INDUSTRIES OF INDIA

THE BARCODE

Line, Light, Ledger

Source Companion



KETINENI RAMARAO

INDUSTRIES OF INDIA

The Barcode

Line, Light, Ledger - Source Companion

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How This Companion Works

Every numbered source below was consulted during the writing of The Barcode: Line, Light, Ledger. Each entry records the publication, its link, what was actually read (full text, extract, abstract or page), and the claims in the book the reading supports. In the book's text, superscript numbers point to these entries.

Entries read in full say so; entries read as extracts or abstracts are marked as such, and the claims drawn from them are limited to what the extract showed. Forecasts and modelled figures are used as forecasts. Historical incidents that survive mainly in one telling (the Miami Beach epiphany, the beanbag demonstration, the first morning at Troy) are attributed to that telling in the book's text. Company financial figures are from the companies' own reporting or regulatory filings; industry scale figures are from GS1's published statements; market-size projections are labelled as forecasts in the text. Forty-two sources follow.

S1 Weightman, G., "The History of the Bar Code", Smithsonian Magazine, 23 Sep 2015. https://www.smithsonianmag.com/innovation/history-bar-code-180956704/ READ: full article. 1948 grocer's plea at Drexel; Woodland leaving for Miami Beach; January 1949 sand epiphany (Morse code, four lines, then circle); 1949 filing and 1952 grant; 500-watt-bulb prototype with oscilloscope, judged ~20 years ahead of its time; Maiman's 1960 laser announcement and his not foreseeing the checkout scanner; Kroger's 1966 booklet plea; RCA's bull's-eye test at Kroger Kenwood Plaza from 3 July 1972 and its print-smudge weakness (ballpoint turret, astronaut pen); Laurer's last-minute IBM entry and the beanbag-ashtray demonstration; the 30 March 1973 decision meeting near Grand Central with ~90% confidence declarations; Kmart as first mass-merchant adopter; Fortune's 2004 estimate that 80-90% of top US companies used bar codes; Woodland's death in 2012 at 91; the Smithsonian's facsimile gum pack and the original remaining with Dawson.

S2 Gerena, C., "Reading Between the Lines", Econ Focus, Federal Reserve Bank of Richmond, Q2 2014. https://www.richmondfed.org/publications/research/econ_focus/2014/q2/economic_history READ: full article. Grocery margins under a penny on the dollar; clerk labor and sticker-repricing costs; NAFC president Adamy, the 1968 McKinsey approach ($100,000 study declined), the Ad Hoc Committee of ten executives and its first meeting in August 1970 near O'Hare with McKinsey facilitating; the 10-digit all-numeric code split 5+5 between central authority and manufacturers; Gookin's May 1971 Dallas speech and the written commitments collected beforehand; the Symbol Standardization Subcommittee under Alan Haberman (March 1971), seven proposals, the 1.5-square-inch limit, Battelle testing, RCA's July 1972 Kroger trial; January 1973 presentations and April 1973 announcement; adoption thresholds (75% of goods marked; ~8,000 scanning stores); $1.4 billion projected hard savings; FDA 1973 nutrition-label rules easing repackaging; union and consumer-advocate opposition; item-pricing laws in six states by 1976; the 1999 PricewaterhouseCoopers retrospective on payback damage; Das and Mulligan on slow diffusion; Basker's finding that grocery prices fell with scanning, most for produce and meat.

S3 National Inventors Hall of Fame, "The First Optically Scanned Bar Code: Joseph Woodland and Bernard Silver". https://www.invent.org/blog/inventors/Joseph-Woodland-Bernard-Silver READ: page text. Biographies; the overheard request; light-sensitive-ink proposal refused by the dean; Woodland leaving graduate school; Morse-based code; patent filed 1949; Woodland joining IBM 1951; IBM's role in the rectangular UPC; Silver's early death context.

S4 US Patent 2,612,994, "Classifying Apparatus and Method" (Woodland & Silver), Google Patents. https://patents.google.com/patent/US2612994A/en READ: bibliographic data and abstract. Filed 20 October 1949; granted/published 7 October 1952; concentric-circle (bull's-eye) code and optical reading apparatus.

