The Little Book of Barcodes

40 YEARS

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Barcodes are everywhere. We're so used to seeing them that we usually don't give them a second thought. But these unassuming little groups of lines and spaces are incredibly important to modern life.

What's more, the story of barcodes and what they can do is truly an amazing one!

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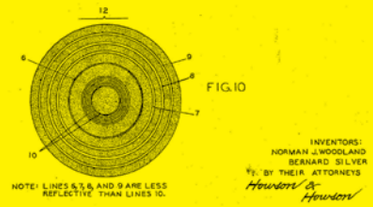
The barcode timeline

Back in 1948 in the USA, the fast growing supermarket sector was desperate for some way of storing and retrieving product information at the checkout. Norman Woodland and Bernard Silver believed they had the answer.

1948

Americans Norman Woodland and Bernard Silver begin to experiment with symbol based coding.



1958

First workable system is launched based on 'bull's eye' format.

1967

US railroad companies track rolling stock movements by barcodes.

1971

Pontiac and General Motors track components on production lines via barcodes.

1974

A pack of Wrigley's chewing gum becomes the first product scanned by an IBM UPC system – the code that has become the world standard.

1977

New York Marathon uses barcode scoring.

1980

8,000 grocery stores a year are introducing barcodes.

1981

Code 39 is adopted by US military for marking everything from boots to warheads.

1991

'Bars & Stripes' software system introduced, making barcodes cheaply available to smaller organizations.

1992

Norman Woodland receives the US National Medal Of Technology for his invention of the barcode.

- Woodland and Silver extended the dots and dashes of Morse Code into lines, combining this with a scanning system originally designed for 'reading' the audio track attached to movie film
- By the 1960s barcodes like those we would recognize were in use – one of the first applications helped US railroad companies keep track of their rolling stock
- The retail sector started adopting barcoding in the early 70s – then the system really took off around the world

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Dots and Dashes

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Morse code is a system where letters are represented by dots and dashes – so ● ● ● ▬ ▬ ▬ ● ● ● stands for SOS in Morse. A barcode is similar, with narrow elements (bars or spaces) representing the dots, and wide bars representing the dashes.

A barcode is simply a group of bars and spaces, usually black and white, that encode data based on their varying widths. Because it's all about symbols, barcoding is often referred to as a form of symbology.

There are three kinds of barcode in general use, or 'character sets' if you want to be a little more technical:

Numeric
a code which can contain numbers from 0 to 9.

Alphanumeric
includes numbers from 0 to 9 and the alphabet from A to Z.

Full ASCII
this stands for American Standard for Communication and Information Interchange, and can represent letters, numbers and punctuation, plus other characters such as å, é or ö.

Barcodes can be complex characters!

There are two basic ways a barcode can be constructed:

- They can comprise a set of characters where each stands alone as a 'discrete' symbol. These all start and end with a bar, and each character is separated from its neighbours by a space
- In a 'continuous' symbol every bar and space is utilized, making them more space-efficient

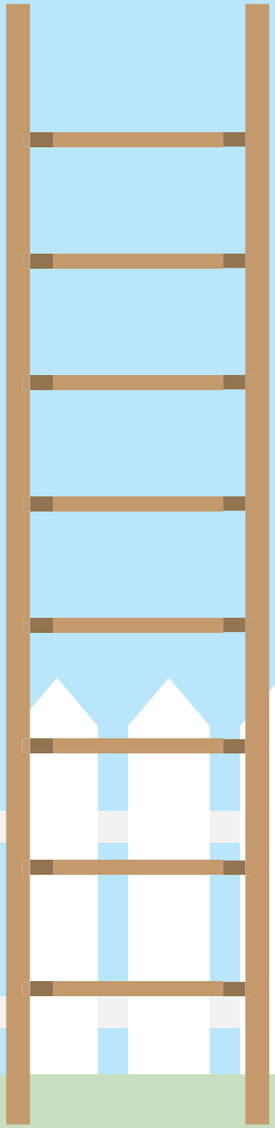
In most barcodes there are two widths of bars and spaces – narrow and wide. However, Code 128 breaks the mold and uses four different element widths.

The fact is, barcodes can be a whole lot smarter than most people realize!

