BARCODES

The History and Evolution of Barcodes.

Welcome

- Who am I?
  - Jonathan A Burt BSc Cert Mgmt HND FIAP IEng MBCS CITP
    - Batchelor of Science Degree (Open)
    - Professional Certificate in Management
    - Higher National Diploma in Computing
    - Fellow of the Institute of Analysts and Programmers
    - Incorporated Engineer with the Engineering Council
    - Member of the British Computer Society
    - Charted IT Professional
    - PRINCE2 Practitioner
    - Foundation Certificate in IT Service Management (ITIL)
    - Certified Novell Administrator (v5.x)
  - 25+ years experience of working in IT, now retired.
  - Long time member of the Isle of Wight PC User Group!


Invention

- The barcode was invented by **Norman Joseph Woodland** and **Bernard Silver** and patented in the US in 1952.
- The invention was based on Morse code that was extended to thin and thick bars.
- However, it took over twenty years before this invention became commercially successful.

History

- In 1948, **Bernard Silver**, a graduate student at Drexel Institute of Technology in Philadelphia, Pennsylvania, US overheard the president of the local food chain, Food Fair, asking one of the deans to research a system to automatically read product information during checkout.
  - It worth noting that the dean was not interested and believed it was a non-problem.
- **Silver** told his friend **Norman Joseph Woodland** about the request, and they started working on a variety of systems.
  - Their first working system used ultraviolet ink, but the ink faded too easily and was expensive.

History

- Convinced that the system was workable with further development, **Woodland** left Drexel and continued working on the system.
  - His next inspiration came from Morse code, and he formed his first barcode from sand on the beach. "*I just extended the dots and dashes downwards and made narrow lines and wide lines out of them.*“
- To read them, he adapted technology used in optical soundtracks in movies, using a 500-watt incandescent light bulb shining through the paper onto an RCA935 photomultiplier tube (from a movie projector) on the far side.
  - He later decided that the system would work better if it were printed as a circle instead of a line, allowing it to be scanned in any direction.

History

- In 1951, **Woodland** moved to IBM and continually tried to interest IBM in developing the system.
  - IBM eventually commissioned a report on the idea, which concluded that it was both feasible and interesting, but that processing the resulting information would require equipment that was some time off in the future.
- This was the BIG issue, as the barcode idea was believed to be 20 years ahead of its time. **Woodland** and **Silver** had the right idea, but they lacked both the computing power (for the back-end processing) and, critically, a very bright light with which to "read" the black and white bar code.

Oct. 7, 1952 N. J. WOODLAND ET AL 2,612,994

CLASSIFYING APPARATUS AND METHOD

Filed Oct. 20, 1949 3 Sheets-Sheet 1

FIG. 1

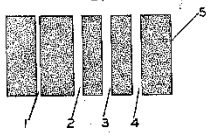


FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

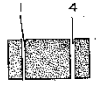


FIG. 8

FIG. 9

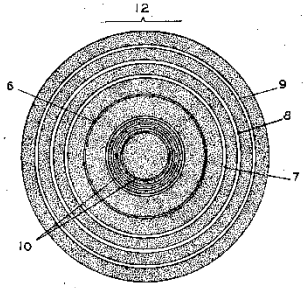


FIG. 10

NOTE: LINES 6, 7, 8, AND 9 ARE LESS REFLECTIVE THAN LINES 10.