S5 "David Collins, SM '59", MIT Technology Review, 20 Oct 2015. https://www.technologyreview.com/2015/10/20/165688/david-collins-sm-59/ READ: page text. Collins's Pennsylvania Railroad summers and punch-card chaos; Sylvania's KarTrak with photomultiplier color reading; 1967 national standard selection; Collins founding Computer Identics in 1968 for laser-scanned black-and-white codes.

S6 "KarTrak", Wikipedia (retrieved 3 Nov 2026). https://en.wikipedia.org/wiki/KarTrak READ: full article. 1959 proposal; railroad requirements (~$1 labels, 0-60 mph, 7-year life, ~9 ft read distance, gunfire resistance); 1961 Boston & Maine testing; 50,000 captive cars in three years; AAR trials at Spruce Creek; 1967 mandate; ~86% of 2 million cars labeled by 1970; ~90% by 1975 with ~80% read rate and 10% label failure after seven years; Sylvania's 1972 exit to Servo; abandonment around 1977. Wikipedia used here as a consolidated narrative of dates and rates, consistent with S5 and S7.

S7 AIDC 100, "AUTO ID History" timeline. https://aidc100.org/auto-id-history/ READ: full timeline. 1934 Kermode/Young/Sparks patent; 1961 Sylvania scanner on the Boston & Maine; 1971 milestones (GM's $10,000 HeNe laser scanner, AIM founded with four companies, Norand wand, Monarch's Codabar, NCR Color Bar Code); 1972 Kroger first retail scanning and Allais's Interleaved 2 of 5; 1974 Code 39 (Allais & Stevens, Intermec) and first UPC scan; 1980 Sato first thermal transfer printer; 1981 Code 128 (Computer Identics), first CCD scanner (Norand), UPC-EAN shipping container symbol; 1982 MIL-STD-1189 and Symbol's handheld laser scanner; 1983 ANSI standards (Code 39, Codabar, I 2 of 5).

S8 Smithsonian National Museum of American History, object record: "Supermarket Scanner" (Spectra Physics model A). https://americanhistory.si.edu/collections/object/nmah_892778 READ: full record. First scanner installation at Marsh, Troy, 26 June 1974; one of the first ten scanners; He-Ne laser, rotating mirror, glass plate, photodiode; NCR computerized register; Ad Hoc Committee organized 1970 by McKinsey; the original gum pack never came to the Smithsonian.

S9 HISTORY.com, "Pack of chewing gum becomes first-ever item scanned with a UPC barcode", This Day in History, 26 June. https://www.history.com/this-day-in-history/june-26/barcode-scanner-invention-first-use READ: page text. 8:01 a.m. timing; Laurer's last-minute submission; bull's-eye smudging rationale; Dawson as first scanner; billions scanned daily context.

S10 GS1 US, "GS1 US Celebrates 50-Year Barcode Scanniversary", press release, 26 June 2024. https://www.gs1us.org/industries-and-insights/media-center/press-releases/gs1-us-celebrates-50-year-barcode-scanniversary READ: full release. 26 June 1974 first scan; barcode identifies over 1 billion products; scanned more than 10 billion times daily; UCC as UPC administrator.

S11 GS1, "2022/23 Year in Review". https://www.gs1.org/about-gs1/202223-year-review READ: page text/extracts. 25+ industries; 150+ countries; over 2 million companies served; 1 billion+ products carrying GS1 barcodes; 10 billion+ scans per day.

S12 GS1 US, "What is GS1 Sunrise 2027?". https://www.gs1us.org/industries-and-insights/by-topic/sunrise-2027 READ: full page. Global transition from 1D UPC to 2D barcodes at POS; crawl-walk-run guidance for brands and retailers; 2D carrying variants, dates and richer data; GTIN extraction at POS.

S13 GS1 GO Customer Service Portal, "Why is GS1 leading the transition to 2D barcodes?". https://support.gs1.org/support/solutions/articles/43000743464 READ: page text. 10 billion beeps per day; 1 billion+ products; endorsement of 25+ companies including Alibaba, Carrefour, L'Oréal and Procter & Gamble for QR Codes powered by GS1.

S14 Japan Patent Office, "QR Code (DENSO WAVE INCORPORATED)", Innovation Japan. https://www.jpo.go.jp/e/news/koho/innovation/01_qrcode_e.html READ: full article. 1994 invention; DENSO's post-bubble search for new business; ~20-character limit of 1D codes; no kanji support in US-invented codes; Hara Masahiro's motivation; position-detection research for high-speed, orientation-free reading.