Watch the bar, mind the gap

It's all about bars and the spaces in between.

- **Start and stop characters** – these grouped patterns of bars and spaces tell the scanner where the code starts and ends. They also tell the scanner which symbology is to be scanned.
- **Check characters** – these are placed in the barcode at a predetermined position (usually at the end). They're related mathematically to the rest of the characters, and help confirm that the correct data has been decoded



Is it a fence or a ladder?

Barcodes can be orientated in two different ways:

Picket fence – where the code is arranged vertically, like a picket fence.

Step ladder – you guessed it, when the code's bars lie horizontally, it's called a step ladder.

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Linear codes:

Getting information perfectly aligned

There are several kinds of linear barcodes – so why the variety?

One reason is that the different symbologies suit different tasks. Some encode just numerical data, others mix number and letters.

The variations also exist because they were originally created by different companies to meet similar challenges – they all started with the same linear principles, but developed their own ways of applying them.

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1:

Interleaved 2 of 5

These codes are known as 'interleaved' because the first numeric data is held in the first five bars, and the gaps between them hold the second numeric data. So that first section actually holds two characters.

- A continuous code, so data is encoded in both the bars and the spaces
- Numeric, so there are no alpha characters involved
- Two element widths only – narrow and wide
- Includes start and stop characters
- Message must have an even number of characters

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2:

Code 39

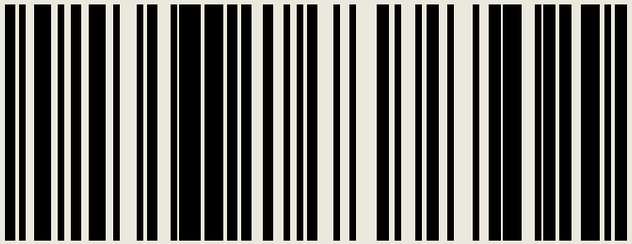
Code 39 was the first alphanumeric code to be developed. Back in 1981 it became the official standard for US Department of Defense, and the overall government symbology standard. It's also the code recommended by the Automotive Industry Action Group and the Health Industry Business Communications Council.

- A discrete code, must be read in an identical fashion to a continuous code from the standpoint of the scanner. The difference is that characters in discrete codes 'stand alone', and require a space between each adjacent character. This means they are slightly less space-efficient than a continuous code
- Alphanumeric – uses numbers 0-9, capitals A-Z and seven special characters
- Two element widths – narrow and wide
- Variable length
- Can be used in concatenation formats

AKA Code 3 of 9

Code 39 is sometimes called Code 3 of 9, and is widely used in industrial, medical, electronics, telecoms, shipping containers, commercial and government applications.

3:



Code 128

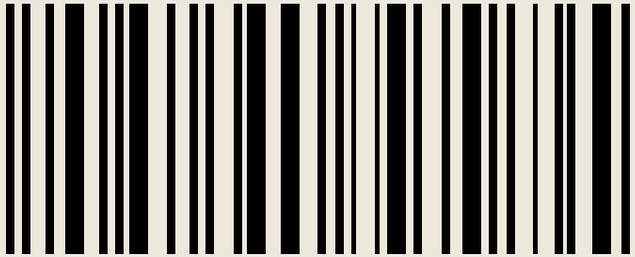
Code 128 is a very high density symbology that can be used for alphanumeric and numeric-only barcodes. It's often chosen ahead of Code 39 because of its density, and because it has a much bigger selection of characters available. Basically, Code 128 can carry a whole lot more information.

- A continuous code with no inter-character gaps
- Alphanumeric, can use the full ASCII 128 character set
- Variable length
- Has four element widths
- A high density code
- Can be used in concatenation formats

Good for blood

A customized version of Code 128 allows blood products around the globe each to be given a unique donation identification number.

4:



Codabar

Codabar came on the scene in 1972, and has become widely used by libraries, blood banks and air parcel services. The most popular version is Rationalized Codabar, and because it has a wide to narrow ratio of 3, it produces widely readable barcodes.

