Copyright Notice

Published by:

Supply Chain RFID Consulting, LLC.,.
7607 Langley Road
Spring, Texas 77389-5051
U.S.A.

2nd Edition December 2011

ePub Version - ISBN: 978-0-9836560-2-9

eBook conversion by

Supply Chain RFID Consulting, LLC.,.
7607 Langley Road
Spring, Texas 77389-5051
U.S.A.

Acknowledgements

I would like to thank some special people without whose help, encouragement, pioneering spirit and contribution this book may never have come into being.

- **Chris Adcock**, formerly President of EPCglobal Inc.
- **Gay Millson-Whitney**, formerly Director of Standards Development at EPCglobal, now SVP Industry Engagement GS1 US
- **Dr. Ken Traub**, formerly founder of Connecterra and now President of Ken Traub Consulting LLC
- **Didier Chennevau**, formerly VP Supply Chain Americas, HP Printing & Imaging Division
- **Nick Fergusson**, of GS1 Global Office who still manages the relationship with the AutoID Labs
- **Dick Cantwell**, founding and current Chairman of the Board of Governors of EPCglobal
- **Chris D'Orio**, co-founder and Chairman of Impinj, Inc.
- **Dick Lampman**, formerly Senior Vice President and head of HP Labs
- **Salil Pradhan**, formerly CTO for the HP RFID program
- **Robert Gifford**, formerly VP Global Logistics at HP
- **Bernie Hogan**, Senior Vice President and CTO at GS1 US
- **Professor Sanjay Sarma** of MIT and founder of the AutoID Labs consortium around the globe
- **Robin Kidd**, standards representative at Nestlé
- **Mike O'Shea** of Kimberly Clark and **Simon Langford** of Walmart who provided such excellent leadership as the very first Co-Chairs for the EPCglobal Business Action Group

An extra thank you is due to **Gay Milson-Whitney**, who encouraged me more than once to “go and write it all down”!

I owe a special debt to **Ken Traub** and **Robin Kidd** who were kind enough to read through the entire manuscript and provide invaluable insight into errors, inconsistencies, ambiguities and different perspectives of some of the business cases and processes covered. Indeed, in a sense this is as much their work as mine since without their help it would be far less complete than it is.

Thanks also to **Brooke Peterson** of Convene, Inc. for editing the final version and for turning my author’s grammar into something more readable and pleasant to the eye.

And special thanks to **Trisha**, **Jennifer** and **Kirsty Robertson** for their love, tolerance and support during my RFID journey for the last 8 years.

About the Author

Ian Robertson, MBCS, CITP, Cert Mgmt, BSc (Hons) was GS1's Director for Transportation & Other Industry Sectors. He has a long multifaceted background covering IT, Supply Chain and international large scale program management, and was formerly HP's Worldwide Program Director of RFID, having spent 22 years in the HP, Compaq and DEC components of HP. He originates from the UK, but left 21 years ago to gain international experience from living and working in France, Switzerland, Holland, Germany and the USA, and specialises in taking on complex start up situations where the rules have yet to be written and in troubleshooting Supply Chains. He has written various papers on change management within large corporations and consulted for many companies in this respect.

Ian's background in supply chain troubleshooting positioned him well to create the HP RFID program from scratch and drive its implementation into HP's supply chain in 28 sites all over the globe, but particularly in Asia, where he also initiated trials and negotiations with many governments for the allocation of RFID frequencies and operating parameters. He has worked extensively across North America, Europe and Asia Pacific regions.

His pioneering work in RFID included collaboration with Professor Sanjay Sarma from MIT on the concept of using RFID for Electronic Proof Of Delivery and the use of analytics derived from EPC event data to predict supply chain events and reduce the effort and time required to reconcile receiving discrepancies between trading partners. He also promoted the adoption of pallet association and aggregation techniques from the electronics industry by FMCG industries to overcome the limitations of reading tags through difficult materials.

And he wrote the original RFID Cook Book to share his experiences of implementing RFID at HP with others seeking to do the same.

In November 2005 he took up the roles of Global Industry Development Director and of Asia Pacific Regional Director for EPCglobal. In his Asia Pacific role he has consulted on RFID applications and regulations for many governments and major industries. He worked closely with the Apparel, Aerospace & Defense, Automotive and Consumer Electronics industries to form their industry groups within EPCglobal. His collaboration with China contributed to the development and publication of China's UHF RFID regulations. From April 2009 he was responsible for Transportation and Other Sectors for GS1 Global Office. Today he is the founder and CEO of *Supply Chain RFID Consulting LLC*. He is also a graduate of the International Advanced Management Program at INSEAD France, of the UK Open University and a Charter Member of The British Computer Society

Forwards

Professor Sanjay Sarma, MIT

RFID is an exciting technology, but successful adoption is not trivial. There have traditionally been two primary reasons. For years the rallying cries of the Résistance were “the technology needs to improve” and “the costs are too high.” Today, we can safely say that the technology is beyond anything many of us had believed possible a mere 10 years ago. Thanks to the commitment of hundreds of engineers from over a hundred companies, Gen 2 and the EPC suite of standards have killed any vacillations about standards. Read accuracies have become extraordinary; in our lab at MIT, it is often more difficult to prevent a read than it is to actually read a tag. Several companies today sell affordable readers that deliver excellent read ranges. Complex reader systems consisting of technologies such as phased array antennae and have begun to make inroads into hitherto uncharted territories such as warehouses. Tags meanwhile have progressed a great deal – they have become cheaper and smaller, and new tag substrates are making it possible to place tags on the most taboo of materials: metal. Finally, software systems themselves have become easier to install, and cheaper to maintain. Thanks in no small part to standards such as LLRP, erstwhile nightmares of upgrading code to keep track of reader versions, for example, no longer trouble the RFID engineer at night.

