

BAR CODES A LINEAR HISTORY

BAR CODES A LINEAR HISTORY TRACES THE EVOLUTION OF ONE OF THE MOST SIGNIFICANT TECHNOLOGICAL INNOVATIONS IN MODERN RETAIL, LOGISTICS, AND DATA MANAGEMENT. FROM THEIR INCEPTION AS SIMPLE LINEAR PATTERNS ENCODING NUMERICAL DATA TO THEIR WIDESPREAD ADOPTION ACROSS GLOBAL INDUSTRIES, BAR CODES HAVE REVOLUTIONIZED HOW PRODUCTS ARE TRACKED AND INFORMATION IS PROCESSED. THIS ARTICLE EXPLORES THE ORIGINS, DEVELOPMENT, AND TECHNOLOGICAL MILESTONES OF BAR CODES, EMPHASIZING THEIR LINEAR DESIGN AND THE IMPACT ON SUPPLY CHAIN EFFICIENCY. IT ALSO DELVES INTO THE VARIOUS TYPES OF BAR CODES, THE TRANSITION FROM MANUAL INVENTORY METHODS TO AUTOMATED SCANNING, AND THE FUTURE TRENDS SHAPING BARCODE TECHNOLOGY. UNDERSTANDING THIS LINEAR HISTORY PROVIDES VALUABLE INSIGHT INTO HOW BAR CODES HAVE BECOME AN INDISPENSABLE TOOL IN COMMERCE AND DATA AUTOMATION.

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THE ORIGINS OF BAR CODES

THE HISTORY OF BAR CODES BEGAN IN THE MID-20TH CENTURY AS A SOLUTION TO IMPROVE THE EFFICIENCY OF RETAIL CHECKOUT PROCESSES. EARLY EFFORTS FOCUSED ON CREATING A MACHINE-READABLE CODE TO REPLACE MANUAL PRICING AND INVENTORY TRACKING. THE CONCEPT OF REPRESENTING DATA IN A VISUAL, LINEAR FORMAT DATES BACK TO THE 1940S WHEN INVENTORS SOUGHT WAYS TO ENCODE INFORMATION THAT COULD BE QUICKLY SCANNED AND DECODED. THE FIRST SUCCESSFUL PATENT FOR A BAR CODE WAS FILED IN 1952 BY NORMAN JOSEPH WOODLAND AND BERNARD SILVER, WHO DEVELOPED A SYSTEM USING CONCENTRIC CIRCLES THAT LATER EVOLVED INTO THE LINEAR BAR CODES FAMILIAR TODAY. THIS INNOVATION LAID THE GROUNDWORK FOR THE WIDESPREAD USE OF BAR CODES IN VARIOUS INDUSTRIES.

EARLY CONCEPTUALIZATION AND PATENTS

IN 1948, BERNARD SILVER OVERHEARD A CONVERSATION ABOUT THE NEED FOR A SYSTEM TO AUTOMATICALLY READ PRODUCT INFORMATION AT CHECKOUT COUNTERS. COLLABORATING WITH NORMAN JOSEPH WOODLAND, THEY DEVELOPED A CODE BASED ON MORSE CODE, USING LINES AND SPACES TO REPRESENT DATA. THEIR FIRST PATENT FEATURED CIRCULAR PATTERNS, BUT THE DESIGN SOON SHIFTED TO THE LINEAR FORMAT FOR SIMPLICITY AND EASIER SCANNING. THE 1952 PATENT MARKED A PIVOTAL MOMENT IN BAR CODE HISTORY, THOUGH PRACTICAL IMPLEMENTATIONS WOULD TAKE YEARS TO MATERIALIZE.

INITIAL CHALLENGES AND ADOPTION

DESPITE THE PROMISING CONCEPT, EARLY BAR CODE TECHNOLOGY FACED SIGNIFICANT HURDLES, INCLUDING LIMITED SCANNING TECHNOLOGY AND LACK OF INDUSTRY STANDARDS. THE ABSENCE OF RELIABLE LASER SCANNERS AND COMPUTING POWER DELAYED PRACTICAL APPLICATIONS. MOREOVER, RETAILERS AND MANUFACTURERS WERE SLOW TO ADOPT THE SYSTEM DUE TO COSTS AND THE NEED FOR COMPATIBLE INFRASTRUCTURE. HOWEVER, THE PROMISE OF FASTER AND MORE ACCURATE DATA COLLECTION KEPT RESEARCH AND DEVELOPMENT EFFORTS ONGOING.

