

Barcodes – History and symbology

Identification systems (IDFS)

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Contents

- 1. What is barcode
- 2. Development
- 3. Types
- 4. How does it work?
- 5. Readers
- 6. Benefit
- 7. References



1. What is barcode

- A **barcode** is an optical machine-readable representation of data, which shows certain data on certain products.
- Originally, barcodes represented data in the widths (bars) and the spacing's of parallel lines.
- Some barcodes can also included symbols and they can be 2 or 3 dimensional.



Contents

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- **2. Development**
- 3. Types
- 4. How does it work?
- 5. Readers
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2. Development

Initial Stage (1932 To 1967)

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- 1932 - Wallace Flint
 - the idea of barcodes was first conceptualized as a part of his Master's thesis paper
 - invented an automated checkout system for a grocery store using punched cards and flow racks to automatically dispense products
 - **Problem:** card reading equipment of the day was bulky, utterly unwieldy, and hopelessly expensive -> unrealistic

2. Development

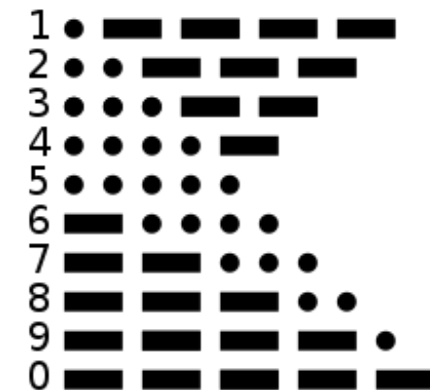
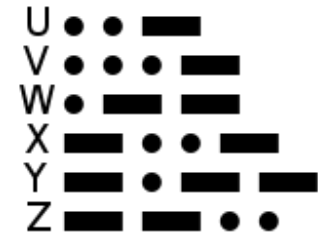
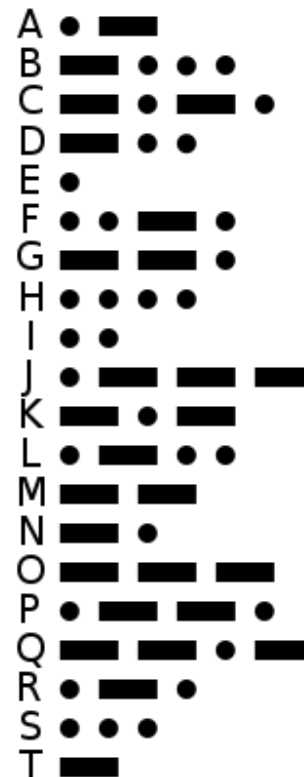
Initial Stage (1932 To 1967)

Initial Stage (1932 To 1967)

- 194? - Norman Joseph Woodland and Bernard Silver
 - BAR Morse code and, printed on film and transformed via light from projector and receiver into sound.
 - Planned to make light reflection instead of passing through

International Morse Code

1. A dash is equal to three dots.
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to seven dots.

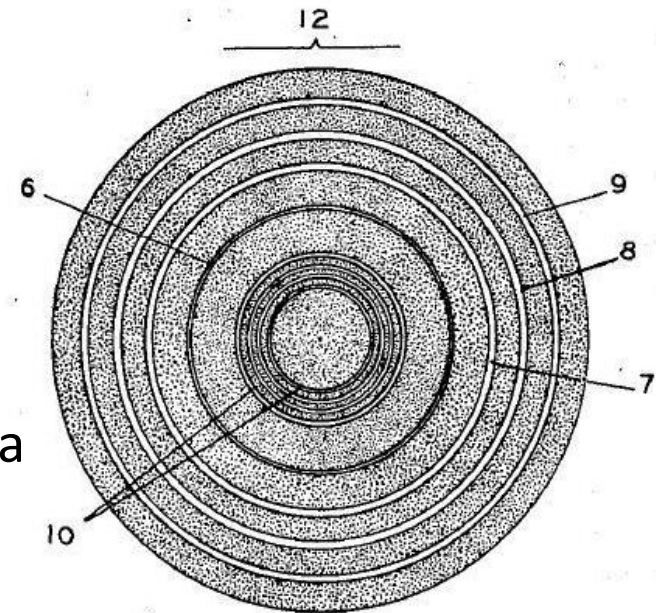


2. Development

Initial Stage (1932 To 1967)

Initial Stage (1932 To 1967)

