Barcodes and RFIDs

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Introduction

One of the key phenomena of the globalization of commerce has been the internationalisation of goods and brands. A set of diverse practices and processes, including the transformation of transport infrastructure and logistics and the virtualisation of money, have enabled both producers (e.g., goods manufacturers) and sellers (e.g., wholesalers, supermarkets) to massively extend supply chains, to globally expand their markets, and to increase their turnover and profits. A key technology in improving the efficiency and productivity of logistical organisation and operation has been development of sophisticated identification systems that overcome the anonymity of manufactured products by assigning unique numerical identifiers – digital thumbprints - to material products. These identification systems allow products to be effectively and unambiguously processed, shipped and traced through complex logistical networks, to monitor sales, aid account management, refine supply chains and inform marketing strategies. Conceptually they have two distinct components, first an agreed allocation of unique id code numbers and, second, an agreed media to physical store the code. The most obvious manifestation of this technology for product identification and tracking are the parallel black and white printed stripes of barcodes.

Barcodes

Barcodes, visible on nearly all, retail products are the physical manifestation of UPCs (Universal Product Code) – a code that uniquely identifies a product regardless of location or language. The original UPC concept can be traced back to 1940s, but gained widespread acceptance and usage in the 1970s with the development of a UPC standard by a group of U.S. retailers and food manufacturers, based on a design by IBM (Brown, 1997; Savir and Laurer, 1975). This standard consisted of two distinct components: the 13 digit code numbering system and the particular barcode design. The resultant barcode system was first used 26th June 1974 in a supermarket in Troy,

Ohio to scan a pack of chewing gum (Morton, 1994). Instead of manually keying in the price of the product being sold, the barcode could be scanned by a laser, automatically looking-up both the product type and the price in a stock database. Working in parallel with the replacement of manual tills by computerised point-of-sales technologies, barcodes quickly became an ubiquitous part of any packaging, and a vital part of logistical organisation and marketing know-how, so much so that by April 1976, some seventy-five percent of goods in U.S. supermarkets had a UPC barcode (Dunlop and Rivkin, 1997). In short, barcodes linked material objects to their virtual representation making them machine-readable and thus facilitated computational efficiency to be bought to bear on production, distribution and sale. Hosoya and Schaefer (2001, 157) thus describe them as the 'bit structures' that organise and synchronise flows, acting as "the mechanism by which the virtual establishes its logic in the real." Today barcodes also appear on nearly all manufactured goods, letters and parcels, and an increasing number of documents. Many large organisations and industrial sectors have developed their own particular form of barcode and protocols for allocating numbers and tracking products (see Dodge and Kitchin, 2005).

Importantly, however, the barcode system only provides a single identification code number, with all other details concerning the object (e.g., product type, date of manufacture, price) being held in an information system. Further, each UPC barcode is unique to a single product class, not to each item being produced and sold. As such, a product barcode lacks granularity – that is discrimination at the item level. For example, every bottle of a particular brand and type of shampoo has the same barcode. Each bottle cannot be uniquely identified. A second major weakness with barcodes is that the product needs to be handled to faciliate line-of-sight scanning. As a consequence, barcodes are being replaced by new smart labels and tags that have finer granularity and can be read remotely and en-mass by radio signals.

Radio Frequency Identification (RFID) tags

RFID tags represent and communicate product information quite differently to barcodes. RFID tags have been developed to provide a means to 'identify any object anywhere automatically'. Each tag consists of a small chip composed of a simple digital circuit into which is embedded a unique identification code with attendant

information, and an antenna which broadcasts the information and can be queried via radio signal at a distance by a reader without handling (Figure 1). RFID systems greatly increase the granularity of product identification to enable individual object recognition.

[Figure 1 here]

The first commercial RFIDs were developed in the 1970s and entered the mainstream in the 1980s with respect to farm animal tagging and transportation transponders. They are still most widely used in vehicle dashboard tags for automatic toll payment (the main system in the U.S. is known as E-ZPass) and in livestock to facilitate "'farm-to-fork' traceability" (Wired News, 2003). Their main application though is likely to be in retail and logistics where their increased granularity is seen as a major advance in inventory management (for example, improving just-in-time logistics and facilitating 'smart-shelving' that is aware of its own stock-levels), to combat shoplifting and staff pilfering, and enhance customer profiling (Ferguson, 2002). Other forecasted uses include household appliances interacting with RFIDs so that microwave ovens check the best cooking settings for ready-meals, washing machines choose the most appropriate cycle for clothing, and medicine cabinets are able to identify out of date or recalled pharmaceuticals. There could also be potential for tracking goods at the end of the life-cycle, alerting waste companies to items containing toxic substances for example. In turn, the many potential, sophisticated uses of RFIDs raise many concerns relating to consumer privacy and individual confidentiality that are beyond the scope of this short entry (see Albrecht and McIntyre, 2005).

