PRODUCTS TALKING TO ONE ANOTHER

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Executive Summary

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This report is about the GS1 universal product code, its history, and its current and future uses. There are four basic messages:

- to be effective an object language needs to be as universal as possible;
- the most common language – the bar code - has become so ubiquitous that we are not always aware of how effective and important it is;
- RFID (radio frequency identification) systems are to become as pervasive as the bar code or more so; and
- there are further potential uses for a universal object language, including many that are surprising and others that we are not yet aware of.

The GS1 universal product code has already had a profound impact on the way we shop. It seems likely it has generated total cost savings in New Zealand of over a $1 billion annually. Because of fierce retailing competition the benefits accrue to shoppers rather than stores. The savings to each New Zealander are around $280 per year, or over $20 a week for a family of four. Because these savings are the result of a reduction in the resources to provide the product, the gains represent a productivity improvement to the whole economy of over 0.5%.

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Introduction

When two people are talking there is a transmitter (the voice box), a receiver (the ear) and some complex system in the brain to give one's message a meaning to the other. But there is also the language, the code which carries the message.

Objects 'talking' to one another need a similar set of arrangements. The transmitter may be a bar code symbol on an object (or, more recently, a RFID chip), and the receiver a scanner. Both the scanner and the software that drives it are quite complicated and it may seem that the language code for objects to talk to one another is simple by comparison. It is certainly simpler than human language, typically involving a dozen or so digits, represented by a set of bars marked on a label fixed on the product. Yet this language has powerful commercial uses which ultimately reduce costs, increase reliability and visibility, and provide a net benefit to consumers.

The 'talking' between objects is entering a new phase with the introduction of RFID (radio frequency identification) chips which will replace line-of-sight reading of bar codes with rapid, long distance reads down to a lower level of granularity – indeed down to a unique object (an individual can of baked beans, a bottle of pills, a boarding pass etc). The transmitter and the receiver may be changing and the uses may be extending, but the underlying language will remain largely the same with the continued objective of cost reductions and consumer benefit.

What is a Bar Code?

A bar code (or 'barcode') is the small image of lines (bars) and spaces that is affixed to retail store items, identification cards, and postal mail to identify a particular product, person, or location. The code uses a sequence of vertical bars and spaces to represent numbers and other symbols. A bar code symbol typically consists of five parts: a quiet zone, a start character, data characters (including an optional check character), a stop character, and another quiet zone.

A bar code reader is used to read the code. The reader uses a laser beam sensitive to the reflections from the line and space thickness and variation, translating the reflected light into digital data that is transferred to a computer for immediate action or storage. Bar codes and readers are most often seen in supermarkets and retail stores, but many other uses have been found for them.

Note that while the linear form of the bar code is the simplest and most common, other forms which are circular or two dimensional are also used.

GS1 standard bar codes like this appear on grocery items across the world. It is said that at least 5 billion bar codes are read every day.

The History of Bar Codes

Although the first bar code patent was as early as 1952, there did not then exist the cheap scanners and computers which made installation worthwhile. It was not until 1974, in Ohio, that the first retail product was sold using a scanner. (It was a packet of chewing gum, now housed in a Smithsonian Museum in Washington DC.)

The bar code most familiar to us arose in a relatively unusual way. Typically such technologies evolve through a pioneer innovator. This one was developed cooperatively by a group of US grocery retailers. It succeeded because it had to take into consideration their particular and practical needs, and because they were a sufficiently large part of the industry that their decision flowed on to others.

As so often happens with a technology that took years to introduce, its success exceeded expectations. Instead of the projected 10,000 companies – mainly in the US grocery industry – that were expected to use the Universal Product Code (UPC) bar code when it was introduced, 35 years later there are almost two million companies in over one hundred countries identifying their products with a standardised bar code – 4500 in New Zealand alone. So successful has this one bar code been – the GS1-standard EAN-13 – it is now almost universal for packaged goods, for once a manufacturer has to bar code the item for one customer, it is simpler to do it for all.