In fact further change lies around the corner, offering the hope of lessening the burden of installation costs even more. With the growth of the cloud and the increasing reliability and affordability of networking technologies such as LTE, it is a matter of time before an RFID installation is simple as plugging in a reader at the site, and commissioning it on the web on Amazon EC2, say. No wires, no local servers, no software on-site, and no local network – just two screws and power! If Google can turn a humble printer into a cloud printer, there is no reason why a simple RFID reader cannot work directly off the cloud.

Cost, however, remains a more nettlesome issue. There are several sides to the cost story: component costs, installation costs and – most importantly, benefits, because costs are only relevant through the lens of the benefits they bring. Component costs are not as great an issue today as they were a few years ago. Reader and tag costs have come down a great deal, and, in bulk, are a small portion of total deployment costs (if the deployment strategy is at all thought through!) It is the benefit side of the equation though that is most misunderstood and least leveraged. An RFID deployment may enable certain benefits, but the company must reach out and grab those benefits. This involves a clear articulation of the business case, significant changes to business processes, and often, fundamental changes to the software environment that the system will be deployed in. Often, companies see RFID as a type of "drop in" system that replaces their bar-code scanning system, say. A cross-silo look at all the advantages of RFID tags is necessary to really take advantage of the infrastructure, and to extract all the advantages that RFID has to offer. In "*Improving Supply Chains Using RFID & Standards*", Ian Robertson lays out the areas where RFID could be useful to a typical company. More importantly, though, he explains how to extract value from RFID.

Lessons on technology deployment are best delivered by a veteran. Before he joined EPCglobal, Ian was responsible for some of the most extensive RFID deployments in the world. The deployments he oversaw while he was at HP were exceptional not only in their technical design, but also in the careful consideration of business value for HP. Since joining EPCglobal, Ian has evangelized, guided and coaxed RFID adoption into innumerable industries – from gas cylinders to aerospace. It is no surprise that Ian's coverage of industries and of the different aspects of adoption here is comprehensive, ranging from the automotive to the retail industries, and covering activities ranging from shipping and receiving to warranty and repair. The devil is often in the details, though, and this is especially true with RFID. Ian's explanation of the most unglamorous but important of topics – such as operations – is nothing short of profound. In his usual pithy way, he hits points out all the key issues – saving time counting, for example, or preventing errors. This book is a little treasure and I recommend a careful reading to anyone who wishes to understand RFID and find value in it.

Dr. Sanjay E. Sarma, Massachusetts Institute of Technology

One might think that a book about supply chains and RFID would be a technology primer or a "how to" manual. Ian Robertson's "*Improving Supply Chains Using RFID & Standards*" offers a refreshingly different perspective which is absolutely essential for any business practitioner.

It goes beyond educating the reader about how supply chains and RFID work, offering insight into real business benefits, how to mine them across the value chain and across a variety of use cases. RFID happens to be a technology whose time has come and it is rapidly delivering business benefits across many industries so the timing of this focus on the business aspects is perfect.

This book touches on many key principles for understanding how to apply and benefit from RFID technology. Never start with the technology and ask "what can we do with it" Always start with the strategic priorities of the business and ask "how can we create value." RFID technology then becomes an enabler to help achieve your strategic business goals. But it's a "disruptive" technology that drives both process and management changes which demand some different concepts about how roles in the supply chain are executed. It is a definite challenge to the status quo.

As with any major change, there is also a period of discovery when you don't realise what you don't know, but by testing, observing and learning, new applications are usually uncovered and this is just as true for RFID. To get the greatest benefit one must take a holistic view and understand that supply chains are effectively a group of dynamically networked interdependent processes, so it's the aggregate of benefits across those processes that is key, rather than smaller benefits at specific points in the process chain.

And applying an enabling technology like RFID creates new opportunities for visibility that spans not only those processes but organisations, functions, trading partners and geographies. This super connected world of today can only effectively be managed through that "helicopter view" of business needs, operations, processes and relationships. Supply chains are inherently complex so it is no wonder that the barcode that we take for granted today took over 40 years to become pervasive (and is still evolving today with new applications).

And much of that progress can be attributed to the increasing use of standards within supply chains over the last few decades. GS1, formerly The Uniform Code Council and EAN International, has been providing global standards for supply chain improvement for many decades, and I would like to pay tribute to the GS1/EPCglobal community and to MIT for their respective contributions to these global standards.

In my own RFID journey across several companies and many, many more use cases, I have come to know Ian as a colleague whose considered advice is backed by real knowledge and business experience. With that in mind, I recommend "*Improving Supply Chains Using RFID & Standards"* not as a textbook, but as a roadmap on a journey of discovery and promise.

Dick Cantwell
Vice President, Cisco Systems

Introduction

The original idea for this book came from the need to educate members of the Hewlett Packard (HP) global RFID team back in 2003. The team had only recently been formed and at that time there was very little in the way of passive RFID implemented in most commercial supply chains. Some industries, such as automotive, animal management, road tolls and security had been using RFID for many years but its use was not widely spread to other industries. In 2003 the standard form of passive UHF RFID proposed at MIT by Professor Sanjay Sarma and his team was still in the first generation and its performance limitations, later very successfully overcome with the introduction of EPCglobal Gen2, meant that few companies had ventured beyond pilots and laboratory work into implementation. However, HP went on to pioneer the implementation of RFID in parts of its supply chain and wished to take advantage of this position to offer RFID related services to its customers based upon its own practical experiences.