INVENTORS:
NORMAN J. WOODLAND
BERNARD SILVER
BY THEIR ATTORNEYS
Howson & Howson

Oct. 7, 1952 N. J. WOODLAND ET AL 2,612,994

CLASSIFYING APPARATUS AND METHOD

Filed Oct. 20, 1949 3 Sheets-Sheet 2

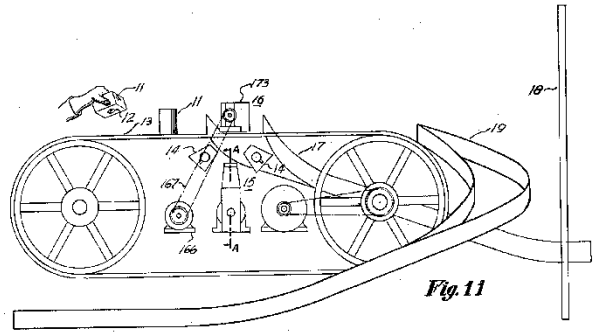


Fig. 11

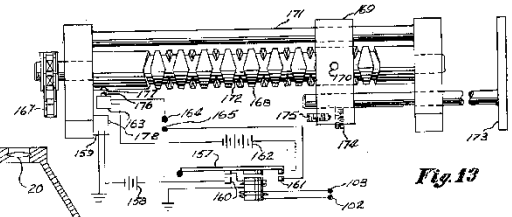


Fig. 13

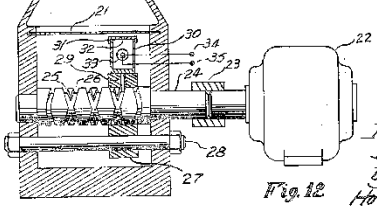


Fig. 12

INVENTORS:
Norman J. Woodland
Bernard Silver
by their Attorneys
Howson & Howson

History (*KarTrak*)

- During his time as an undergraduate, **David Jarrett Collins** worked at the Pennsylvania Railroad and became aware of the need to automatically identify railroad cars.
  - After receiving his master's degree from MIT in 1959, he started work at GTE Sylvania and began addressing the problem.

- He developed a system called KarTrak using blue, white and red reflective stripes attached to the side of the cars, encoding a four-digit company identifier and a six-digit car number.
  - Light reflected off the coloured stripes was read by photomultiplier vacuum tubes.

History (*KarTrak*)

- The Boston and Maine Railroad tested the KarTrak system on their gravel cars in 1961.
  - The tests continued until 1967, when the Association of American Railroads (AAR) selected it as a standard, automatic car identification, across the entire North American fleet.
- The installations started in October 1967. However, the economic downturn and rash of bankruptcies in the industry in the early 1970s greatly slowed the rollout, and it was not until 1974 that 95% of the fleet was labelled.
  - To add to its woes, the system was found to be easily fooled by dirt in certain applications, which greatly affected accuracy.
  - This led to the AAR abandoning the system in the late 1970s, and it was not until the mid-1980s that they introduced a similar system, this time based on radio tags.

History (*Lasers*)

- The first breakthrough for barcodes came in 1960 when the laser (Light Amplification by Stimulated Emission of Radiation), or "*Science Fiction Death Ray*" as the press called it, was developed by **Theodore Maiman**.
  - This allowed the creation of controlled "very bright lights", which is needed to accurately read barcodes.
  - However, it took a few years before the barcodes and lasers joined up.

History (*CIC*)

- In 1967, **David Jarrett Collins** left GTE Sylvania and formed Computer Identics Corporation.
- There he moved from bulbs to helium–neon lasers and mirrors to improve the reading of barcodes in motion.
  - This was the world's first commercial laser scanner!
- This system was implemented by General Motors (1969) and the General Trading Company in it's distribution centres.
- This system was also used in the 1984 summer Olympics, for identifying athletes, journalists, and staff members.

History (*Universal Product Code*)

- However, the biggest breakthrough for barcodes happened in 1966, when the National Association of Food Chains (NAFC) held a meeting on the idea of automated checkout systems.
  - In the mid-1970s the NAFC established the Ad-Hoc Committee for U.S. Supermarkets on a Uniform Grocery-Product Code to set guidelines for development.
  - In addition, it created a symbol-selection subcommittee to help standardize the approach. In cooperation with consulting firm, McKinsey & Co., they developed a standardised 11-digit code for identifying products.

History (*Universal Product Code*)

- Radio Corporation of America, which had purchased the rights to the original **Woodland** patent, initiated a project to develop a system based on the bullseye code.
  - The Kroger grocery chain volunteered to test it, and, in 1972, the first bar code scanner was introduced in a Kroger supermarket in Cincinnati, Ohio.
  - Barcodes were printed on small pieces of adhesive paper and attached by hand by store employees when they were adding price tags.
  - However, the code proved to have a serious problem; the printers would sometimes smear ink, rendering the code unreadable in most orientations.