S15 EH.net Encyclopedia, "A History of the Bar Code". https://eh.net/encyclopedia/a-history-of-the-bar-code/ READ: page text. Six industry associations; two-year effort; UPC announced 1 April 1973; economic studies projecting $40+ million savings by mid-1970s, unmet on schedule; Business Week's "The Supermarket Scanner That Failed" eulogy.

S16 Supermarket News, "Scanning Transforms the Store". https://www.supermarketnews.com/grocery-operations/scanning-transforms-the-store READ: page text. 8:01 a.m., 26 June 1974 details; NCR/Spectra-Physics system; five years for most products to arrive bar-coded; early scanner cost ~$10,000; ~70% of US supermarkets scanning by about 1986; Wal-Mart and Kmart supplier mandates mid-1980s; scanner-scale integration late 1980s; bioptic scanners early 1990s; PSC's 1996 purchase of Spectra-Physics.

S17 Zebra Technologies, "Zebra Technologies Announces Fourth-Quarter and Full-Year 2024 Results", 13 Feb 2025. https://www.zebra.com/us/en/about-zebra/newsroom/press-releases/2025/zebra-technologies-announces-fourth-quarter-2024-results.html READ: release text. Q4 2024 net sales $1,334M (+32.2% y/y); segment detail.

S18 StockAnalysis, "Zebra Technologies (ZBRA) Revenue 2005-2026". https://stockanalysis.com/stocks/zbra/revenue/ READ: revenue table. FY2024 revenue $4.98B; FY2025 $5.40B.

S19 Medscape, "Bar-Code Technology May Help Improve Patient Safety" (reporting Poon et al., N Engl J Med 2010;362:1698-1707), 6 May 2010. https://www.medscape.com/viewarticle/721364 READ: full summary. 14,041 administrations and 3,082 transcriptions observed; non-timing administration errors 11.5% to 6.8% (41.4% relative reduction); potential adverse drug events 3.1% to 1.6% (50.8% relative reduction); transcription errors eliminated; Brigham and Women's Hospital setting.

S20 Federal Register, "Unique Device Identification System", final rule, 24 Sep 2013. https://www.federalregister.gov/documents/2013/09/24/2013-23059/unique-device-identification-system READ: summary and dates. UDI on device labels in plain text and AIDC form; GUDID submissions; direct marking for reprocessed devices; error-reduction and adverse-event rationale.

S21 Barcoder documentation, "LOGMARS - 1D Linear (Code 39) standard". https://docs.barcoder.ai/docs/standards/logmars READ: full page. 1 September 1981 DoD adoption of Code 39; ~50,000 suppliers required from 1982; MIL-STD-1189 lineage (1189A 1984, 1189B 1989); Code 39's 43-character set and 9-element structure; ANSI MH10.8M-1983 civilian standard; AIM's crediting military adoption for industrial spread.

S22 GS1 GO Customer Service Portal, "The History of GS1 Barcodes: First Scan to QR Code Future" (GS1 historical timeline). https://support.gs1.org/support/solutions/articles/43000734073-gs1-historical-timeline READ: full timeline. UCC appointed 1974; EAN established 1977 in Brussels, fully UPC-compatible; first EDI standard; healthcare expansion; GS1 DataBar approval; 90 countries by 2000; GSMP launch; GS1 DataMatrix first 2D adopted; GDSN launch; 2005 UCC-EAN merger with 101 member organizations; first global traceability standard; FDA UDI issuing-agency accreditation; LEI issuance; GS1 Registry Platform and Verified by GS1; GS1 Digital Link standard; end-2027 2D-at-POS ambition; 2017 BBC "50 things that made the modern economy"; 116 member organizations at the 50th anniversary.

S23 heise online, "35 Jahre Barcode in den Supermärkten". https://www.heise.de/news/35-Jahre-Barcode-in-den-Supermaerkten-211487.html READ: full article (German). McKinsey-run selection process and October 1970 UPCC founding; Albert Heijn's role and guest attendance 1973-74; Germany's CCG founded 1974; twelve countries founding EAN in 1977 with Heijn as chairman; December 1976 approval of the 13-digit EAN with upward compatibility; Laurer as developer of the EAN-13; mutual UPC-EAN compatibility formalized 2005; Swartz's early self-scanning patent; fresh-goods in-store label printing as a subindustry.