- A discrete symbology featuring inter-character gaps
- Numeric, but includes six extra characters
- Used in two formats – variable ratio 'Rational' and `and fixed ratio 'Traditional'
- Two element widths
- Variable length
- Can be used in concatenation formats

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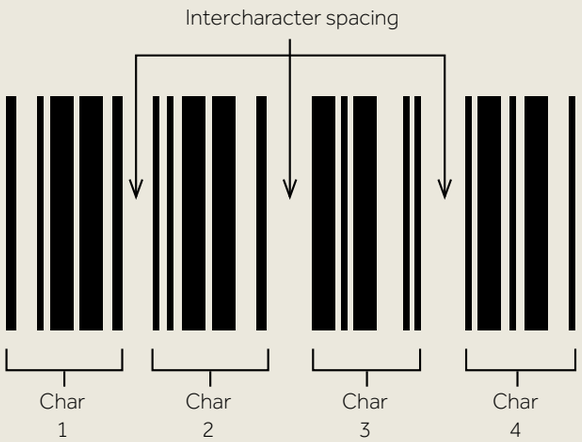
5:



Discrete symbologies

A discrete symbology like CODE 39 contains individual characters that start and end with a bar, and each character is separated from its neighbour by a space called the 'Intercharacter Gap'. This gap carries no information; it's wasted space that makes a discrete symbology generally larger than a continuous barcode containing a similar amount of information. However the precision of the gap is less critical, which was useful back in the days of old dot-matrix and daisy wheel printers.

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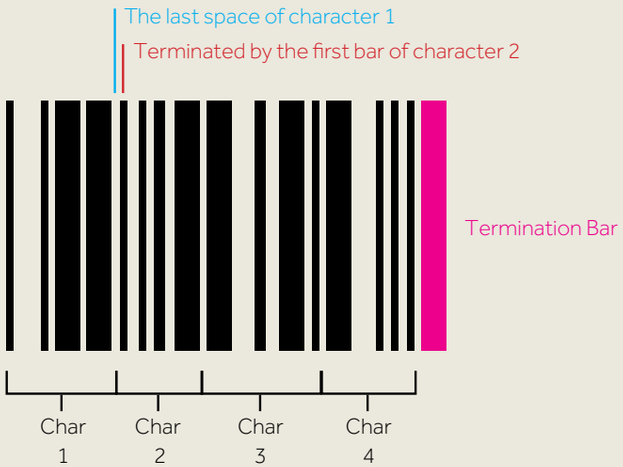
6:



Continuous symbologies

A continuous symbology like Code 128 or Interleaved 2 of 5 actually uses every single millimetre of the width of the barcode to hold data. The data characters effectively terminate each other, so the last space in one character is then followed by the first bar of the next. The overall code is bracketed by a start character that begins with a bar, and a stop character that ends in a bar. This tells the scanner where to start and stop decoding data.

Discrete symbologies & Continuous symbologies

Barcodes can be arranged in either of these two formats. Which one is chosen is usually down to the application, and both symbologies have differing advantages.

Barcodes with an extra dimension

You might have guessed by now, at Computype we're fascinated by barcodes! And today's 2D codes are a particular speciality of ours...

- Using both horizontal and vertical dimensions, they can hold more data in a compact space
- In a stacked format: multiple rows of linear symbols stacked on top of each other can be read by conventional scanners
- In a matrix format: back and white 'cells' resembling a checkerboard can be read by camera scanners
- A datamatrix code can store between one and 2.000 characters

We'd love to share our enthusiasm for 2D barcodes with you – we think you'll be impressed by what they can do!

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Datamatrix: Small is beautiful

Datamatrix is a 2D code that packs an amazing amount of data into a small space. It's been specifically designed to be read using vision-based scanning readers, in any direction and angle.

Each symbol is made up of:

- A perimeter 'quiet zone'
- A border comprising two solid edges and two dashed edges
- Data cells inside the board which are dark or light

There are two types of Datamatrix code:

ECC-000 to ECC-140 – this has an odd number of modules running along each square side.

ECC-200 – this features an even number of modules on each side. Its maximum data capacity is 3116 numeric digits, or 2335 alphanumeric characters, in a symbol 144 modules square.

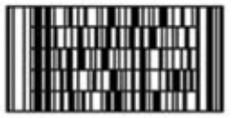
Other 2D codes include...