At this time most emphasis was on the RFID technology that would be used in commercial supply chains, with less emphasis on why it would be used and even less on how. This was not surprising as there were virtually no case studies and associated observations on which to base such material. Understanding how RFID could best be used in supply chains then, as now, requires a good understanding of how supply chains work to begin with. Add the fact that another technology is involved, radio, and the lack of expertise in that subject for most supply chain managers, then you can start to see the reasons that the “why” and “how” weren’t being tackled. And the fact that some early pioneers, such as Walmart, asked suppliers to tag goods delivered to them meant a stronger focus on getting pallets tagged and shipped rather than understanding how the technology could benefit the supplier too.

In explaining this at a conference I stated that the last thing a Walmart supplier should do was to just slap on the tag and ship the pallet to Walmart. Sadly, a journalist in the audience interpreted this as “slap and ship” was all that was required to meet the Walmart “mandate”. In fact neither Walmart, nor any other company that I know of, issued a strict mandate that a supplier would be dropped if they weren’t tagging.

So amongst all of this activity, we realised in the HP RFID Team that perhaps the most important thing to do was to write down why using this technology combined with international standards could provide real benefits in a supply chain. The United States Department of Defense (US DoD) had proven this at a container level for many years through their pioneering use of active RFID technology provided by the equally pioneering Savi Technology Company (now part of Lockheed Martin Corporation). But we were sure that there was even greater potential in using this combination at a pallet, carton and even item level. Costs were still relatively high for readers and tags compared to today’s prices and we knew that not everything that was possible was yet viable financially. At HP we decided that our competitive advantage was to be ready and waiting to go when the financial paradigm finally shifted - and that meant having the cook book ready to be used.

That first small cook book was in reality a stab in the dark by those still in the dark themselves as more was unknown than known at the time. The first cook book was donated to EPCglobal and formed the basis for much of their early work on implementations. But it was, and remains, nowhere near adequate enough for a thorough understanding of the business potential of this technology and standards combination.

So it was time to bring the cook book up to date... but in doing so we decided to concentrate on the business aspects of RFID in supply chains. So this is not a “cook book” in the sense that cook books tell you *how* to cook something, though they don’t tell you what the impact may be on you and your dinner guests of eating what has been cooked. You might think of this book as a menu planner that helps you understand what the beneficial impacts of eating that dinner may be on your business, your supply chain and your customers.

2. Navigating This Book

2.1 Introduction

This book covers many different aspects of using RFID technology, together with global identification and event data exchange standards, within supply chains. This brief chapter is intended to help you navigate through the book and be able to jump to specific subject areas as you wish.

2.2 Chapter 3 - Why Focus on Business Benefits?

This chapter takes a quick look at how things are identified in supply chains today, explains the basic data used to manage and improve supply chains and then explains the basic advantages of RFID technology, global identification standards and global standard event data exchange and how they are used in the context of a supply chain.

This chapter is recommended for those:

- unfamiliar with how items are identified and events recorded in today's supply chains or
- who are new to RFID technology.

2.3 Chapter 4 - Operations Management

This chapter explains the concept of multiple layers of operations management and its reliance on timely, granular and accurate information of events taking place in operations for quality decision making and strategic planning.

It then explains why visibility into operations is absolutely key to having that timely, granular and accurate information and why RFID in particular opens up new possibilities to get that vital visibility.

This chapter is recommended for all readers, as it is essential to an understanding of the significant potential that the RFID and standards combination has for improving strategic and tactical performance in supply chains.

2.4 Chapter 5 - Supply Chain Efficiencies

This chapter starts by emphasising the need to understand current processes before embarking on supply chain improvements and then discusses process time (duration) and how RFID can reduce the amount of physical work undertaken.

It then looks at why RFID can reduce duplication of work and how it can improve process accuracy and help identify unnecessary processes. Next it covers how RFID and standards can help improve warranty & repair operations and ensure that what is being submitted for warranty really is entitled to that service. This is followed by a look at managing part history, essential in industries such as aerospace, and the product returns processes. This will be of particular interest to those seeking overall process efficiencies.

A larger section follows on the wide subject of improving inventory management, with various observations on the problems encountered and how the RFID/standards/event data exchange combination can help reduce inventory issues, write offs and pipeline levels.

The next discussion is on physically extended supply chains and the special problems that such environments can generate. This is of interest to those managing global supply chains where goods are manufactured in one region of the world for sale in another. The use of RFID & Standards to automatically trigger processes and to then monitor performance of those executing those processes and/or providing related services follows next. This will be of interest to those responsible for monitoring and managing service providers such as logistics service providers. You will find two supply chain maps in Appendix B. They are based upon a supply chain for consumer electronics but are generic enough to be representative of supply chains in general. The first map simply shows the major processes mapped out and the second one shows the same environment labelled with sections in this chapter, which refer to each process.

This chapter is recommended for those

- Responsible for inventory management and efficient use of capital,
- Seeking overall process efficiencies, and

- Managing global supply chains where goods are manufactured in one region of the world for sale in another

2.5 Chapter 6 - Retailing

This chapter focuses on processes that take place inside a bricks and mortar retail store. It will be of interest to anyone responsible for any part of retail operations, and the key subject areas are in bold through this text. As the term “retailing” means different things to different people, the chapter begins by offering a definition, which is used for this book. It then tackles store receiving, which although similar to receiving in a warehouse or distribution centre does involve a different environment.