Why Use a Universal Product Language?

While all humans have voices, ears and brains, they may speak in different languages. A language is an example of an economic network, in which the

unit benefits increase as the number of users increases. (The classic example is a telephone network. The more people hooked up, the more useful it is to those who already have a telephone.)

Just like human languages, a product language works like an economic network and all users of a standardised language benefit more from the more products and parties involved in the network.

Even so, given that scanning equipment, printers and fonts for the creation of bar code symbols are readily obtainable, it is possible, indeed somewhat tempting at times, for a business to invent its own system of bar codes and object identifiers, just as any person or group may invent their own language.

However, once a firm using a proprietary language interacts with other businesses, communication risks becoming unintelligible, costly, imprecise and prone to error.

For instance, some courier firms have their own code; if it becomes necessary to transfer the package to another courier, there has to be some clumsy conversion at the interface. Similarly if an airline uses its own code, any transfer of passenger and baggage to another airline may not go smoothly at the interface.

This is the reason that the grocery retailers and suppliers got together in 1974 to set up a system which is so widely used today that it might be called the 'universal language of products' – the GS1 System. Today, the system is composed of four key pillars:

- Bar codes (used for automatic identification);
- eCom (electronic business messaging allowing automatic electronic transmission of data);
- GDSN (Global Data Synchronisation Network which allows partners to have consistent item data in their systems at the same time);
- EPCglobal (which uses RFID technology to track items).

GS1 is a global organisation which sets global standards for the universal product language. Its system of standards is the most widely used supply chain standards system in the world. It is a not-for-profit federation with its global office in Brussels (Belgium) and Lawrenceville, New Jersey (USA) and locally owned and also not-for-profit Member Organisation offices in 108 countries. GS1 maintains a list of country codes used by member organisations to assign GS1 company prefixes to their member companies enabling them, in turn, to create GS1 Identification Keys. The most common GS1 Identification Key is colloquially known as the 'bar code number'.

Globally, GS1's System is particularly active in the following sectors:

- Retail
- Defence
- Fresh Produce
- Grocery
- Hardware
- Healthcare
- Books & Magazines
- Transport & Logistics
- Liquor

In point-of-sale management, the use of a standardised product language (unique identifiers, messages, bar codes, RFIDs) can provide very detailed up-to-date information on key aspects of the business, enabling decisions to be made much more quickly and with more confidence. These include:

- fast-selling items can be identified quickly and automatically re-ordered to meet consumer demand;

Each year Christchurch-based outdoor clothing and equipment supplier Kathmandu produces and sells over 145 million items around the world. It uses bar codes to reduce the global logistic challenge, with less stock shrinkage and lower inventory levels, a saving in staff time and management headaches.

- slow-selling items can be identified, preventing a build-up of unwanted stock;
- the effects of repositioning a given product within a store can be monitored, allowing fast-moving more profitable items to occupy the best space;
- items may be repriced on the shelf rather then on the product itself to reflect both sale prices and price increases; and
- historical data can be used to predict seasonal fluctuations more accurately.[1]

Besides sales and inventory tracking, identifiers are very useful in shipping, receiving and tracking.

- When a manufacturer packs a box with any given item, a unique identifier can be assigned to the box.

1 – Source: http://www.bsdinfotech.com/barcode.asp

- A relational database can be created to relate the unique identifier to relevant information about the box; such as order number, items packed, quantity packed and final destination.
- The information can be transmitted through a communication system such as Electronic Data Interchange (EDI) so the retailer has the information about a shipment before it arrives.
- Tracking results when shipments are sent to a distribution centre before being forwarded to the final destination.
- When the shipment gets to the final destination, the unique identifier gets scanned, and the store knows where the order came from, what is inside the box and how much to pay the manufacturer.

The (Net) Benefits of Bar Codes

In terms of costs, printing a bar code is trivial; the total cost may be less than a cent. Bar code scanners are now relatively low cost and extremely accurate compared to key stroke-entry – only about one substitution error in 15,000 to 36 trillion characters entered, depending on the type of bar code.