- 1949 - Norman Joseph Woodland and Bernard Silver (an idea)
 - developed a bull's eye style barcode as a part of university research project to develop an automated system to gather product information during checkout for a local food chain. (patent in 1952)
 - [US patent 2,612,994](#) used light bulb 500 Wats and RCA935 photo multiplier tube as a reader



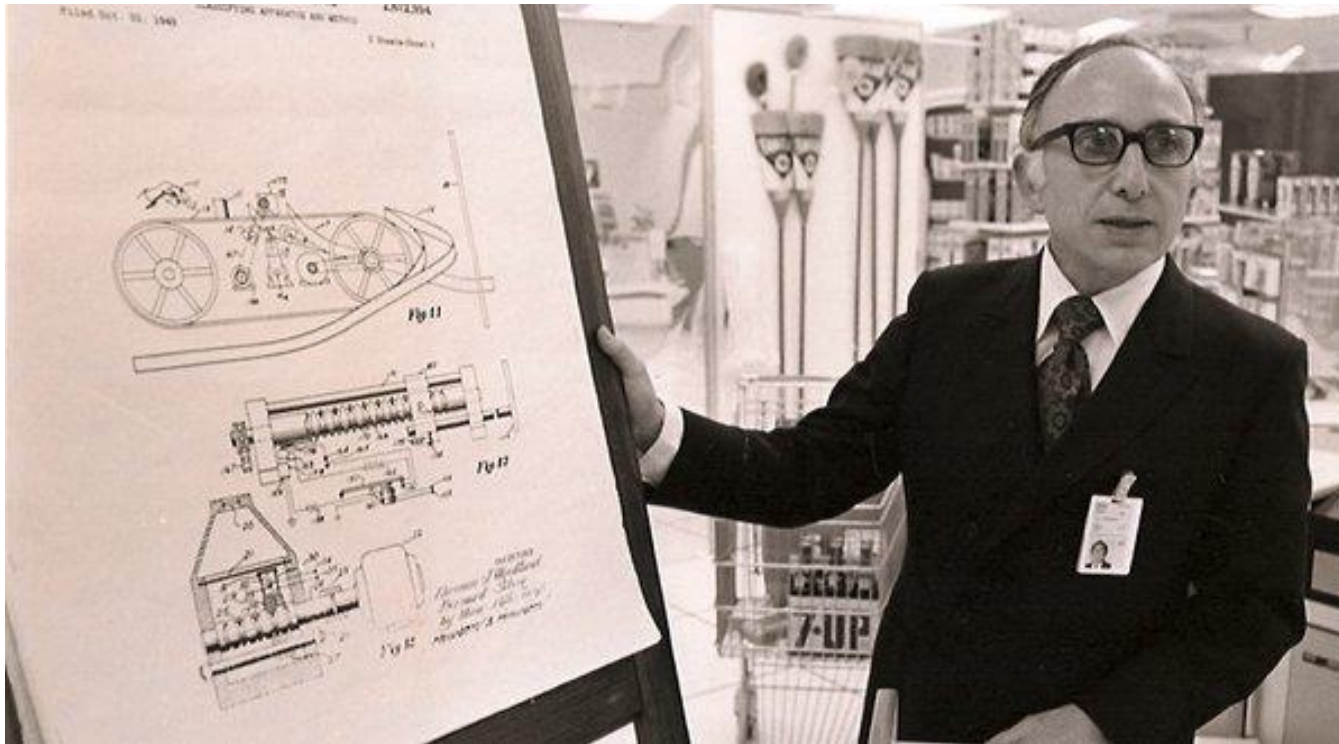
NOTE: LINES 6, 7, 8, AND 9 ARE LESS REFLECTIVE THAN LINES 10.

Video: <http://www.youtube.com/watch?v=QyCpi9Guhbk>

2. Development

Initial Stage (1932 To 1967)

- bull's eye style barcode



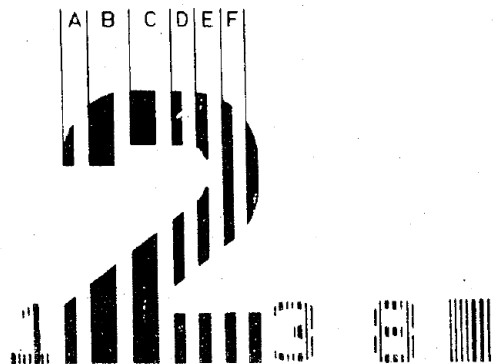
Source: <http://www.nytimes.com/2012/12/13/business/n-joseph-woodland-inventor-of-the-bar-code-dies-at-91.html>