History (*Universal Product Code*)

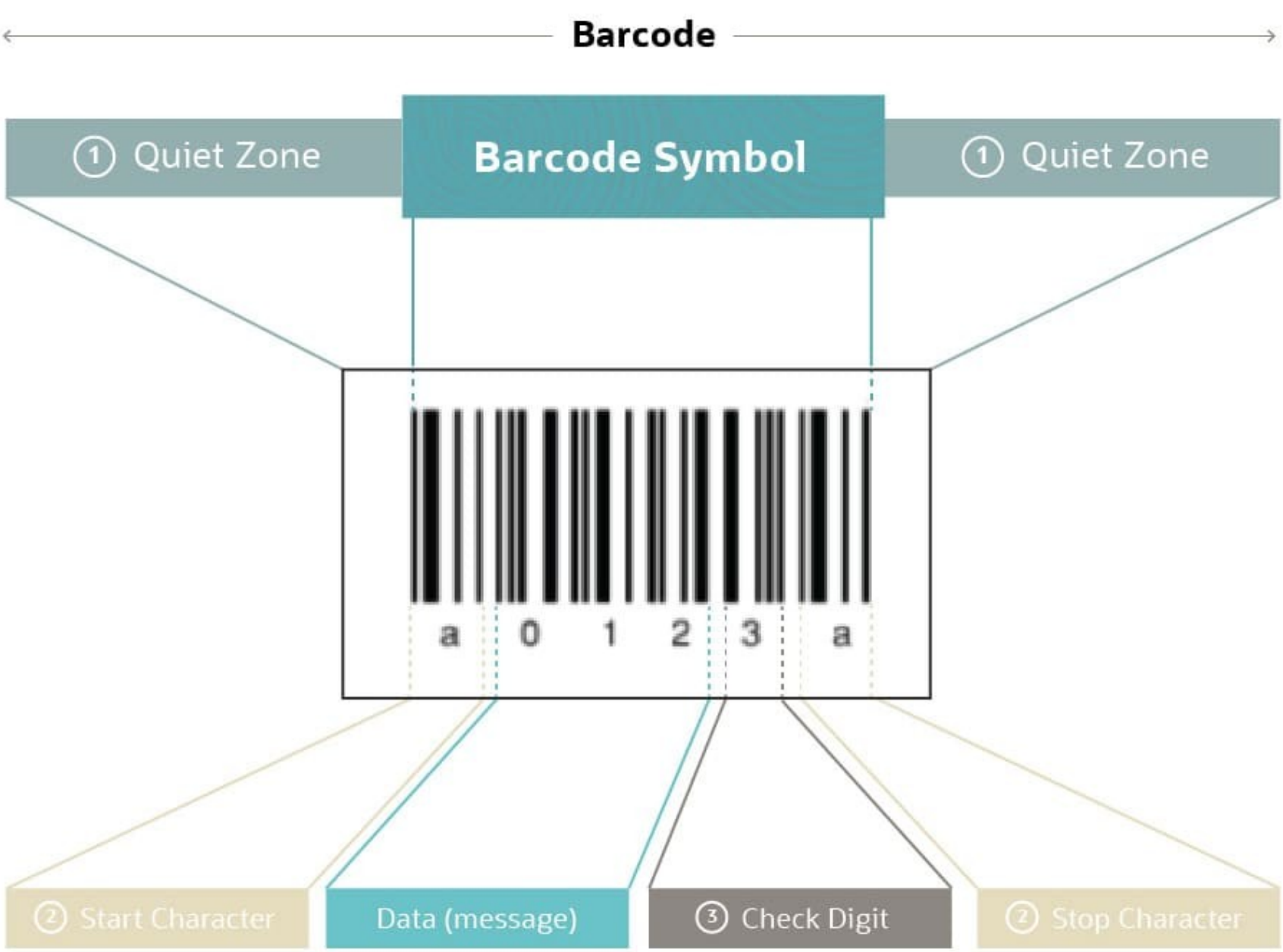
- After the "*failure, but successful proof-of-concept*" with the bullseye barcode, NAFC opted to move to the linear version.
  - One reason for this was, as the linear code was printed in the direction of the stripes, any extra ink (smudges) would simply make the code "taller" while remaining readable.
- In 1973, NAFC selected the IBM UPC solution as their standard, coincidently a team led by the original barcode creator **Woodland**!
- NCR installed a testbed system at Marsh's Supermarket in Troy, Ohio, near the factory that was producing the equipment.
  - On 26 June 1974, a 10-pack of Wrigley's Juicy Fruit gum was scanned, registering the first commercial use of the UPC.