DEVELOPMENT AND STANDARDIZATION

THE PROGRESSION OF BAR CODES FROM A NOVEL IDEA TO A GLOBAL STANDARD INVOLVED EXTENSIVE COLLABORATION AND TECHNOLOGICAL REFINEMENT. STANDARDIZATION WAS CRITICAL TO ENSURE INTEROPERABILITY AMONG MANUFACTURERS, RETAILERS, AND SCANNING DEVICES. DURING THE 1960S AND 1970S, ORGANIZATIONS SUCH AS THE UNIFORM CODE COUNCIL (UCC) AND THE INTERNATIONAL ARTICLE NUMBERING ASSOCIATION (NOW GS1) EMERGED TO DEVELOP AND PROMOTE STANDARDS FOR BAR CODE SYMBOLOGIES AND NUMBERING SYSTEMS. STANDARDIZATION FACILITATED THE ADOPTION OF BAR CODES ACROSS INDUSTRIES, ENABLING SEAMLESS COMMUNICATION AND DATA EXCHANGE WORLDWIDE.

THE UNIVERSAL PRODUCT CODE (UPC)

THE INTRODUCTION OF THE UNIVERSAL PRODUCT CODE (UPC) IN THE EARLY 1970S MARKED A TURNING POINT IN THE HISTORY OF BAR CODES. THE UPC FEATURED A LINEAR DESIGN ENCODING A 12-DIGIT NUMBER, INCLUDING A MANUFACTURER IDENTIFICATION NUMBER AND A PRODUCT CODE. THIS SYSTEM ALLOWED FOR RAPID RETRIEVAL OF PRODUCT INFORMATION AT RETAIL CHECKOUTS, DRASTICALLY IMPROVING INVENTORY MANAGEMENT AND SALES TRACKING. THE FIRST COMMERCIAL USE OF THE UPC OCCURRED IN 1974, WHEN A PACK OF WRIGLEY'S CHEWING GUM WAS SCANNED AT A SUPERMARKET IN OHIO, SYMBOLIZING THE DAWN OF MODERN BAR CODE APPLICATION.

GLOBAL STANDARDS AND VARIANTS

FOLLOWING THE SUCCESS OF THE UPC, OTHER STANDARDIZED BAR CODE SYMBOLOGIES EMERGED TO MEET DIFFERENT NEEDS. THE EUROPEAN ARTICLE NUMBER (EAN) SYSTEM WAS DEVELOPED AS AN EXTENSION OF UPC FOR INTERNATIONAL MARKETS. VARIOUS INDUSTRY-SPECIFIC CODES WERE ALSO CREATED, SUCH AS CODE 39 FOR LOGISTICS AND CODE 128 FOR HIGH-DENSITY ENCODING. THESE STANDARDS ENSURED THAT BAR CODES COULD BE APPLIED FLEXIBLY ACROSS MULTIPLE SECTORS WHILE MAINTAINING CONSISTENCY AND RELIABILITY.

TYPES OF LINEAR BAR CODES

LINEAR BAR CODES, ALSO KNOWN AS ONE-DIMENSIONAL (1D) BAR CODES, REPRESENT DATA THROUGH VARYING WIDTHS AND SPACINGS OF PARALLEL LINES. MULTIPLE SYMBOLOGIES EXIST, EACH DESIGNED FOR SPECIFIC USE CASES AND DATA REQUIREMENTS. UNDERSTANDING THESE TYPES IS ESSENTIAL FOR RECOGNIZING THE VERSATILITY AND APPLICATION SCOPE OF LINEAR BAR CODES.

COMMON LINEAR BAR CODE SYMBOLOGIES

- **UPC (UNIVERSAL PRODUCT CODE):** PRIMARILY USED IN RETAIL, ENCODES 12 NUMERICAL DIGITS FOR PRODUCT IDENTIFICATION.
- **EAN (EUROPEAN ARTICLE NUMBER):** SIMILAR TO UPC BUT WITH 13 DIGITS, COMMON IN INTERNATIONAL RETAIL MARKETS.
- **CODE 39:** ENCODES ALPHANUMERIC CHARACTERS, WIDELY USED IN AUTOMOTIVE AND DEFENSE INDUSTRIES.
- **CODE 128:** HIGH-DENSITY CODE CAPABLE OF ENCODING THE FULL ASCII CHARACTER SET, USED IN LOGISTICS AND SHIPPING.
- **INTERLEAVED 2 OF 5:** NUMERIC-ONLY SYMBOLOGY USED IN WAREHOUSE AND INDUSTRIAL APPLICATIONS.