2. Development

Initial Stage (1932 To 1967)

Initial Stage (1932 To 1967)

- 1959 - Girard Feissel
 - registered an U.S. patent 3309667
 - Represents the digits 0 to 9 by seven parallel bars



Intervals between these consecutive forward edges. In each character, the six intervals are made up of four short intervals and two long intervals. As previously indicated, if a short interval has the value 0 and if a long interval has the value 1, the following coding table can be prepared:

	A	B	C	D	E	F
0	0	0	0	1	1	0
1	1	0	0	0	1	0
2	0	1	1	0	0	0
3	0	1	0	0	1	0
4	1	0	0	1	0	0
5	1	0	1	0	0	0
6	0	0	1	0	1	0
7	1	1	0	0	0	0
8	0	0	1	1	0	0
9	0	1	0	1	0	0
X	0	0	0	0	1	1
Y	0	0	1	0	0	1
Z	1	0	0	0	0	1

The letters A to F correspond to the significant intervals of the characters and the 0's and the 1's indicate the respective positions of the short and long intervals. Thus, in accordance with the above table, the intervals B and C in the digit 2 are long.

2. Development

Initial Stage (1932 To 1967)

Initial Stage (1932 To 1967)

- 1959 - David Collins (**Automatic Car Identification Plate**)
 - developed the barcodes to accurately track train cars
 - used groups of reflective orange and blue stripes, which could be arranged to represent the digits 0 through 9
 - barcodes were read by mailbox-sized scanners installed trackside
 - mandated by the Association of American Railroads in 1968 and installed on all equipment by 1970.
 - The system was abandoned in 1978.

2. Development

Initial Stage (1932 To 1967)

- 1959 - David Collins (ACI)
 - consists of 13 double bars comprised of red, blue, black or small black and white checks.
 - This plate is read from the bottom up.
 - The first set is "Start."
 - The second is the equipment code, 8.
 - The next three sets (3-5) indicate the owner of the equipment, 050.
 - The next six sets (6-11) indicate the car number, 003734.
 - The net set (12) is "Stop."
 - And the last set (13), is a check digit, 5.

<http://www.flickr.com/photos/stall/3948532073/>



2. Development

Middle Stage (1967 To 1970)

Middle Stage (1967 To 1970)

- efforts to establish a standard for the checkout started in 1966.
- The NAFC called hardware manufacturers to develop a system for automation of checkout in supermarkets.
- RCA developed a „Bull’s Eye“ Symbology and Scanner-Devices, (used in a Kroger-Supermarket in Cincinnati for a **18 month test** period in 1972) - resulted in many useful data

Standardization attempts:

- Universal Grocery Products Identification Code" (UGPIC) in summer 1970

2. Development

Middle Stage (1967 To 1970)

- **Middle Stage (1967 To 1970)**
 - RCA started to investigate the issue, formed ad hoc committee of the grocery industry **UGPCC Committee (Uniform Grocery Product Code Council)** to choose the symbol which should be used as their industry standard.
- **Guidelines:**
 - to be readable from almost any angle at a wide range of distances.
 - To be cheap and easy to print.
 - And to be affordable, automated checkout systems would have to pay for themselves in two and a half years.

2. Development

Current Generation (After 1970's)

Current Generation (After 1970's)

- IBM, had the Barcode's inventor on staff. (but patent had expired 1969). Led to the **Universal Product Code (UPC)**.
- barcodes were transformed from a raw concept to a viable enterprise technology
- The adoption of the UPC, on April 3, 1973.
- on June 26th, 1974, a pack of Wrigley's chewing gum became the first item to be scanned by a barcode system using UPC (Universal Product Code)



2. Development

Current and Next Generation (After 1970's)

Current and Next Generation (After 1970's)

- In Dec 1976 a similar code type - "EAN" (European Article Numbering) was adopted.
- further standardization provides that until 2005 all barcode scanners in the USA must be able to scan also EAN-13 Code.
- Small data space / just for one number
- **Solutions?**



2. Development

Current and Next Generation (After 1970's)

Current and Next Generation (After 1970's)