S24 CIO, "45 Years of Wal-Mart History: A Technology Time Line". https://www.cio.com/article/274537/ READ: timeline text. 1983 POS barcode scanning; 1984 Texlon handheld shelf scanning; 1985: 882 stores, $8.4B sales; 1987 largest private US satellite communication system.

S25 Grand View Research, "Automatic Identification & Data Capture Market Report, 2030". https://www.grandviewresearch.com/industry-analysis/automatic-identification-data-capture-market-report READ: summary page. Market size $69.8B in 2024; forecast $88.2B (2026) to $136.9B (2030), CAGR 11.7%; North America 38.5% share 2024. Forecast figures are used as forecasts in the text.

S26 Digimarc, "Birth of the Barcode" (PDF). https://www.digimarc.com/sites/default/files/content/paragraphs/content-with-icons/2022-07/birth-of-the-barcode.pdf READ: extract. Patent sold to Philco in 1962 for $15,000; 1960 Hughes laser announcement; the 500-watt lamp's bulk and heat problems that the laser solved.

S27 U.S. FDA, "Bar Code Label Requirements for Blood and Blood Components: Questions and Answers". https://www.fda.gov/vaccines-blood-biologics/labeling-cber-regulated-products/bar-code-label-requirements-blood-and-blood-components-questions-and-answers READ: full Q&A. Final rule of 26 Feb 2004; compliance by 26 April 2006; 21 CFR 606.121(c)(13); required data: facility identifier, donor lot number, product code, ABO/Rh.

S28 Federal Register, "Bar Code Label Requirement for Human Drug Products and Biological Products", final rule, 26 Feb 2004. https://www.federalregister.gov/documents/2004/02/26/04-4249/ READ: summary and dates. NDC number in a linear bar code on drug labels; right drug/dose/route/patient/time verification purpose; effective 26 April 2004; compliance within 2 years for previously approved products.

S29 MIT Technology Review, "Wal-Mart Details RFID Requirement", 7 Nov 2003. https://www.technologyreview.com/2003/11/07/40397/wal-mart-details-rfid-requirement/ READ: full note. EPC tracking for pallets and cases from January 2005; 96-bit EPC; 868-956 MHz; top-100 US suppliers by end of 2005.

S30 Computerworld, "Wal-Mart Backs RFID Technology" (2003). https://www.computerworld.com/article/1727203/wal-mart-backs-rfid-technology.html READ: full note. Top 100 suppliers required by January 2005; expectation of nearly 1 billion EPC tags (reported as expectation).

S31 Smithsonian National Postal Museum, "The Increasing Pace of Change". https://postalmuseum.si.edu/exhibition/america%E2%80%99s-mailing-industry-the-united-states-postal-service/the-increasing-pace-of-change READ: page text. POSTNET introduced 1982 (5-digit ZIP); ZIP+4 in 1983; two more digits 1990; PLANET/Confirm tracking 2002; Intelligent Mail barcode 2006 with four bar types and ~3x data; 2010 ~30% of business mail; required for automation rates from 2013.

S32 RFIDbix, "History of Barcode Baggage Tags and the LPN". https://rfidbix.org/history-of-barcode-baggage-tags-and-the-lpn/ READ: full article. Eastern Air Lines first barcode baggage sorting, early 1980s, circular codes; the license-plate-number concept; IATA Baggage Security Working Group after ICAO Annex 17 changes; ten-digit LPN design (leading digit, 3-digit airline code, 6-digit serial); Interleaved 2 of 5 chosen for compatibility with numbering-wheel tag printers; IATA adoption.

S33 Cognex Corporation, Form 10-K (fiscal 2024), SEC EDGAR. https://www.sec.gov/Archives/edgar/data/851205/000085120525000012/cgnx-20241231.htm READ: results-of-operations extract. 2024 revenue $914,515,000, +9% over 2023; logistics and semiconductor strength; automotive softness.

S34 GS1, "Leading scanning solution providers support GS1 global transition to next generation barcodes". https://www.gs1.org/resources/articles/leading-scanning-solution-providers-support-gs1-global-transition-next-generation-barcodes READ: full article. 10 billion+ scans per day; solution-provider support for 2D migration; batch/expiry/sustainability data in one symbol.