ENCODING MECHANISMS AND DATA CAPACITY

EACH LINEAR BAR CODE SYMBOLOGY EMPLOYS SPECIFIC RULES FOR REPRESENTING CHARACTERS THROUGH THE WIDTH AND SPACING OF BARS AND SPACES. THE DATA CAPACITY OF LINEAR BAR CODES IS LIMITED COMPARED TO TWO-DIMENSIONAL CODES, TYPICALLY ENCODING UP TO 20-30 CHARACTERS DEPENDING ON THE SYMBOLOGY. DESPITE THIS LIMITATION, THE SIMPLICITY AND SPEED OF LINEAR BAR CODES MAKE THEM IDEAL FOR MANY APPLICATIONS.

TECHNOLOGICAL ADVANCEMENTS IN BAR CODE SCANNING

THE EVOLUTION OF BAR CODES IS CLOSELY TIED TO ADVANCEMENTS IN SCANNING TECHNOLOGY. EARLY BAR CODE READERS RELIED ON SIMPLE PHOTOELECTRIC SENSORS, BUT MODERN SCANNERS UTILIZE LASER AND IMAGING TECHNOLOGY TO ENHANCE SPEED, ACCURACY, AND VERSATILITY. THESE IMPROVEMENTS HAVE EXPANDED THE USABILITY OF LINEAR BAR CODES ACROSS DIVERSE ENVIRONMENTS AND CONDITIONS.

FROM PHOTOCELLS TO LASER SCANNERS

INITIAL BAR CODE SCANNING DEVICES USED PHOTOCELLS TO DETECT LIGHT REFLECTED FROM THE BARS AND SPACES. THESE EARLY READERS WERE BULKY AND SLOW, LIMITING WIDESPREAD ADOPTION. THE DEVELOPMENT OF LASER SCANNERS IN THE 1970S REVOLUTIONIZED THE FIELD BY OFFERING PRECISE, HIGH-SPEED READING WITH THE ABILITY TO DECODE BAR CODES FROM GREATER DISTANCES AND ANGLES. LASER SCANNERS BECAME THE STANDARD IN RETAIL AND INDUSTRIAL SETTINGS.

CCD AND IMAGING SCANNERS

CHARGE-COUPLED DEVICE (CCD) SCANNERS EMERGED AS AN ALTERNATIVE TO LASER SCANNERS, USING AN ARRAY OF LIGHT SENSORS TO CAPTURE BAR CODE IMAGES. MORE RECENTLY, CAMERA-BASED IMAGING SCANNERS HAVE GAINED POPULARITY DUE TO THEIR ABILITY TO READ DAMAGED OR POORLY PRINTED BAR CODES AND TO DECODE MULTIPLE SYMBOLOGIES, INCLUDING 2D CODES. THESE DEVICES OFFER FLEXIBILITY AND ENHANCED PERFORMANCE, ENSURING THE CONTINUED RELEVANCE OF LINEAR BAR CODES IN MODERN APPLICATIONS.

APPLICATIONS AND IMPACT ON INDUSTRIES

THE ADOPTION OF BAR CODES HAS TRANSFORMED NUMEROUS SECTORS BY STREAMLINING OPERATIONS, REDUCING ERRORS, AND ENABLING REAL-TIME DATA COLLECTION. THE LINEAR HISTORY OF BAR CODES REFLECTS THEIR GROWING IMPORTANCE AS A FOUNDATIONAL TECHNOLOGY FOR INVENTORY MANAGEMENT, RETAIL SALES, HEALTHCARE, LOGISTICS, AND MANUFACTURING.