The chapter goes on to look at shelf replenishment, and how improvements can be made to out of stock items (used in this context to mean that there is no stock on the shelf even though it may be elsewhere on the site). Promotions are considered in detail, specifically because of the importance of having the right material and goods on the floor during the planned promotion period - a common issue for many retailers. Next are the opportunities offered by RFID and global identification standards at Point of Sale (POS)/check out. It is interesting to note that these processes were the original driver for the invention of the bar code, which has served the retail industry so well for more than 3 decades.

A key customer consideration is addressed next, providing customers with accurate product information and how RFID can enhance the ability to do so. This is followed by a discussion on the possibilities of radically changing the customer experience in the changing room, including a section on the use of a “magic mirror” to combine information not only on the product being worn but on other complimentary products the customer may wish to buy, a form of automated up-selling.

The next group of sections deal with making sure that the wrong product doesn't go out of the store and equally that only the right products come back. EAS (Electronic Article Surveillance) has used a form of electronic tag for many years to prevent shrinkage (theft) from stores. A comparison is made between traditional EAS systems and those using new forms such as UHF RFID. Next, product recall is examined and the advantages of product serialisation, global identification and event data standards in support of recall. Lastly in this group are the advantages of product serialisation, global identification and RFID technology to ensure the return of only valid products.

The final sections in this chapter start with improving track & trace capability, vital for not only for timely store replenishment but also for customers that have ordered online for delivery to a local store to be able to know if their goods are en route and on time. Next is how RFID can help provide more accurate and timely warranty management to reduce overall warranty provision costs. And the final section takes a very brief look at how to improve the provision of customer specific information. You will find two store layout maps in Appendix B. They are based upon a layout created by Dr. Angela Stanton at Radford University and are generic enough to be representative of store layouts in general. The first map simply shows the generic store layout and the second one shows the same environment labelled with sections in this chapter, which refer to each process.

2.6 Chapter 7 - Asset Management

This chapter highlights how the combination of RFID and global identification standards can be used to tag, track and manage assets within an organisation. It gives examples of fixed assets that remain under the control of the organisation, e.g. computer equipment, and also of assets that may be handed off to another organisation for their use and eventually returned back to the owner, e.g. Returnable Transport Units commonly used in the food and automotive industries.

2.7 Chapter 8 - Counterfeiting et al

This chapter deals briefly with various forms of irregular manufacturing or distribution of products, including counterfeiting, adulteration, over production and market diversion. It then discusses how RFID and standard can help detect, reduce and discourage such practices. It will be of interest to anyone who works to counter these techniques.

2.8 Chapter 9 - Electronic Proof of Delivery (EPOD)

Reconciling what was physically delivered against what was ordered has long been an issue that consumes large amount of effort, time and cost for trading partners. It can also damage trading relationships and destroy trust. This chapter looks at how RFID and identification standards could revolutionise how receiving reconciliation is executed.

2.9 Chapter 10 - Outside of Supply Chain

This chapter briefly looks at uses of RFID and standards outside of supply chains in areas such as road tolls, the automotive industry, animal tracking, the military, passports, libraries, paper file tracking and toys.

2.10 Chapter 11 - The Environment

The environment has risen as a key issue for our countries, societies, governments and organisations. It is generally accepted that actions to reduce, reuse, recycle and correctly dispose of materials used to make products reduce harmful impacts to the environment. This chapter looks at how RFID and standards can help in this effort.

2.11 Chapter 12 - Closed Loop Environments

The final chapter of this book takes a look at “closed loop” supply chains, both from the perspective of suppliers as well as those running the operation. It explains why many supply chains are not completely closed loop and why you might want to still use standards even if yours truly is. If you run a closed loop supply chain then you should definitely read this chapter.

3. Why Focus On Business Benefits?

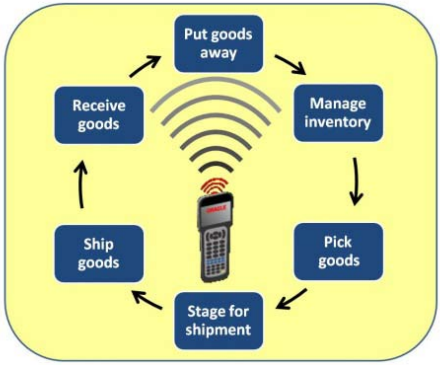
3.1 Introduction

It may seem strange that in a book aimed at understanding RFID technology, and the associated identification standards that enhance it, we are not going to put our focus on either of those subjects. They are both very interesting and very important subjects, and we will get to them, but first we have to tackle the most important subject of all - the business benefits.

RFID is a great enabling technology and having standards to help identify things and places is a great addition to that technology. But standards are only great if used in the correct context of providing benefits to people, companies and even governments. This context, however, can only be understood correctly through an understanding of the basic business processes carried out. It is how this combination of technology and standards can impact these processes, and the resulting benefits that are provided, which forms the key to understanding why anyone would undertake to use this combination in the first place.

Using RFID just for the sake of it, or because it is an exciting technology or even perhaps just because it's interesting, has no real place in the commercial and government supply chains of this global world. It is for this reason that we delve first into those basic business processes and look at how the combination of RFID technology and identification standards can impact those processes in a way which is beneficial not just to those carrying out the processes, but all of the stakeholders involved.

