

# Product traceability and the RFID revolution

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When the world comprised a series of small, localised communities, product traceability was often inherent. The butcher knew which farmer he had purchased his cow from, and the customer knew which butcher she had purchased her beef joint from. She also knew the tinsmith who made her milk can and the cobbler who made her shoes. Industrialisation changed all this. Shoes started to come from a shoemaking factory in some other town a long way away, and today, if you live in Europe for example, are as or more likely to be made in China or the Philippines. One of the prices paid for industrialisation was a loss of traceability. This was generally considered unimportant so long as product quality seemed acceptable, and tracing product was seen as a bureaucratic luxury that could be avoided in the quest for cost reduction. It turns out, however, that product tracing represents something far greater than bureaucratic luxury.

## The ravages

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The ravages of foot-and-mouth disease, food poisoning, defective car tyres and other car parts, the spread of counterfeit product, concern over the environment leading to swingeing end-of-life disposal regulations, and the final factor - particularly emanating from the US - of fear of terrorism, have changed the game. Product traceability is now 'hot' business, one for which business analysts and technology vendors are still arguing their cases.

The manual paper chain that existed in the earlier generations of industrial society, with rooms full of clerks, is of course inadequate, impractical and cost-inefficient in a complex modern world, and so automatic identification technologies lie inherently at the heart of product traceability. Simple product ID is no longer enough. You need not only to be able to identify the product and who made it, but also the source of its components, and possibly their component part sources, maybe even down to batch number or item number within a batch. And you also need to know what has happened to the product through its lifecycle.

## The use of nanotechnology in product ID and traceability

Over the years, many efforts have been made to achieve product traceability by using information technology (IT). The objectives of these efforts have ranged widely, from those aiming at product lifecycle control, to efforts focusing on the computerisation of transaction and settlement management, improvement of logistics efficiency, advancement of logistics, and rationalisation of production control at plants and factories.

These conventional product traceability methods have largely been based on using one-dimensional barcodes with restricted information volume, as typified by the point-of-sale (PoS) used in retail business. In the past decade the spread of virtual private networks (VPNs) and the Internet have given new capability and life to such systems.

Product traceability needs were achieved by product control measures implemented by industry through the labelling and management of different barcodes in the manufacturing, transportation and distribution stages, according to the flow of products and parts used for manufacturing these products.

In the food supply chain, livestock identification data is conveyed to consumers using slips etc., and can be referenced to databases. In some cases this data can even be accessed by the consumer using the Internet. Even with vegetables, fruits and processed foods, more and more production centres and companies are allowing consumers to access production and manufacturing information from the Internet.

It was the advent in the early 1980s of the high-speed laser printer, enabling printing of barcodes with sequential numbering series, that enabled the birth of true auto ID-based end-to-end traceability through the supply chain. It was pioneered in the UK by the Royal Mail's Trackback system, which innovatively linked this new technique with peel-off 'bullet' labels, obviating the need for the postman to use high-tech barcode-reading equipment that was at that time still very expensive. With postal track-and-trace, sender-consumers are handed receipts indicating the tracking number in exchange for the mail/parcels sent. The same number is printed on the shipping tag in barcode form. This barcode is read at each point in loading, sorting, shipment, unloading etc. to pool information, and allows consumers to track their parcels at all times on the Internet.

Often a pioneer, Japan has, for the four home appliances subject to its Electric Appliance Recycling Law (covering air-conditioners, televisions, refrigerators and washing machines), provided consumers with written documents (called a manifesto) issued by the Home Appliance Recycling Coupon Centre upon collection of home appliances they have disposed of.

This allows consumers to confirm the transferred state of the scrapped home appliances via the database of the Home Appliance Recycling Coupon Centre using the document number.

#### Current trends in product traceability

In recent years, product traceability has undergone massive changes, largely brought about by the barcode, which has by now become pervasive - and by the advent of the Internet. The next stage of capability enhancement is being introduced via the use of radio frequency identification (RFID) systems.

The emerging needs related to product traceability can be functionally summarised in two themes:

- Increased social needs for 'safety' in the broad sense of the word (and including safety of the environment);
- Economical needs seeking stronger corporate competitive strength through 'efficiency' (i.e. increased income/decreased costs).

The development of changes in social needs have meant that the consumer needs to confirm the production centre, manufacturing and distribution records of products purchased, mainly in the areas of meat, fruits and vegetables. Similarly, the producer/vendor needs to reinforce risk management by conducting prompt investigation into causes of food accidents that occur, for example.

In recycling, unmanaged dumping has already led to significant environmental damage. This is mainly confined to the local area, but in the case of CFC gases in refrigerators and freezers, it has caused recordable global harm.

To better manage recycling, certain criteria must be met: to prevent illegal dumping, and to promote environment conservation through recycling; the registration and management of information on materials used during manufacturing; and for clear differentiation of these materials during recycling, detailed lifetime product ID, and traceability of their components must be known.