PDF417

Maxicode

Aztec code

QR code



Codablock

Code 16k

Reading the signs

The old-school way still works!

The first barcode scanners used a fixed light and one or more photosensors to 'read' the barcode – a economic and effective tool that's still in use today.

Contemporary barcoding and in-depth expertise... Computype can offer you some amazing possibilities...

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Today the key defining factor for scanners is whether they can read both linear and 2-D symbols.

- Historically scanners required additional programming to interface with relevant computer applications
- Later scanners were designed to work through the PC's keyboard interface
- USB scanners are basically 'plug-and-play', no special code is required to input their data
- More recently, the onboard cameras of smart phones can be used to read and interpret barcodes

RFID

It stands for a different way of coding data

We love what conventional barcodes can do, but there can be limitations:

- If a barcode can't be 'seen' by the scanner, no data can be transferred

So in some scenarios RFID (Radio Frequency Identification) can be a useful alternative to conventional barcodes.

- System comprises a 'reader' and a 'tag'
- They communicate with each other by radio waves
- Some tags are powered simply by the electromagnetic energy received from the reader
- The reader/writer contains a processor, radio and antenna; the tag has a chip and antenna

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TOP SECRET

RFID was invented in the 1940s to operate secret listening devices for covert ops.

The four ways RFID can work

Binary

simply registers whether an object is present or not – ideal for article security in retail and libraries

Active

the tag receives and transmits radio signals and has its own power source. Often used for tracking non-disposable objects

Passive

the tag is powered by the signal from the reader, and can modify that signal. An economic way to security mark goods

NFC

Near Field Communication is passive RFID operating through a specific communication protocol, for use with smart devices

Tag types

- **Encapsulated tags** - usually sealed or molded. Typically used as security key fobs, animal tags, and disks to track clothing through laundry processes
- **Cards** – often integrated with credit and debit cards, ID cards and entry system labels

BARCODES

V

RFID

RFID

can provide some useful advantages in certain applications:

- operates through radio waves – there's no need for a 'line of sight' between the code and the reader
- allows data held in the tag or label to be changed
- supports data security, anti-cloning and kill capabilities

The end of the line for barcodes?

We don't think so! But in certain cases, RFID does offer significant advantages. At Computype we're certainly being called on more and more to provide RFID expertise, for all kinds of businesses and organizations.

RFID is a technology with potentials that are not yet widely understood. So our cutting edge experience and capability in RFID is well worth exploring – why not get in touch with our expert team to discuss the possibilities?

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When we talk about barcodes, it can get a little 'tech-speak' at times, so here are a few definitions to help make things clear...

Element - any individual bar or space in the barcode.

X dimension – the width of the narrowest element in the barcode.

Ratio – the relationship between wide and narrow element widths – 2:1 or 3:1, for instance.

Module – the amount of space a bar or gap takes up, measured in Xs. A narrow bar might be 1X = one module; a medium width bar could be 2X and therefore take up two modules.

Density – the amount of characters that can fit in one linear inch (cpi).

Nominal – the exact intended value for a parameter.

Tolerance – in discrete symbologies, this describes + or – variations from the nominal.

Quiet zone – the blank margin either side of the barcode which tells the reader where the code starts and stops. The quiet zone is usually ten times the width of the narrowest element, or ¼ of an inch, whichever is the greater.

Concatenation – a long message broken up into multiple shorter barcodes. This is helpful when the overall message is long, or if there's a need to create two barcodes side by side, with one functioning as a security check. Blood banks use concatenation for scanning DIN and ABO, product code and expiry date.

We appreciate there's a lot to take in with barcoding, so if you have any questions don't hesitate to get in touch with us.

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Raising the bar

At Computype we've been working with barcodes for many years, and we're still amazed by how they can be applied in so many variations.

We know the technology of barcoding inside-out, and while barcodes are all about lines and spaces, there are definitely no gaps in our knowledge.

Whatever your business, whatever you requirements, Computype can help you achieve a barcode solution which genuinely boosts your efficiency and productivity.

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We'd love to discuss how barcodes could work for your organization – just contact Computype any time.

Visit us at **www.computype.com**

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