3.2 What Happens Today



Much has been written about the benefits of RFID compared to other methods of automatic identification of objects. The most often stated benefit is that RFID does not require "a line of sight" to be able to identify objects. This is a natural reaction when comparing the physical process of identifying an object with RFID against the more traditional method of doing so with bar codes.

There is nothing inherently wrong with this statement, but if the assessment is left at just this one difference, the hidden RFID/standards of RFID will remain undiscovered and probably unused.

In Appendix A you will find an assessment of the differences between RFID and bar codes. This assessment explains the differences in the technology, but not the differences in how and where they can be applied within operations. Yet, it is this difference which is the key to understanding how to obtain the maximum benefit from implementation of RFID in supply chains and similar operations. In order to better understand this concept we take a practical example to clearly illustrate the differences between what is typically done today and what could be done using this technology.

3.3 What Is On A Pallet?

Imagine an operation where it was very important to know exactly when items were moved from one place to another and precisely where they were moved to. In addition, imagine that these items are quite small with 240 of them on each pallet. With bar codes, if the pallet was moved from one zone of the warehouse to another there would only be one way to be sure that you knew which items had been moved. As it is unlikely that every box on the pallet would present one of its faces to the outside world, it is virtually impossible that the majority of the 240 boxes could not have their bar code scanned without dismantling the pallet.

So you can imagine the scenario where every pallet is stopped at the transition point between zones and broken down and then each box is lined up so that the bar code can be scanned in sequence. The pallet must then be rebuilt, wrapped again, re-labelled and then sent to the next location. This would, of course, take a considerable amount of time and require a lot of human intervention.

Today, most commercial supply chains work around this limitation by logically associating each item on a pallet with the pallet identifier such as a Serial Shipping Container Code (SSCC). In this case it is then only necessary to identify either the pallet, or a single item on the pallet, in order to go and look up the contents and receive all of it by reference. In many cases this is a practical work around, however you must still remember that logically receiving something that isn't physically identified may cause problems in inventory management, potentially leading to stock issues including not having what your customers want to buy or worse having what they do not want to buy.

If we take a warehouse operation for instance, the following are the process points at which identification is typically made:

- Receiving of goods
- Putting the goods away
- Inventory management
- Picking the goods
- Staging for shipment
- Shipment

Importantly, identification is made at these process points not because these are the only points at which it is beneficial to do so, but because these are the points at which it is ***viable*** to do so. As we shall see, the ability to identify items at many more points in the process can be extremely beneficial.

3.4 Improving Supply Chains

There are many different methods and techniques for improving supply chains, and they all have one thing in common: they all depend upon having an accurate picture of what is actually happening in the supply chain. This can only come from knowing where things have been in the supply chain, both physically and in terms of process, and when they were there. Indeed, this is the basic information required not only to improve supply chains but also to manage them on a day-to-day basis.

With this information it is possible to implement such strategic planning activities as planning facilities, capacity, resources, expansion and so on. Just like managing operations itself, strategic planning in support of operations is heavily dependent upon having accurate information about how the operation is being executed at present.

3.5 The Basic Data

Having arrived at the conclusion that knowing where objects are in the process is key, we can further refine this to specifying exactly what form this knowledge must take. That “knowledge” consists of knowing:

- ***What*** the object was
- ***Where*** the object was
- ***When*** it was there

As we have seen, although this knowledge can be acquired by the use of bar codes alone, it can be acquired far more often and accurately, and at many more points in the process, with the use of RFID. By knowing which prior processes a specific object has been through, it is often possible to infer which process is being undertaken at the time the object is identified (*Why* it was there) .

It can even be possible to determine the status of an object from a combination of statuses the object was in during prior processes (*How* it was when it was there). An example is an object, which has been received and is then moved into a temporary storage area for un-reconciled receipts. We can then deduce that it is in that particular storage area because it didn't match any expected receipt record.

This then adds two more elements to that "knowledge":

- ***Why*** it was there
- ***How*** it was - its state or condition

3.6 Advantages: The RFID & Standards Combination

There are many advantages in using the combination of RFID technology and global standards in item identification and for the exchange of information. The sub sections following set out exactly what these advantages are and a series of icons are used in each business use case to indicate which type(s) of advantages can be achieved in each case. Look for the visibility symbol in the right hand margin, which will indicate that the text on the left is relevant to visibility.

3.6.1 The RFID Advantage

Situations in which the RFID Advantage apply

As previously discussed, you can see that RFID enables the accurate and timely capture of where things are and when they are there, at a level of granularity that was simply not viable before. RFID has advantages over other forms of Automatic Identification Data Capture (AIDC) techniques in that it is a more feature-rich technology, as illustrated in Appendix A. These collectively form the RFID advantage. It is interesting to note that RFID does not depend upon identification or data exchange standards to provide benefits, however there are far more benefits available from their combination. It should also be highlighted that RFID has some disadvantages, especially related to cost and infrastructure, compared to other forms of AIDC, and these too are shown in Appendix A.

3.6.2 The Unique Identification Advantage

Situations in which the Unique Identification Advantage apply

Although many industries already provide a unique identity for everything that they produce, it is not the case for all industries. Sometimes, even where an industry does provide such "serialisation", it is in a proprietary form that cannot easily be understood or used by other industries that they may interact with. Being able to uniquely identify an item provides benefits such as being able to track the progress of a specific object through the supply chain processes and using a globally acceptable identifier means being able to do so regardless of which player in the supplier chain happens to have custody of the item at any given point in time or process.