RETAIL AND INVENTORY MANAGEMENT

RETAIL IS THE MOST VISIBLE SECTOR IMPACTED BY BAR CODES. THE ABILITY TO SCAN PRODUCTS AT CHECKOUT HAS EXPEDITED TRANSACTIONS AND IMPROVED INVENTORY ACCURACY. BAR CODES FACILITATE AUTOMATIC STOCK REPLENISHMENT, PRICING UPDATES, AND SALES ANALYTICS, CONTRIBUTING TO ENHANCED CUSTOMER SERVICE AND OPERATIONAL EFFICIENCY.

HEALTHCARE AND PHARMACEUTICALS

IN HEALTHCARE, BAR CODES ENSURE ACCURATE PATIENT IDENTIFICATION, MEDICATION ADMINISTRATION, AND EQUIPMENT TRACKING. LINEAR BAR CODES ON PHARMACEUTICAL PACKAGING HELP PREVENT ERRORS AND COUNTERFEITING, ENHANCING PATIENT SAFETY AND REGULATORY COMPLIANCE.

LOGISTICS AND SUPPLY CHAIN

BAR CODES ENABLE PRECISE TRACKING OF SHIPMENTS AND INVENTORY THROUGHOUT THE SUPPLY CHAIN. LINEAR BAR CODES ON PALLETS, CONTAINERS, AND PACKAGES ALLOW FOR AUTOMATED SORTING, SHIPMENT VERIFICATION, AND DELIVERY CONFIRMATION, REDUCING DELAYS AND LOSSES.

FUTURE TRENDS IN BAR CODE TECHNOLOGY

WHILE LINEAR BAR CODES CONTINUE TO SERVE VITAL FUNCTIONS, EMERGING TECHNOLOGIES AND EVOLVING INDUSTRY NEEDS ARE DRIVING INNOVATIONS IN BAR CODE DESIGN AND USAGE. FUTURE TRENDS FOCUS ON INTEGRATION WITH DIGITAL SYSTEMS, ENHANCED DATA CAPACITY, AND IMPROVED SCANNING CAPABILITIES.

INTEGRATION WITH MOBILE AND IoT DEVICES

THE PROLIFERATION OF SMARTPHONES AND INTERNET OF THINGS (IoT) DEVICES HAS EXPANDED THE POTENTIAL FOR BAR CODE SCANNING BEYOND TRADITIONAL SETTINGS. MOBILE APPS EQUIPPED WITH CAMERA-BASED SCANNERS ENABLE CONSUMERS AND WORKERS TO ACCESS PRODUCT INFORMATION, VERIFY AUTHENTICITY, AND MANAGE INVENTORY ON THE GO.

HYBRID AND 2D BAR CODES

WHILE LINEAR BAR CODES REMAIN PREVALENT, 2D CODES SUCH AS QR CODES OFFER HIGHER DATA DENSITY AND ERROR CORRECTION. HYBRID SYSTEMS COMBINING LINEAR AND 2D CODES ARE BEING DEVELOPED TO LEVERAGE THE STRENGTHS OF BOTH FORMATS, FACILITATING COMPLEX DATA ENCODING WHILE MAINTAINING COMPATIBILITY WITH EXISTING INFRASTRUCTURE.

ADVANCES IN PRINTING AND MATERIALS

INNOVATIONS IN PRINTING TECHNOLOGY AND MATERIALS ARE IMPROVING THE DURABILITY AND READABILITY OF BAR CODES IN HARSH ENVIRONMENTS. THERMAL TRANSFER PRINTING, RFID INTEGRATION, AND NANOTECHNOLOGY ARE AMONG THE ADVANCEMENTS ENHANCING THE FUNCTIONALITY AND LIFESPAN OF BAR CODE LABELS.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE ORIGIN OF BAR CODES IN THE CONTEXT OF LINEAR HISTORY?

BAR CODES ORIGINATED IN THE EARLY 1950S AS A METHOD TO AUTOMATICALLY IDENTIFY PRODUCTS USING OPTICAL SCANNING, WITH THE FIRST PATENT FILED BY NORMAN JOSEPH WOODLAND AND BERNARD SILVER IN 1949.

HOW DID THE LINEAR BAR CODE EVOLVE OVER TIME?

THE LINEAR BAR CODE EVOLVED FROM SIMPLE LINE PATTERNS TO STANDARDIZED FORMATS LIKE THE UNIVERSAL PRODUCT CODE (UPC) IN THE 1970S, ENABLING WIDESPREAD RETAIL USE AND IMPROVED INVENTORY MANAGEMENT.