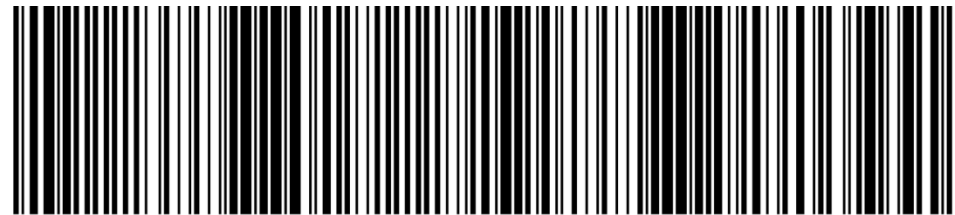
- Development of more sophisticated codes followed
 - 2D Matrix codes – rapid standardization, many standards:
 - GS1 – DataMatrix
 - QR Code
 - PDF417
 - 1D stacked codes
 - GS1 - DataBar

STANDARD

GS1 DataMatrix with GTIN, expiry date and batchnumber



(01)07612345678900(17)100503
(10)AC345G3



(01) 00614141 99999 6 (17) 100101 (10) 123ABC (21) 1234567890

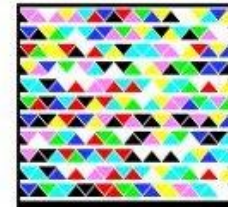
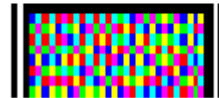
2. Development

Current and Next Generation (After 1970's)

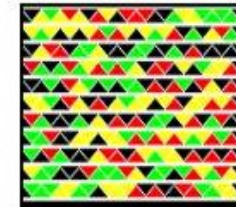
Current and Next (future) Generation

- Development of **even** more sophisticated codes follows:
 - 3D color codes
 - High Capacity Color Barcode
 - Ultra code
 - 4D color/time changing pattern codes
 - 5D color/intensity/time changing pattern codes

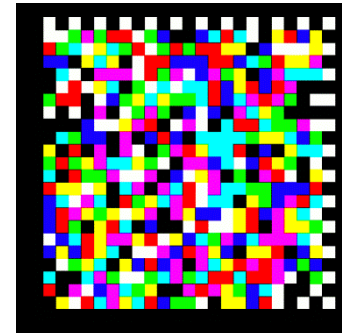
PATENTED



8 color barcode storing 84 RAW bytes



4 color barcode storing 58 RAW bytes



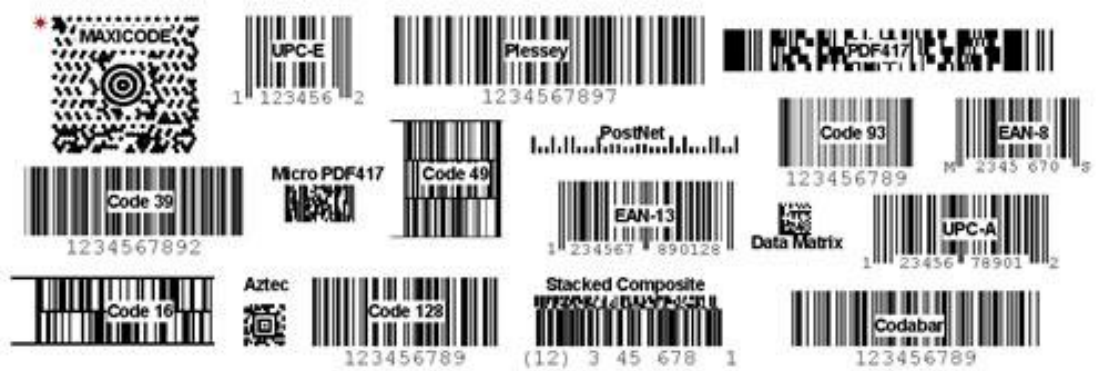
BARCODE SYMBOLOGY

3. Barcode Symbologies

classification

- a Barcode Symbology defines the technical details of a particular type of barcode:
 - the width of the bars
 - character set
 - method of encoding
 - checksum specifications, etc.