3.6.3 The Visibility Advantage

Situations in which the Visibility Advantage apply

Many industries and companies today would claim to have visibility of what is happening in their operations. Companies such as Fedex, DHL and UPS have grown up on providing precise information on where a package is in the process of being moved from the sender to the recipient of the package. But having visibility depends upon the ability to capture data where something is (track) or was (trace) and then interpret that data correctly. It is the combination of the RFID advantage and Unique Identification advantage that enables capturing this data at many more points in the processes in a standard way that enhances visibility within operations. Add to this the ability to infer the business process being undertaken and you have data that is especially useful to business applications such as monitoring operations performance..

3.6.4 The Data Exchange Advantage

Situations in which the Visibility Advantage apply

Data about events in a company's operations are rarely shared directly and in a standard way with other trading partners. Such data may be available on the company's web site or even available for interrogation via API's (Application

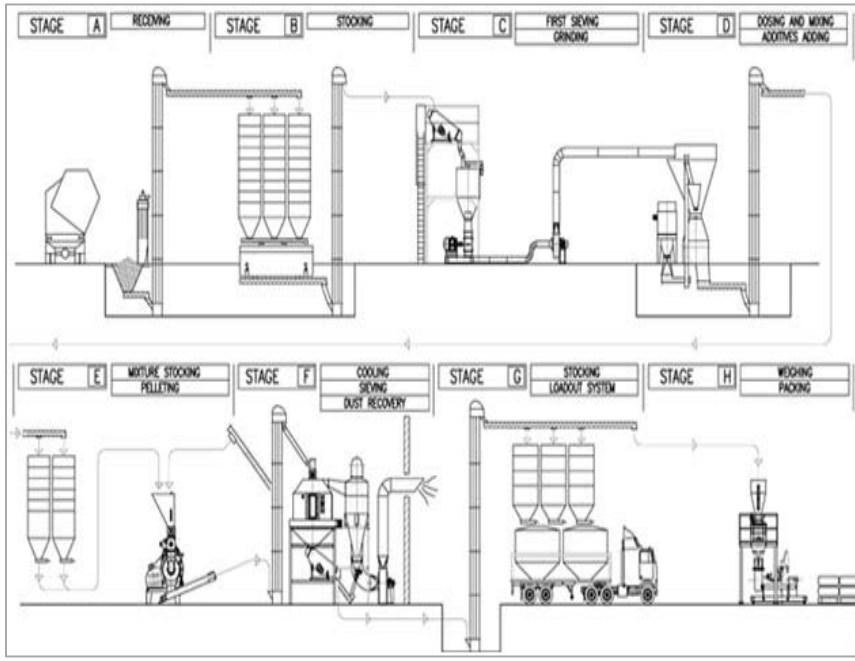
Programming Interfaces), though usually not in a globally standard format. Yet the ability to see what is happening outside of your immediate sphere of control can often be extremely beneficial in managing operations. If some materials in short supply and threatening continued production on your lines are on their way to you, then you need to know that they really are on their way. The EPCIS (Electronic Product Code Information Services) global standards provide for the exchange of event information between any EPCIS compliant system regardless of hardware, operating system or application functionality. And these standards are extensible to accommodate the transfer of private data between trading partners too.

3.7 Understanding These Advantages In Context

So far we have looked briefly at how some processes are done today, at improving supply chains in general terms, the importance of good visibility in supply chains and the various advantages that RFID technology and standards can bring. But before we go on to look at very specific applications within supply chain processes, it will help your understanding if you saw those processes in the overall context of Operations Management. After all, what we seek through these tools is the ability to improve how we manage operations and that won't be clear without a basic understanding of how those processes are layered. The next chapter gives this overview.

4. Operations Management

4.1 What Is Operations Management?



One of the most important aspects of any supply chain is operations management. However, this term is used in many different ways to mean many different things therefore it is worth taking some time to set out what we mean by it in the context of this book. In its simplest form, operations management is managing all of the processes required to accept the input into your operation and the conversion into the output, which you then sell or deliver. It also includes the management of resources, such as equipment, services and people necessary for the completion of those processes.

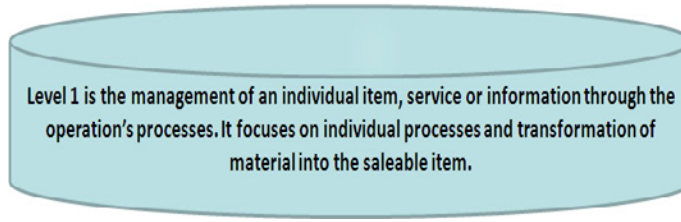
But this “management” is not quite so simple and in reality takes place at three different levels. These levels are not only related, but are intricately connected and depend upon each other as you add layer upon layer. That is already beginning to sound a bit complicated, so let’s move on and expose each of these levels, together with their characteristics and purpose, one by one.

4.1.1 Transaction/Item Level

In essence, this lies at the heart of any operation. It is the process of manufacturing, converting, repairing, servicing or otherwise processing an individual item through the operation. For example, in the automotive industry this could be the manufacturing of a single vehicle through the plant and then shipped on to the dealer. For an electronics repair operation, it could be the whole process of receiving a PC for repair, its initial assessment, the repair process itself, and the repackaging and final shipment back to the customer. The focus here is firmly on individual items and their progress through all necessary processes within the operation.