In the automotive sector, a series of spectacular product recalls for defective tyres, defective engines and defective running gear have led to strict regulations on responsibility and legal liability.

In the medical sector, to achieve thorough and more efficient management of medication to prevent mistaking one patient for another, and to limit the misuse of medical supplies, there is a need for product identification and tracking.

Some cases bridge the two requirements of safety and economy - for example, the need to systemise management of expiry dates of foods so that product past its sell-by date is not on retail shelves. Equally, the economic need is to get the product onto the shelf and sold before it has to be thrown away or heavily discounted.

Similarly bridging safety and economy is the need to prevent the circulation of fake brand name products such as automotive parts and medicines, as well as bags, clothing and other expensive brand name products.

In terms of economy and efficiency, in order to achieve rationalisation and labour saving in manufacture, support of just-in-time (JIT) manufacturing techniques, inspections, inventory control and minimisation is required. Doing so will help efficient tracking of stock quantities of products dispersed in shipping storages and stores, and will promote efficient distribution through the supply chain. It will also place demands for product and component identification and tracking, often through the lifetime of the product.

The goal is to implement thorough customer-oriented marketing by detailed management of products held by consumers and products sold, and to distinguish corporate strategies by quantitative marketing techniques.

## Tasks that still need to be overcome

The technical possibility of traceability through the use of barcodes, RFID, VPN and the Internet is one thing. Realising consistent product traceability across the industrial boundaries of agriculture, transportation, manufacturing, distribution, wholesale, retail, and across the areas governed by regulation, various government departments, and through global supply chains, requires harmonisation and agreement, often even between competitors.

Important tasks here include standardising the interface protocols, technology selection and data and code structure management to allow mutual reading of data. If basic consensus is not acquired on these important issues amongst all involved parties, the risks are high. Unfortunately, many of the major stakeholders choose not to invest in the standardisation process, often because they simply do not understand its relevance to them in the longer-term. This is a particular problem in respect of RFID systems. With a barcode system you only have to structure the code and define the barcode symbology. With RFID, whilst you have to identify the code structures, you also have to define the air interface protocols and the rules for contention management.

In a narrow sense of the phrase, product traceability can be considered as the constant verification of records on the whole product lifecycle process of each product. Figure 1, prepared by the Japan Study Group on Improvement of Product Traceability, shows the requirements along the chain.

### Steps needed to improve product traceability

#### Data standards

Barcode data standards, although endorsed as ISO Standards, are largely managed by EAN.UCC; ISO Standards for the overall architecture of data in RFID systems. EAN now manage EPCglobal. The data definition is still under debate as the ePC scheme did not use, nor take proper account of, the need for application family identifiers (AFIs). This not only took them outside of compliance with the ISO Standards, but also did not adequately address the issue. At this late stage they now have a project team to finalise the issue and take account of AFI.

However, because it inherited the ePC project from Massachusetts Institute of Technology (MIT), EAN has also got itself involved in the technology and interface Standards, and here the situation is even more difficult and unresolved.

#### Interface standards

ISO/IEC SC31 has now finalised, approved and published the ISO/IEC 18000 series of International Standards for item identification using RFID. Standards have been prepared for each of the main frequencies likely to be used for product traceability using RFID. They cover the major frequencies commonly allowed around the world. ISO/IEC 18000-2 covers low frequency systems, ISO/IEC 18000-3 covers systems at 13.56MHz, ISO/IEC 18000-4 covers systems at 2.45GHz, ISO/IEC 18000-6 covers systems at 860-930MHz, ISO/IEC 18000-7 covers systems at 433MHz. The Standards for barcodes have been available for a number of years. In the supply chain UHF systems at 860-930MHz are likely to be used for pallet- and carton-level identification. If RFID becomes used for retail item-level identification it is less clear whether UHF or VHF (13.56MHz) systems will prevail.

The complication comes from EPCglobal/EAN and its inherited solution (the shortcomings of which have been much described in previous issues of Product id) from the MIT Auto-ID Center. This is particularly difficult for EAN.UCC, which has pursued the goal of adequate regulatory regimes for UHF RFID for item identification, holds the Chair of the ISO Committees that have developed the 18000 series of Standards, and indeed sponsored the GTAG protocol resolution project which was the precursor of the ISO/IEC 18000-6 UHF Standard for item identification using RFID. The MIT conception was a simple ID on a tag and a super Internet-based database, and specifications were designed around this concept. When MIT came to finalise the specs it found that their sponsors and clients also expected to carry private data that they would not trust to the super database. This changed the nature of the tag from pre-programmed to read/write (GTAG, because it had started out by asking the customers what they wanted, had made this assumption from an early stage, and hence both variants of the ISO/IEC 18000-6 Standard are read/write). MIT/EPCglobal have both had to redesign and get consensus amongst their technology providers, and still have not completed this process, which will finish up very similar to ISO/IEC 18000-6. However, politics will ensure that it is not quite the same. ISO has approved a work item for an ISO 18000-6 Type C, but it is not yet clear if EPCglobal will co-operate or will continue to try to pursue an IPR protected route.