S35 GS1, "GS1 Barcodes" (standards overview). https://www.gs1.org/standards/barcodes READ: full page. Linear vs 2D definitions; UPC/EAN, GS1 DataBar, GS1-128 and ITF-14 families and their roles; the GS1 General Specifications as the system's core standards document; GS1 syntaxes including Digital Link URI; healthcare GS1 DataMatrix use; Solution Provider 2D Focus Group.

S36 DENSO WAVE, "QR Code Standardization" and "Information capacity and versions of QR Code". https://www.qrcode.com/en/about/standards.html + https://www.qrcode.com/en/about/version.html READ: both pages. AIM 1997, JEIDA 1998, JIS 1999, ISO/IEC 18004 June 2000 standardization; patent No. 2938338 waived for standardized QR codes; symbol sizes 21x21 to 177x177 modules growing by fours; capacities 7,089 numeric / 4,296 alphanumeric / 2,953 bytes / 1,817 kanji; error-correction levels L/M/Q/H restoring ~7/15/25/30% of codewords; structured appending to 16 symbols; version-selection method.

S37 GS1, "How to calculate a check digit manually". https://www.gs1.org/services/how-calculate-check-digit-manually READ: full page and tables. Supports chapter 9's alternating 3/1 weighting and next-multiple-of-ten rule. The worked UPC example and adjacent-swap limitation are calculations shown in the book, not claims of a separate experiment.

S38 GS1, *2D Barcode Verification Process Implementation Guideline*, Release 1.3.21 (July 2015). https://www.gs1.org/docs/barcodes/2D_Barcode_Verification_Process_Implementation_Guideline.pdf READ: fetched extract through section 9.1.3, including sections 5-8 and 9.1.1-9.1.3; not the complete PDF. Supports chapter 28's verification workflow, weakest-parameter grading, illumination/aperture reporting, measured parameter list, and 1X DataMatrix versus 4X QR quiet zones. A dated explanatory guideline, not a substitute for current application specifications.

S39 GS1, *2D Barcodes at Retail Point-of-Sale Implementation Guideline*, version 1.1.0 (15 December 2025). https://ref.gs1.org/guidelines/2d-in-retail/1.1.0/GS1-2DRetailPOS-Guideline-i1.1-r-2025-12-15 READ: fetched extract: executive summary, background, definitions, and general guidance through section 4.1.3; later implementation sections not read. Supports chapter 30's voluntary transition, minimum GTIN-processing ambition, software/equipment changes, imaging-scanner caveat, dual marking, data syntaxes and URI-to-element-string translation. Does not establish that any particular retailer is ready.

S40 GS1, General Specifications Change Notification, GTIN-8 / GS1-8 Prefix (November 2021). https://www.gs1.org/docs/barcodes/GSCN_21-271_GTIN8.pdf READ: fetched change-notification extract, especially sections 1.4.3-1.4.5 and 2.1.3.2-2.1.3.3. Supports chapters 9 and 14: variable company-prefix lengths; UPC-E as zero-suppression of eligible GTIN-12s; GTIN-8 individually assigned for small packages rather than zero-suppressed EAN-13. Historical change document used only for these structural distinctions.

S41 Zebra Technologies, "Learn About Zebra Technologies", updated July 2026. https://www.zebra.com/us/en/ai-info.html READ: full fetched page. Original-company confirmation of $5.4 billion revenue in 2025, headquarters in Lincolnshire, Illinois, and portfolio including mobile computing, data capture, RFID and software. Supports chapter 26; this is total company revenue, not barcode-only sales.

S42 Poon EG et al., "Effect of bar-code technology on the safety of medication administration", New England Journal of Medicine 2010;362:1698-1707, PubMed record. https://pubmed.ncbi.nlm.nih.gov/20445181/ READ: full abstract, not the full study. Supports chapter 23: before-and-after quasi-experiment; 14,041 medication administrations and 3,082 transcriptions; non-timing errors 11.5% to 6.8% (41.4% relative reduction); non-timing potential adverse drug events 3.1% to 1.6% (50.8% relative reduction); transcription errors eliminated in the observed intervention units. Findings concern barcode eMAR, not a barcode alone, and potential adverse events rather than measured actual injury.