WHY ARE BAR CODES CONSIDERED A SIGNIFICANT DEVELOPMENT IN LINEAR HISTORY?

BAR CODES REPRESENT A KEY ADVANCEMENT IN LINEAR DATA ENCODING, ALLOWING QUICK AND ACCURATE DIGITAL REPRESENTATION OF INFORMATION THROUGH LINEAR PATTERNS, REVOLUTIONIZING COMMERCE AND LOGISTICS.

WHAT ARE THE MAIN TYPES OF LINEAR BAR CODES USED HISTORICALLY AND TODAY?

MAIN TYPES INCLUDE UPC, CODE 39, CODE 128, AND EAN BAR CODES, EACH DESIGNED FOR DIFFERENT INDUSTRIES AND APPLICATIONS, WITH UPC BEING THE MOST COMMON IN RETAIL.

HOW DID THE ADOPTION OF BAR CODES IMPACT SUPPLY CHAIN AND RETAIL INDUSTRIES?

BAR CODES STREAMLINED INVENTORY TRACKING, REDUCED ERRORS, ACCELERATED CHECKOUT PROCESSES, AND IMPROVED DATA COLLECTION, TRANSFORMING SUPPLY CHAIN EFFICIENCY AND RETAIL OPERATIONS.

WHAT TECHNOLOGICAL ADVANCEMENTS HAVE INFLUENCED THE DEVELOPMENT OF LINEAR BAR CODES?

ADVANCEMENTS INCLUDE LASER SCANNING TECHNOLOGY, DIGITAL PRINTING, AND COMPUTER DATABASES, WHICH ENHANCED THE READABILITY, PRODUCTION, AND INTEGRATION OF BAR CODES INTO BUSINESS SYSTEMS.

WHAT IS THE FUTURE OUTLOOK FOR LINEAR BAR CODES IN THE AGE OF DIGITAL AND QR CODES?

WHILE QR CODES AND RFID TECHNOLOGY ARE GAINING POPULARITY, LINEAR BAR CODES REMAIN WIDELY USED DUE TO THEIR SIMPLICITY, COST-EFFECTIVENESS, AND COMPATIBILITY WITH EXISTING SYSTEMS, ENSURING THEIR CONTINUED RELEVANCE.

ADDITIONAL RESOURCES

1. *THE BARCODE REVOLUTION: A LINEAR HISTORY OF AUTOMATED IDENTIFICATION*

THIS BOOK EXPLORES THE ORIGINS AND DEVELOPMENT OF BARCODE TECHNOLOGY FROM ITS INCEPTION IN THE 1940S TO ITS WIDESPREAD ADOPTION IN RETAIL AND LOGISTICS. IT HIGHLIGHTS KEY INVENTORS AND TECHNOLOGICAL BREAKTHROUGHS THAT SHAPED THE BARCODE INDUSTRY. READERS GAIN INSIGHT INTO HOW BARCODES TRANSFORMED SUPPLY CHAIN MANAGEMENT AND DATA COLLECTION.

2. *SCANNING PROGRESS: THE STORY OF BARCODES AND THEIR IMPACT ON COMMERCE*

FOCUSING ON THE COMMERCIAL APPLICATIONS OF BARCODES, THIS BOOK PROVIDES A COMPREHENSIVE OVERVIEW OF HOW BARCODES REVOLUTIONIZED INVENTORY CONTROL, PRICING, AND CHECKOUT PROCESSES. IT TRACES THE EVOLUTION FROM SIMPLE LINEAR BARCODES TO MORE COMPLEX SYMBOLOGIES. THE NARRATIVE INCLUDES CASE STUDIES OF MAJOR RETAILERS WHO PIONEERED BARCODE USAGE.

3. *LINE OF CODE: THE LINEAR HISTORY BEHIND BARCODE TECHNOLOGY*

THIS TITLE DELVES INTO THE TECHNICAL AND HISTORICAL ASPECTS OF LINEAR BARCODES, EXPLAINING THEIR DESIGN PRINCIPLES AND ENCODING METHODS. IT COVERS THE TRANSITION FROM MANUAL TRACKING SYSTEMS TO AUTOMATED BARCODE SCANNING, EMPHASIZING THE ENGINEERING CHALLENGES OVERCOME. THE BOOK IS VALUABLE FOR BOTH TECHNOLOGY ENTHUSIASTS AND HISTORIANS.