The benefits of bar codes, measured as net cost savings, can be separated into 'hard savings' and 'soft savings'. Hard savings are the net reduction in labour costs at the checkouts and costs from price marking and remarking of individual items. Soft savings come from direct store delivery (DSD) and shrink control, the value of bar code data for data analysis and more efficient replenishment. (There do not seem to be any estimates of the gains to shoppers from taking shorter times through checkouts and more accurate pricing.)

When what was to become the GS1 bar code was under consideration, the estimates of hard savings on sales were 0.77% of sales, while the soft savings were 0.60% (which were discounted by three quarters, because some of the savings would accrue to manufacturers and wholesalers).

It may seem that 0.77% (or 0.92 to 1.37% including soft savings) would be too small to proceed with a new technology. However, the food stores on which the calculations were made typically had margins as low as 17.5% on final sales, so that a 0.77% reduction represents a gain of almost 5% in store productivity. In any case, in a very competitive industry even small gains matter.

In 1998, 25 years after the adoption of the GS1 bar code, a PricewaterhouseCoopers report found hard savings of 2.75% and soft savings of 2.89% of sales.[2] (Substantially bigger gains than initially expected are not unusual for successful technologies.)

Because the gains apply across such a substantial turnover, in total they are substantial. New Zealand's supermarkets, groceries, liquor retailing, hardware and chemist retailing represents an annual turnover of about $20 billion. Allowing that not all of these use GS1 bar codes but offsetting them there are omitted stores in other store types, the total cost savings are over $1 billion annually. Put another way, because benefits accrue to shoppers rather than stores – they occur in fiercely competitive industries – the savings to each New Zealander are around $280 per year, or more than $20 a week for a family of four. Because these savings are the result of a reduction in the resources to provide the product, these gains represent a productivity improvement to the whole economy of over 0.5% per year.

In contrast to languages spoken by humans, a product code is a very utilitarian language. Unlike the spoken languages each with a glorious literature and providing a particular cultural perception of the world, there are rarely significant gains from maintaining a private code.

Although languages are examples of an economic network in which the unit benefits increase as the number of users increases, some firms use an in-house language (identifiers, bar codes). While such choices may suit their current needs, they may face difficulties. As selling their product extends to other (especially big) retailers, they will eventually have to adopt a universal product language. If they combine with another business which uses a different product code, there will be additional costs of merging.

Moreover, it seems likely that the further integration of supply

The GS1-standard Databar type of bar code enables an individual apple to be automatically identified by its type and supplier. Databars are scanned like all other bar codes but require only half the space, making them applicable to small objects (a piece of fruit or something smaller). Larger-sized Databars can carry more data (eg use-by-dates, batch numbers).

2 – **V. Garg, C. Jones & C. Sheedy** *17 Billion Reasons to say Thanks: The 25th Anniversary of the U.P.C and Its Impact on the Grocery Industry.* PricewaterhouseCoopers, 1998.

chains, especially as a result of next generation technologies such as RFIDs, will lead to some convergence and demand for standardisation as shippers and border regulators demand interoperability.

Indeed given the likelihood that there will be major – even revolutionary – changes in supply chain management, it would seem unwise not to adopt the common language that the new technologies will use.

The Next Generation: the Electronic Product Code - Radio Frequency Identification

Bar codes are a form of Automatic Identification and Data Capture (AIDC) technology. It is likely that the next generation of AIDC technology which will replace today's bar codes will be an Electronic Product Code (EPC) in a radio frequency identification (RFID) system. A RFID system identifies objects by storing and remotely retrieving data using devices called RFID tags or transponders. The tag can be applied to or incorporated into a product, animal or person for the purpose of identification and tracking using radio waves. Some tags can be read from several metres away or beyond the line of sight of the reader.