#### Common efforts

It is important for all parties to undertake product traceability jointly; one company alone is not enough. In practice, companies tend to opt to 'wait and see' and this attitude has to change if the benefits are to be achieved.

Interests in electronic tags etc. are definitely growing stronger in each area. It is therefore hoped that items and directions which need to be standardised at the least will be determined while bearing adequately in mind the need to ensure

flexibility in business development, and that studies and practical applications in all directions will be accelerated (the ISO/IEC 18000 series standards being a significant step in this direction).

As these identifications will often have to cross industries (for example in respect of end-of life provisions, the radio in a car comes from the electronics/electrical component sector, however it spends most of its life in, and is scrapped/recycled in, an automotive environment). Common cross-industry reference models and data concepts are needed.

In the construction of "reference models on management methods of product records information" in each industry, formats must be the same by industry, otherwise mutual referencing will not be easy. The Japanese Study Group on Product Traceability has proposed that group work to the format of the reference model, the output should be standardised, and to acquire ISO certification for this format.

Whilst organisations such as EAN and UCC have performed a valuable service in respect of barcodes, they stand at risk of failing the RFID generation. Also, they are supply chain focused and these issues are wider than just the supply chain. ISO Standards, achieved by the consensus process (with EAN.UCC making significant contribution to that process) will be a better model to follow, so long as ISO can continue to speed up its standardisation process.

Considering future developments, information on efforts to enhance traceability should be shared even between different industries as much as possible. The Japanese Study Group on Product Traceability proposes that the reference models that serve as precedent cases themselves will be constructed by each industry, but it is essential to enable them to be referenced across different industries. Consequently, the Japanese Study Group on Product Traceability proposes that the reference models constructed in each industry should be accumulated in one cross-industrial database, and mechanisms for mutual referencing established.

#### Role of government

If, for safety and environmental reasons, government is passing legislation that requires traceability, it is inadequate for it not to be involved in making solutions to achieve this. This does not mean onerous legislation, but instead stimulation of, participation in or contribution to the process.

Giving the UK example, the Government needs to promote more flexible use of radio wave bands based on the trends of international discussions, rather than seeking to maximise short-term gain by selling off bandwidth allocations.

Information dissemination is not always conveyed accurately to the user. And despite the ever-increasing speed of technological progress, precise information is often not being conveyed to users at all. Government therefore has a role to centrally promote, or financially support, the collation and dissemination of accurate and reliable information to assist the communities that it serves.

It follows that government has a responsibility to promote and support training related to the new technologies to ensure that there is an adequate supply of properly trained competent people. Government should also support the creation of industry institutes/associations to provide levels of qualification and professional standards maintenance.

#### Associated social challenges - privacy

Product records information may at times hold both the name of the producer and the production history. At times, the record of use by individual consumers may be recorded and used for recycling, reuse and quality assurance. In this case, there is a need to clarify specifically under what conditions individual information is held, and there must be an adequate data protection framework in place, including a framework that protects the individual from the government so that future governments may not abuse information to the detriment of some or all of their citizens.

Businesses handling individual information have the responsibility to devise measures for the secure management of individual information. For this reason, when recording information which can identify individuals (such as electronic tags and two-dimensional codes etc.), there is a need to devise adequate security measures beforehand to prevent unauthorised third parties from reading and copying the information.

Consequently, for electronic tags to be accepted by the community confidently, the attachment of individual information itself to economical tags should only be effected where there is both an adequate data protection framework, and there are mutually authenticated security measures (such as RSA or DES) in place, and there is a real need for that information to be stored. Needless to say, records on use by users, which by themselves will not lead to identification of the individual's name, do not constitute individual information and there should be no problems in attaching such information to products. Part of the government's and industry's responsibilities is to provide adequate information so that people are not falsely alarmed by characteristics of the technologies that are not only unachievable, but are often outside of the laws of physics, or are sheer scare stories by interest groups.

## Training and competent system design

In distribution and logistics, an important task in determining economic viability of the use of electronic tags is the minimisation of errors in the reading accuracy of product information, and in the information itself. In particular, where distributors and consumers or other parties use the product records information provided by manufacturers, the authenticity of the information provided, and maintenance and management of the information itself, will become major tasks. This therefore calls for the need for continued review of mechanisms to ensure information reliability based on different purpose of use, and the characteristics of each industry.

## Conclusion

Both commercial and legislative safety and environmental legislation are providing impetus both for product ID and product traceability. This provides several technical and commercial challenges that have still to be addressed. Cost-effective technology solutions are now in reach. Issues such as standardisation and the use of common reference models and data concepts have to be developed further. Clearly industry and commerce have a key role in achieving most product traceability objectives, as do they who stand to gain most. However, governments also have a role, especially as it is they who control and require most of the environmental and safety requirements on behalf of their citizens. Depending on your political standpoint, you may also feel that they have a role to promote the efficiency of trade and commerce in their country.