History (*Universal Product Code*)

- There were no cost savings expected for a grocery to use barcodes, unless at least 70% of the grocery's products had the barcode printed on the product by the manufacturer.
- Also, usefulness of the barcode required the adoption of expensive scanners by a critical mass of retailers while manufacturers simultaneously adopted barcode labels.
  - It took a few years for the NAFC to get manufacturers to implement the barcodes on all their products, and it wasn’t until the early 1980’s that barcodes on products in grocery stores started to readily take hold.

Barcode Usage

- Barcodes are used in a various amount of different applications, from product ID (retail checkouts), to patient tracking, inventory management, shipping and logistics, as well as ticketing and documentation.


Barcode
1 Quiet Zone
Barcode Symbol
1 Quiet Zone
a 0 1 2 3 a
2 Start Character
Data (message)
3 Check Digit
2 Stop Character

Variations of Barcodes

- As with all technology, barcodes have evolved and changed based on their industrial need, and there are many different standards.
- For example:
  - Linear Barcodes (26 variations)
  - Bar Height Codes (11 variations)
  - Stacked 2D Barcodes (4 variations)
  - Matrix (2D) Codes (27 variations)

- Also, some companies integrate custom designs into barcodes on their consumer products without impairing their readability (Decorative Barcodes).

Linear Barcodes

Code 25: Wholesale, libraries International standard ISO/IEC 16390

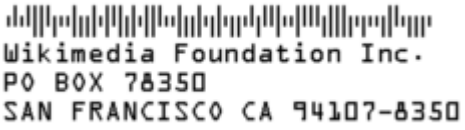
Code 39: Various, used by US DoD – international standard ISO/IEC 16388

Telepen: Libraries (UK)

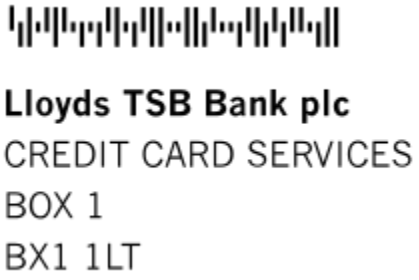
Code 128: Various – International Standard ISO/IEC 15417

IATA 2 of 5: Used by International Air Transport Association had fixed 17 digits length with 16 valuable package identification digit and 17-th check digit.

Bar Height Codes



Intelligent Mail Barcode: United States Postal Service

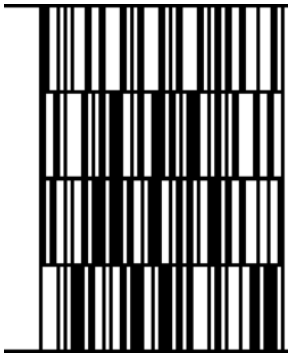


RM4SCC/KIX: Royal Mail

Spotify codes: point to artists, songs, podcasts, playlists, and albums. 37 bits of information, 8 bits of CRC, and 15 Forward error correction bits are encoded in the heights of 20 of the 23 bars.

Stacked 2D Barcodes

Codablock: A family of stacked 1D barcodes (in some cases counted as stacked 2D barcodes) which are used in health care industry (HIBC).



Code 16K: Used to identify chips and printed circuit boards, as well as in medical applications.

DX film edge barcode: Colour print film.