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialised functions. The second is an antenna coupled to a reader for receiving and transmitting the message. A complex system of computers, in the RFID reader itself and in the firm's network and out on the Internet, give the message meaning by working out what item the tag is attached to

RFID tags enlarged. In fact, the silicon chip in the centre of the tag will usually be as small as a grain of sand, and the antenna and label substrate will be between 2 and 10cm in length.

and other key attributes meaningful to trading partners (manufacture date, place of manufacture, product description etc). The series of EPC standards developed by GS1 members worldwide are the next generation language for objects talking to each other.

The first true ancestor of the modern RFID, a passive radio transponder with a memory 'chip', was patented in 1973. There was no 'Day One' for their implementation, but RFIDs began to be used for various purposes in the mid 1990s. These include access control systems (for buildings and cars), passports (New Zealand has used them since 2004 and was only preceded in this regard by Malaysia in 1998), transport payments (from at least 1995 for the RATP in Paris; Wellington's public transport Snapper Card was introduced in 2008), race timing (from 2004), product tracking and inventory systems (recent) and animal identification.

A huge driver of the adoption of RFID globally has been the attention grabbing mandates by large retailers and defense departments worldwide. For example, in January 2005, Wal-Mart required its top 100 suppliers to apply RFID labels to all shipments; the US Department of Defense has a similar requirement.

The ubiquitous use of RFID in supply chain management has yet to be attained. But it seems likely that eventually even small producers will be using RFID tags.

It would seem that RFIDs are going to play a central role in better supply chain management. For the same practical reasons that make the universal product language of GS1 standards attractive in bar codes, most RFIDs will use a universal product language.

There will be exceptions, such as for security reasons. But they also point to another development, an RFID for the individual/customer. Air New Zealand has recently introduced a proprietorial one, but one might imagine a supermarket customer having one acceptable to most stores (say carried on the mobile phone). Perhaps one day the shopping trolley will pass through a gate which will automatically register the products in the basket, and the shopper's RFID. The register will list and sum the sales, apply the discounts and record the loyalty card. All the customer will have to do is authenticate the purchase. In effect the mobile phone (or whatever) may substitute for the credit card.

Similarly RFID type technologies are being introduced to medical practice. The identification bracelet of a hospital patient may have an RFID, as may the medication. The immediate purpose would be to

reduce the likelihood of the wrong medication and the wrong dosage, but ultimately it may have an integral role in the maintenance and updating of patient records.

While such uses are easily conceivable, we cannot rule out many more other uses of a universal product language interacting with RFID. Whether (or when) such opportunities will be implemented is another matter, dependent on the particularities of the circumstances. What we can be sure of is that some opportunities will be taken up.

It is an all too common story. We cannot envisage all the possibilities for a new technology. What this means for an individual business, is that without necessarily adopting the RFID technology yet, it needs to closely follow developments and be ready to adopt when the opportunity is favourable. That means ensuring current systems are prepared. The most obvious one is that any business must be reluctant to use any product language other than the universal product language unless there are very good reasons to do so (and even then it will be wise to maximise the compatibility of the proprietary system with it). The cost of passive RFID tags is expected to fall further.

Supply Chains and the Future

A supply chain or logistics network is the system of organisations, people, technology, activities, information and resources involved in moving a product or service from the supplier to the customer. A closely related process is traceability where those later in the supply chain can identify the history and sources of a product or service.