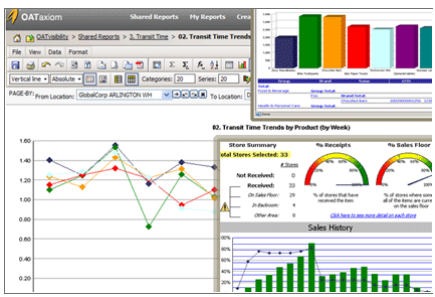
If you have visibility of where the item is now and where it has been, this helps you to track progress of that item, know that it is on time, spot irregularities (such as delays or counterfeits entering the system) and take corrective action very quickly. This is simply good practice for ensuring overall performance and customer satisfaction but it is not just what is going out that needs to be tracked accurately. For instance, in the case of incoming material it is very important to ensure operations do not come to a halt because of material shortages. Even once individual items have been completed it is very likely that they will need to be packaged before shipment. But if there’s no packaging, those finished items will sit there until the packaging is available. You can see from this that having visibility of what is going on, of what is moving where and what remains where, is a vital component of being able to manage this layer of operations efficiently and effectively.

In the above scenario RFID enables you to see much more accurately where things are more frequently and at a much lower level of granularity than you could before. Most operations today already have some form of visibility of their processes. Perhaps the most familiar are courier companies, such as FedEx, with very sophisticated tracking systems which customers can access via the web. Fedex are only able to provide this information because it was already captured during their processes. So with RFID we aren't really talking about providing something that wasn't there before, but instead we are talking about a vastly improved method for capturing the data that is then fed into such systems. And thanks to standards such as EPCIS, which is covered further in this book, the data can be exchanged between trading partners.



This ability to gather data about things, such as where they were when, in a manner that is much more accurate, frequent and granular, is at the heart of that improved visibility and forms the basis of what follows. It is what most people think of when you say 'visibility', but from a benefits perspective, it really is just the tip of the iceberg.

4.1.2 Operational Level

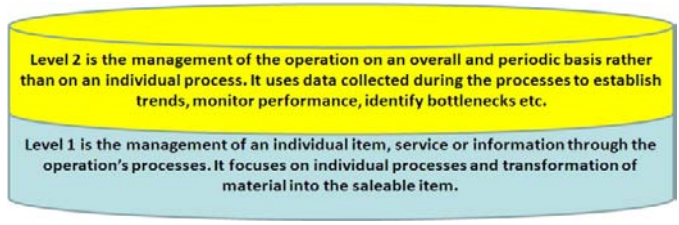


At the operations level we have quite literally risen above thinking about the processes that progress in item through the operation. In fact, let's take that analogy one step further. Imagine that somehow you have floated up of the factory floor and you are now looking down through the transparent roof. In essence, at this level you are really more concerned with overall performance of the operation. By this I mean periodic Key Performance Indicators (KPI's) such as number of items manufactured, failure rates, processing times, comparison

between like operations, consistency of inbound material delivery, vendor performance, etc. Questions such as: Has my Logistics Services Provider (LSP) put away receipts within the agreed service level agreement? Am I running with too much inventory? Are my finished goods getting out in good time? So, basically I take an overall view of what is happening. I am not focused on visibility of an individual item or transaction, but I am keenly interested in such data being accurate and timely because it forms the basis of the trends, summaries and comparisons that I need to manage operations well.

The keyword in managing at this level is “trends” as it tells both what has happened in summary and provides a reasonable indication - though not a perfect one - of what is likely to happen in the future. It is these operational statistics and trends that are used to monitor performance, to make commitments to customers, to decide on inventory levels, and to set the targets, replenishment points, scheduled time for the use of lines and equipment, contract resource levels, etc. But the key thing about trends is that they are made up of the underlying data of individual events, which means that they can only be as accurate as the underlying data.

One of the reasons that many operations run today at sub-optimal levels is the quality of the underlying information upon which the operational reporting is based. An example of this is with a divisional CIO at a large European manufacturing company. Asked if she could tell when a pallet of parts had arrived in their warehouse yesterday, she was sure that their SAP system would tell her that information. She was convinced that this was the case until it was pointed out that SAP would only tell her when that pallet was scanned, but not when it had physically arrived. A clever logistics service provider could easily delay scanning receipts until they know that they will meet the put away requirement. You can see that our ‘knowledge’ of what is happening in operations can be quite different from what is actually happening.



RFID technology, and identification standard data and the means to easily exchange that data in a standard way, can vastly improve the quality and availability of this operational management data. That means getting a much better view of what is happening (e.g. trends, choke points, early warning of degradation) providing key information, which enables you to improve operations. Simply, putting much better data into the management reporting system is likely to result in much better decisions being made. The most important point to make about data at the operational level is that its quality is totally dependent upon the quality of the individual data it is made up from. An operation that is managed based on poor quality and infrequent data is going to be poorly managed, no matter how good the manager might be, simply because that manager doesn't have the right information upon which to base his decisions.

4.1.3 Management/Strategic Level

In the management/strategic level we take long term view of what is happening, such as facilities planning, vendor selection, financial planning, contract renewal, outsourcing decisions, labour planning, systems capabilities, and so on. In effect, this is where the longer term and strategic planning for the operation takes place. It impacts many things such as overall capacity, financial investment, facilities, vendor contracts, human resources planning and even something as fundamental as when to build a new factory.