Matrix (2D) Codes

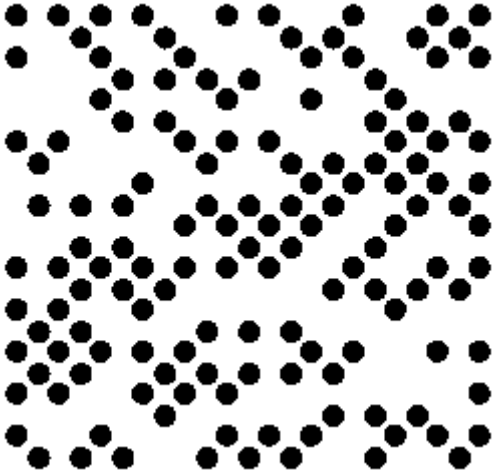
App Clip Code: Apple-proprietary code for launching "App Clips", a type of applet. 5 concentric rings of three colours (light, dark, middle).

Aztec Code: International Standard: ISO/IEC 24778

Matrix (2D) Codes

DataGlyphs: Can be embedded into a half-tone image or background shading pattern in a way that is almost perceptually invisible, similar to steganography.

DotCode: Extended 2D replacement of Code 128 barcode. Is used to track individual cigarette and pharmaceutical packages.



Matrix (2D) Codes

Micro QR code: A smaller version of the QR code standard for applications where symbol size is limited.

NaviLens: A colour matrix barcode intended to help blind and visually impaired people find their way around railway and subway stations, museums, libraries, and other public spaces.

Matrix (2D) Codes

QR Code: Initially developed, patented and owned by Denso Wave for automotive components management; they have chosen not to exercise their patent rights. Can encode Latin and Japanese Kanji and Kana characters, music, images, URLs, emails. De facto standard for most modern smartphones.

ShotCode: Circular pattern codes for camera phones.

QR Codes

- A QR code, short for quick-response code, is a type of two-dimensional matrix barcode invented in 1994 by **Masahiro Hara** for the Japanese company Denso Wave for labelling automobile parts.
- Denso Wave choose to not enforce their patent, so that others could use the system freely.
- With the development of the smartphone, QR codes have become more widespread and common.
- One advantage of QR codes is their error-correction ability, and codes which are damage or even missing parts can still be successfully scanned!

QR Codes: Risks

- The only context in which common QR codes can carry executable data is the URL data type.
- These URLs may host JavaScript code (or a virus), which can be used to exploit vulnerabilities in applications on the host system, such as the reader, the web browser, or the image viewer, since a reader will typically send the data to the application associated with the data type used by the QR code.
- The URLs could also be linked to malicious websites.

QR Codes: Risks

- On a smartphone, the reader's permissions may allow use of the camera, full Internet access, read/write contact data, GPS, read browser history, read/write local storage, and global system changes.
- Risks also include enabling the microphone/camera/GPS, and then streaming those feeds to a remote server, analysis of sensitive data (passwords, files, contacts, transactions), as well as sending email/SMS/IM messages or packets for DDoS as part of a botnet, corrupting privacy settings, and stealing identity.

QR Codes: Risks

- These actions could occur in the background while the user is only seeing the reader opening a seemingly harmless web page.
  - In Russia, a malicious QR code caused phones that scanned it to send premium texts at a fee of $6 each.
  - QR codes have also been linked to scams in which stickers are placed on parking meters and other devices, posing as quick payment options.

Widescale Usage

- QR codes have become common in consumer advertising. Typically, a smartphone is used as a QR code scanner, displaying the code and converting it to some useful form (such as a standard URL for a website, thereby obviating the need for a user to type it into a Web browser).
- Other uses include commercial tracking, warehouse stock control, entertainment and transport ticketing, product and loyalty marketing, in-store product labelling, and even some currencies!

Questions?

Does anyone have any questions?

Further Information

- Wikipedia
  - https://en.wikipedia.org/
- Lots of useful tutorials
  - http://www.howtogeek.com/
- TechRadar has a good selection of reviews.
  - http://www.techradar.com/
- LinkedIn
  - https://www.linkedin.com/in/jaburt/