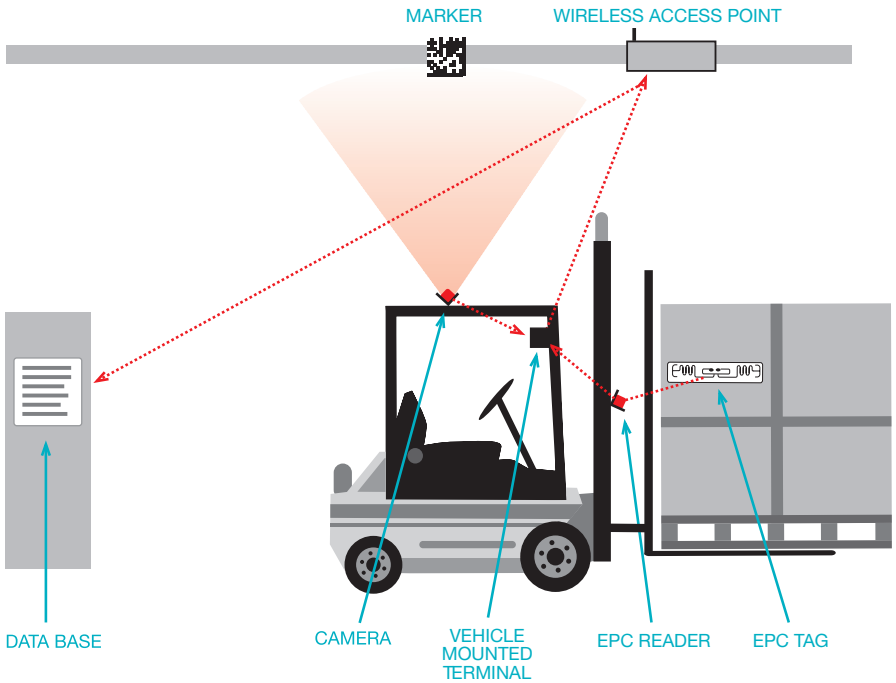
Traceability: It took five months to resolve a 1999 Belgium incident involving dioxin contamination in pork bone fat; with standardised traceability systems it took five days to deal with a repeat in 2006.

Such identifications are becoming increasingly important as consumers become more concerned with environmental, ethical, quality and safety elements of their purchases. Safety is another concern. Traceability increases the speed at which mistakes can be identified and remedied.

Complex supply chains including transport and inventories are increasingly ubiquitous, and their management is a major (and resource-consuming) economic activity. There are strong and continuing pressures on suppliers and retail outlets to reduce the costs involved in any supply chain (including the costs of unnecessarily high inventories). This, of course, reflects the pressures which come from competition, but it is intensified by globalisation, where suppliers seek to penetrate new markets and outlets seek to source from more distant suppliers.

RFIDs will play an important part in supply chain management, because better tracking means smaller inventories, fewer losses, and better customer responses.

EPC/RFID at EastPack



For more efficient management of its kiwifruit flows EastPack (which handles 15% of New Zealand's crop) has adopted RFID with Electronic Product Code (EPC). EastPack applies an EPC tag to each pallet of fruit and tracks this through its cool stores using forklift-equipped readers, a ceiling-mounted bar code system and wireless database connection. EPC/RFID has enabled EastPack to reduce fruit losses and cut by one third its requirement for forklifts. This is the first whole-of-operation application of EPC/RFID in the Asia-Pacific region. It is likely to percolate through the industry as overseas retailers demand GS1 standards.

Conclusion

It is extraordinary how such a revolutionary technology as bar codes has become familiar in a matter of just over 30 years. Today shoppers accept scanning technology as a normal aspect of shopping and do not pause to think about what lies behind it. Some shoppers are even uneasy when other stores – local grocers competing with their supermarket – do not use automatic data capture, and worry about being 'diddled'. They may be unaware of the lower prices which have resulted – more than $20 a week for a family of four – but are, no doubt, grateful for bar codes' contribution to making the weekly spending go further.

Yet the revolution is not at an end. The introduction of EPC/RFIDs will further improve the management of supply chains, with the efficiencies being passed onto the consumer through the process of competition. But it seems likely there will be wider impacts on other aspects of commercial lives.

Both bar codes and EPC/RFIDs involve a language which enables objects to interact in a variety of commercial transactions with the minimum involvement of humans. Commercial logic suggests the fewer languages for cross-business transactions the better. Thus the universal product language of GS1 has a critical role in the cost efficiencies and productivity gains which technologies like bar codes and RFID pursue.

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