohol content, but in many European countries it's also used to express railway gradients. And a rather modern unit is the cpm — the cost permille — the charge levied by some email service providers for delivering 1000 email messages.

There is also the permyriad, symbol ‱, which is more commonly called the basis point (bp). It refers to one part in ten thousand — one hundredth of one percent. Thus 1‰ = 1 bp = 0.01% = 0.0001. I must confess to never having heard of the basis point until the financial crisis of 2008, when banking matters became a subject of front-page news. It seems bankers use the basis point to talk about small changes in interest rates: for example, an interest rate change from 2.34% per year to 2.33% per year involves a change of 10 bp. As Venice in the 15th century, so London now: a global financial centre where bankers and dealers trade in vast sums. A change of 1‰ in an interest rate can equate to a fortune.

TILDE

Of all the symbols in this book my favourite is the tilde. I'm fond of it partly because I first came across it in a maths class where the teacher called it twiddle, so $a \sim b$ was read as 'a twiddles b'. I immediately liked the name — twiddle. (The statement $a \sim b$, incidentally, simply means that a is equivalent, though not identically equal, to b.) But the main reason I'm a tilde fan is that it's a tremendously versatile symbol: not only does it have a variety of uses in mathematics beyond representing the equivalence relation, it also has a place in many other contexts.

In science you will often see ~ used as a shorthand way of saying 'approximately' or 'roughly'. It's also used to express the fact that two things might be of the same order of magnitude. For example, the expression $x \sim 100$ means that x is roughly 100 — it could be a bit more, it could be a bit less, but it's the same order of magnitude as one hundred.

The symbol is also used in logic. In 1897 Giuseppe Peano, an Italian mathematician, started using the tilde to represent negation: $\sim p$ is to be read as 'not p', where p is some proposition. Admittedly this can become confusing, since the tilde has so many other uses, and so logicians nowadays tend now to use the symbol ¬ rather than ~ to represent negation.

In computing you'll see the tilde used in a variety of different ways. In the typesetting language TEX, for example, you can use a tilde to 'tie' two or more words together: when the words are typeset white space will appear between them words, but you can be sure TEX won't try to insert a line break between the words.

The tilde is even used in juggling. Well, it's used in describing juggling patterns not in juggling itself, obviously.