4. *FROM STRIPES TO DATA: THE EVOLUTION OF BARCODES IN THE DIGITAL AGE*

EXAMINING THE TRANSFORMATION OF BARCODES FROM BASIC BLACK-AND-WHITE LINES TO SOPHISTICATED DIGITAL IDENTIFIERS, THIS BOOK DISCUSSES THE INTEGRATION OF BARCODES WITH EMERGING TECHNOLOGIES LIKE RFID AND QR CODES. IT HIGHLIGHTS HOW BARCODES CONTINUE TO EVOLVE IN THE CONTEXT OF E-COMMERCE AND SMART DEVICES. THE WORK ALSO CONSIDERS FUTURE TRENDS IN AUTOMATIC IDENTIFICATION.

5. *BARCODES AND BEYOND: A LINEAR JOURNEY THROUGH IDENTIFICATION SYSTEMS*

THIS COMPREHENSIVE HISTORY SITUATES BARCODES WITHIN THE BROADER CONTEXT OF IDENTIFICATION TECHNOLOGIES, COMPARING LINEAR BARCODES WITH OTHER AUTOMATIC IDENTIFICATION METHODS. IT PROVIDES A CHRONOLOGICAL ACCOUNT OF THE INVENTION, STANDARDIZATION, AND GLOBAL ADOPTION OF BARCODES. THE BOOK IS RICH WITH ILLUSTRATIONS AND PATENT HISTORIES.

6. *THE LINEAR CODE: BARCODES AND THEIR ROLE IN MODERN INDUSTRY*

FOCUSING ON INDUSTRIAL APPLICATIONS, THIS BOOK DETAILS HOW BARCODES HAVE OPTIMIZED MANUFACTURING, LOGISTICS, AND HEALTHCARE. IT DISCUSSES THE DEVELOPMENT OF LINEAR BARCODE SYMBOLOGIES SUCH AS UPC, CODE 39, AND CODE 128. THE AUTHOR PROVIDES INSIGHTS INTO HOW BARCODES IMPROVE ACCURACY AND EFFICIENCY IN COMPLEX SYSTEMS.

7. DECODING THE STRIPES: A HISTORICAL PERSPECTIVE ON LINEAR BARCODES

THIS NARRATIVE EXAMINES THE CULTURAL AND ECONOMIC IMPACT OF LINEAR BARCODES, TRACING THEIR JOURNEY FROM A SIMPLE IDEA TO A CRITICAL COMPONENT OF GLOBAL COMMERCE. IT EXPLORES THE CHALLENGES FACED DURING ADOPTION AND THE STANDARDIZATION EFFORTS BY INTERNATIONAL ORGANIZATIONS. THE BOOK INCLUDES INTERVIEWS WITH PIONEERS IN BARCODE TECHNOLOGY.

8. BARCODE CHRONICLES: THE LINEAR HISTORY OF AUTOMATED DATA CAPTURE

CHRONICLING THE MILESTONES IN AUTOMATED DATA CAPTURE, THIS BOOK HIGHLIGHTS THE INVENTION AND REFINEMENT OF LINEAR BARCODES. IT EXPLAINS HOW BARCODES ENABLED REAL-TIME DATA COLLECTION AND IMPROVED INVENTORY ACCURACY. THE BOOK ALSO DISCUSSES THE INTERPLAY BETWEEN BARCODE TECHNOLOGY AND COMPUTER SYSTEMS.

9. STRIPED INNOVATION: THE LINEAR HISTORY AND FUTURE OF BARCODES

THIS FORWARD-LOOKING BOOK NOT ONLY REVIEWS THE HISTORICAL DEVELOPMENT OF LINEAR BARCODES BUT ALSO SPECULATES ON THEIR FUTURE ROLE IN IoT AND SMART RETAIL ENVIRONMENTS. IT DISCUSSES INNOVATIONS IN BARCODE SCANNING TECHNOLOGY AND THE INTEGRATION WITH MOBILE DEVICES. THE AUTHOR OFFERS EXPERT PREDICTIONS ON HOW BARCODES WILL CONTINUE TO SHAPE AUTOMATED IDENTIFICATION.

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