- GS1 standards
(Global Standards One)



3. Barcode Symbologies

Types

1-Dimensional Barcode Symbologies

- Numeric-Only Character Set Barcode Symbologies:
 - EAN-13, EAN-8, Interleaved 2 of 5, Meter Code, Nixdorf Code, PostNet, RSS-14, RSS Limited, RSS Expanded, UPC-A, UPC-E, ...
- Alpha-Numeric Character Set Barcode Symbologies
 - Code 128, Code 39, Code 93

Stacked, 2-Dimensional Barcode Symbologies

- Code 49, Codablock, Code 16, EAN-13 Composite, PDF417, RSS-14 Composite, RSS-14 Stacked Composite, Data Matrix, MaxiCode, Aztec Code, QR Code

3. Barcode Symbologies

1D- Numeric-only barcodes

Numeric-only barcodes

- **EAN-13** (originally "European Article Number,,")
 - EAN-13 is used world-wide for marking retail goods
 - is defined by the standards organization GS1
 - the symbol encodes 13 characters:

Country identifier		Company identifier					Manufacturer's item number					CD
4	0	1	2	3	4	5	0	8	1	5	0	9
FRG		Company Name 1 Road Name 80001 Munich					Chocolate Rabbit 100 g					



3. Barcode Symbologies

1D- Numeric-only barcodes

- **Bookland EAN (for ISBN numbers)**
 - is used internationally to identify books as well as video and audio cassettes and software
 - the unique number assigned to each item is the International Standard Book Number (ISBN, ex 1-55615-678-2)
 - Group identifier (1 digit),
 - Publisher identifier (5), Title identifier (3),
 - Check digit (1)
- to print an ISBN as a Bookland EAN barcode,
 - add the 978 prefix at the front of the ISBN
 - Replace the ISBN check digit from the end by an EAN check digit



3. Barcode Symbologies

1D- Numeric-only barcodes

- **PostNet** (<http://mdn.morovia.com/kb/POSTNET-Specification-10629.html>)
 - is used by the United States Postal Service to sort mail
 - consists of evenly spaced bars of two different heights
 - each character is represented **by five bars, two tall and three short**, the character set includes the digits 0 - 9.
 - the code begins and ends with a tall bar ('frame bar'), and may contain a 5-digit ZIP code, a 9-digit ZIP+4 code, or an 11-digit Delivery Point Code
 - a Modulo 10 check digit ('correction character') is inserted after the ZIP code and before the ending frame bar



3. Barcode Symbologies

1D- Numeric-only barcodes



- **UPC-A (12 digits)**
 - the first digit identifies the numbering system being used (0: regular UPC codes, 3: National Drug Code and National Health Related Items code, 5: for use on coupons)
 - the next group of 5 digits identifies the manufacturer (this number is assigned by the Uniform Code Council (UCC))
 - the next 5 digits identify the particular product and are assigned by the manufacturer
 - The last digit is a Modulo 10 checksum.
 - a UPC-A code may be augmented with a two-digit supplemental barcode to indicate the issue number for a periodical



3. Barcode Symbologies

1D- Alpha-numeric barcodes

Alpha-numeric barcodes



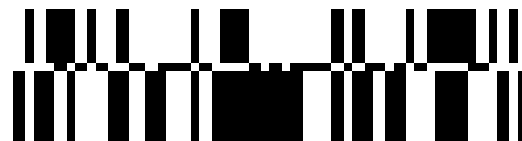
- **Code 39**

- widely used in many industries and is the standard for many government barcode specifications, including the U.S. DoD.
- the Code 39 character set includes the digits 0-9, the letters A-Z (upper case only), and the following symbols: space, minus (-), plus (+), period (.), dollar sign (\$), slash (/), and percent (%)
- start/stop character at the beginning and end of each barcode
- **the barcode may be of any length**
- each character consists of 9 elements, 5 bars and 4 spaces, each character includes 3 wide and 6 narrow elements.