In the 1990s a number of RFID standards were developed. The leading standard RFID data standard is Electronic Product Code (EPC), developed by the Auto-ID Center, an industry-sponsored R&D lab at MIT, and now being commercially implemented by EPCglobal Inc. (www.epcglobalinc.org/; a joint venture of the Uniform Code Council and EAN International, the main players in UPC barcode management). The definition of the EPC standard defines a number range large enough to uniquely identify every object on the planet. RFID tags and their EPCs will be part of a global information network providing the means to automatically 'look-

up' details on any tagged object from any location. Borrowing the domain name schema used on the Internet, the EPC network will use a distributed Object Naming Service (ONS) to link each EPC number to an appropriate naming authority database. Importantly, the querying of the ONS by RFID tagged products as they move through supply chains will automatically create a richly-detailed audit trail, including geographic location. The result will be a much greater degree of routine 'machine-to-machine' generated knowledge on the positioning of many millions of physical objects through time and space. In other words, RFIDs will lead to the creation of what Bleecker (2005) terms "blogjects" — 'objects that blog'; that is objects that can interact across distributed networks and which record their histories with respect to other blogjects and databases and thus are searchable and trackable. Over the next few years, it is likely that RFIDs will replace/supplement barcodes on retail packaging and be embedded in all manner of manufactured goods to facilitate asset management, as well as automating access through keyless entry and smoothing the payment process through contactless cards.

Conclusion

Barcodes and RFIDs are everyday and seemingly banal technologies. And yet, by enabling a transfer from manual coding to a standardised, universal identification, and from manual, anonymous data entry to laser scanning and radio identification, over the past thirty years they have had a profound effect upon how production, logistics, and retail are organised and function. As part of larger technical systems barcodes and RFIDs have re-shaped modes of production and the processes of capital accumulation at a variety of scales. As such, their influence on the global processes and everyday practices of logistics and retail should not be underestimated.

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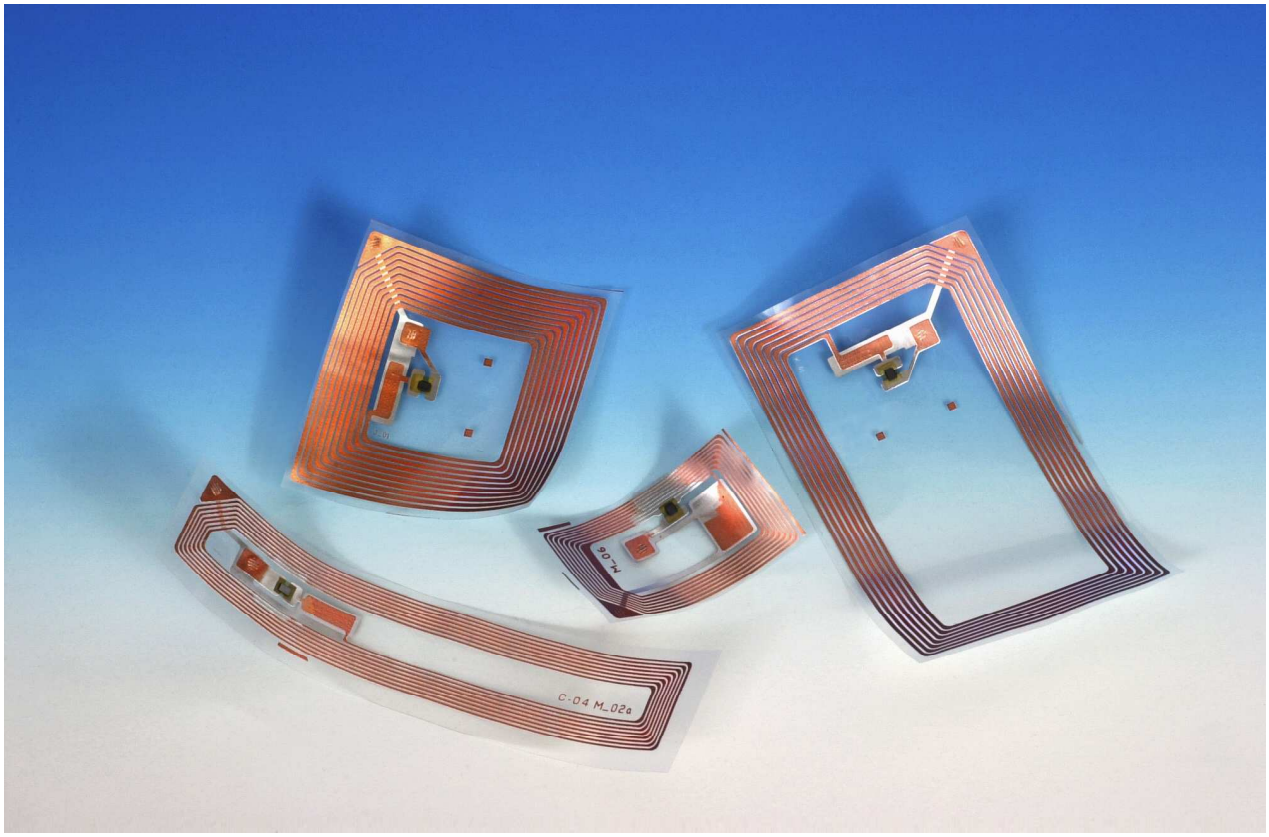

Figure 1: A range of passive RFID tags comprising an antenna linked to a small black chip storing a code number. When the antenna receives an querying radio signal from a reader it replies with this code number. (Source: Texas Instruments, http://www.ti.com/rfid/default.htm.)