3. Barcode Symbologies

1D/stacked variable bar codes

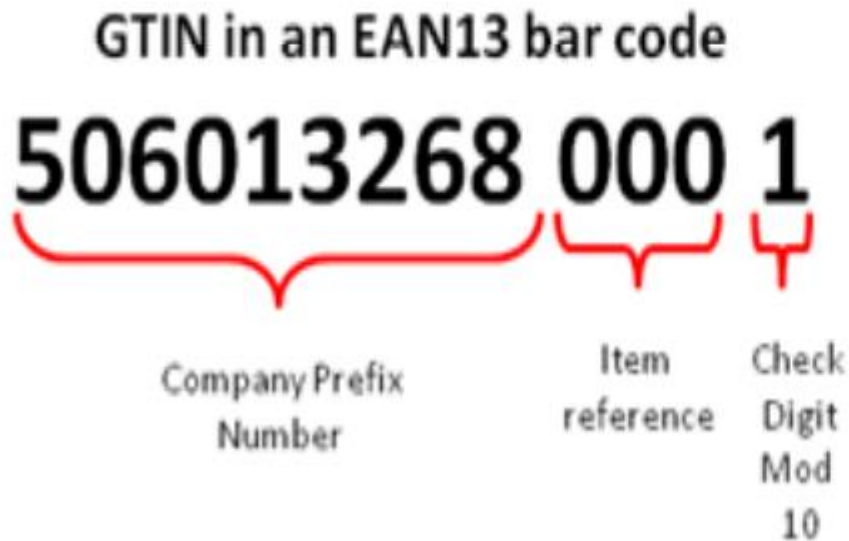
- **GS1-DataBar** (formerly Reduced Space Symbology RSS)
 - widely used in the health care industry
 - encodes 14 digits and can contain any of the 4 Global Trade Item Numbers (GTIN) types: GTIN 8, 12, 13, or 14.
 - is 50% smaller than EAN-13 or UPC-A Bar Code Symbols but carries more information than current EAN/UPC barcode.
 - has data compacting methods optimized for the data strings
 - can carry GS1 Application Identifiers (AI) like serial numbers, lot numbers, and expiration dates



3. Barcode Symbologies

GTIN in EAN13

- The GTIN is the GS1 Identification Key used to identify products and services



3. Barcode Symbologies

1D/stacked variable bar codes

- **GS1 Composite Symbology™**
 - a combination of a linear barcode component and a special 2D Composite Component (CC) symbol printed on top.
 - **GS1 Composite Component A**
 - MicroPDF417 Symbol variant
 - codes up to 56 digits of alphanumeric data
 - **GS1 Composite Component B**
 - MicroPDF417 Symbol subset
 - encodes up to 338 digits of alphanumeric data
 - **GS1 Composite Component C**
 - [PDF417](#) Symbol structure
 - codes up to 2361 digits of alphanumeric data



3. Barcode Symbologies

2-Dimensional barcodes



2-Dimensional barcodes

- **PDF-417**
 - PDF-417 is used for encoding large amounts of data, usually up to one or two-hundred characters are encoded in a single symbol.
 - The PDF417 symbology is mainly used in Europe and in the United States.
 - The 2D barcode symbology is mostly utilized in the areas of **logistic applications** (especially in the automotive industry), **transport systems** (e.g. for shipping labels), **identification** (e.g. driver licenses, passports) and **document management**.

3. Barcode Symbologies

2-Dimensional barcodes

- **QR code**
 - developed, patented and owned by [Toyota](#) subsidiary Denso Wave for car parts management;
 - now public domain. Can encode Japanese Kanji and Kana characters, music, images, URLs, emails.
 - [De facto](#) standard for Japanese cell phones.
 - Used for phones. – Standard : ISO/IEC 18004



3. Barcode Symbologies

3-Dimensional barcodes

- **3D barcodes (physically)**
 - problem is that in manufacturing there are high temperatures, extremely solvents being used, as well as a wealth of chemicals and processes that inhibit the use of a label with bars on it
 - the manufacturers wished to improve their inventory and tracking system - and have done so through the use of 3D barcodes
 - 3D barcodes use the same basic principle as linear and 2D barcodes
 - the 3D barcode is engraved or applied to the product itself as a part of the manufacturing process

3. Barcode Symbologies

3-Dimensional barcodes

- **3D barcodes**



3. Barcode Symbologies

Obscurities

- **Human barcodes**



Original by ToastyKen @ Flickr; CC-BY-2.0 / Tattoo mockup by Anirvan @ BookFinder.com



NWS 2000/2

29/10/2000 02:21
nwsnet.de

4. References

- History of development of barcode
http://www.barcoding.com/information/barcode_history.shtml
- Interviews with inventors <http://idhistory.com/videodirectory.html>
- Barcodes specification <http://mdn.morovia.com/kb/20/>, <http://www.tec-it.com/en/support/knowledge/symbologies/Default.aspx>
- Summary of barcodes <http://en.wikipedia.org/wiki/Barcode>
- Collection of information about barcodes
<http://www.adams1.com/newspage.html>
- Changing color barcode <http://2d-code.co.uk/4d-barcodes/>
- All about QR codes <http://www.denso-wave.com/qrcode/>,
en.wikipedia.org/wiki/QR_code