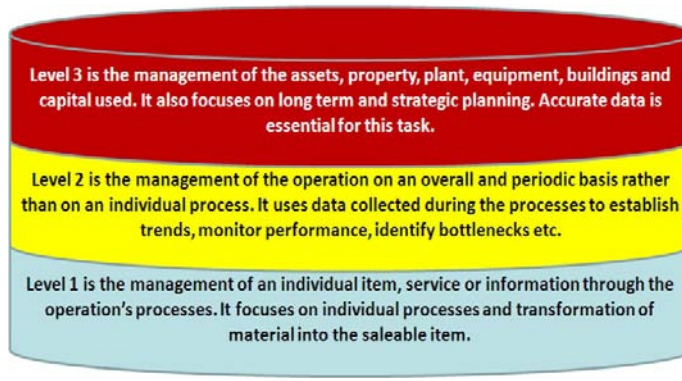
For instance, if you can see that a service provider is on a regular basis not meeting the Service Level Agreement (SLA), then you are probably not going to renew his contract. If you can see that the current physical flows impede good performance, then you will consider new facilities or even a new layout in the existing ones. If you can see ways to run with less pipeline inventory, then you can free up some capital for other uses. Again we are not looking at individual items or transactions but their data forms the basis for all decision-making.

To illustrate the nature of this level let's take an example that is perhaps a little radical, but which at the same time is faced periodically by all operations, the issue of when to expand capacity and capabilities. Imagine that your operation is currently running at 75% of its planned maximum throughput (i.e. the time for material, part, or subassembly to pass though the manufacturing process). It is time to think about expanding that capacity (yes, don't wait until it is 90% or it may take more time than you really have to arrange that expansion!).

Let's assume then that you have decided to build your new factory alongside the existing one and that it will effectively double your overall capacity. From the day you engage the architect even just to design a new factory you have started to make capital investments in order to get that increased capacity. By the time that shiny new factory is ready for you to move some operations into you have probably racked up a sizeable capital expenditure that must now somehow be recovered. Even if the land the factory is built on might appreciate in the future, the equipment that you feed the factory with is unlikely to. This enlarged capital expenditure must be recovered through the sales of the items that you manufacture.

It is very unlikely that in the period in between your throughput for the whole operation will have doubled as well. Indeed it is more likely that it will have gone up by only a fraction of the additional capacity now available. So, those capital investments, much larger than they used to be, must now be recouped in the form of overhead from an only slightly larger operations throughput. This means that you have just increased the overhead charge on every item that you make. This is the reason why many companies dread having to expand capacity in this way, and any opportunity to delay the need to extend capacity would probably be most warmly welcomed.

RFID technology, used in combination with identification standards is not a silver bullet that you can pull out of a drawer to avoid expansion. However, in preceding sections of this chapter we have shown many instances where this combination can be effectively used to speed up the processing of items through your operation. In other words, you can achieve increased supply chain velocity. That also means that you can process more items through your operation in a given time than you could before, which effectively increases your maximum throughput. This in turn could delay the point at which you have to expand. Let's not forget the source of the data and information that is used to manage at this level. It is the accumulated trends, performance reports and other reports from the operational level. The quality of management information systems and the decision taking at this level are totally dependent upon the quality of those reports from the operational level.



4.2 Visibility Is Key

4.2.1 Actionable Visibility

Having the right information is the absolute key to managing and improving operations, but you can also see that in turn the key to having the right information is the ability to know the three basic elements of a supply chain event:

- ***What*** something was
- ***Where*** it was
- ***When*** it was there

Visibility in itself is not the key to understanding and improving operations and supply chains. However, it *is* the key to all the methods and techniques that are themselves key to understanding and improving operations and supply chains. We make this distinction to emphasise the point that having visibility on its own is not enough. As we said at the beginning of this chapter you have to be able to put that visibility into context and to know what to do with it and how it can provide this key information.

Dick Cantwell, Vice President at Gillette termed this having *"actionable visibility"* when discussing Gillette's program to pilot the use of RFID technology. By that he meant visibility that enabled you to take action to improve something and he stressed that having visibility that you did nothing with was just like having any other excellent business tool that you did nothing with - useless.

We have also touched in the previous chapter on two other elements that can greatly enhance the ability to take the right action in operations:

- ***Why*** something was were it was - can often be inferred from prior processes and current location
- ***How*** it was - its state or condition, via sensors or inferred from prior process and current location

On visibility, it is absolutely vital that it is combined with other knowledge and expertise, so you to take full advantage of it. Visibility gives you data that can be transformed into business intelligence, which you can use to monitor and improve your operations.

Getting that data and then not doing anything with it is like buying a brand new car and just leaving it in your garage. Improving supply chains consists mostly of identifying problems and fixing them. Sometimes that is easy and sometimes it is hard, but for the problems that you can't see and don't know about, it is impossible.

After all, you can only fix what you know about

4.2.2 Why RFID?

RFID did not suddenly give the world visibility. Fedex, DHL, TNT and UPS have all run extremely successful track & trace systems and processes for decades based upon the use of bar codes to identify packages and know where they were and when they were there. Indeed, at the time it was this ability to let the customer know where the shipment was in the overall process that differentiated these package courier services from the nation postal services. That capability was built upon the ability to read the bar code attached on top of the package to know what, where & when. In addition, many companies also run there own track and trace systems to cover the process stages that do not take place with the package carrier. Some have even integrated access to the package carrier's system into their own system, to provide a complete track & trace from customer order to delivery. For example, Amazon.com will tell you if your order is in the queue for picking as well as where it is in the delivery process.

What RFID provides is an enhanced ability to identify the item being processed or transported and capture that event data. It is very important to understand that RFID on its own will not provide you with any ability to track where something is or trace where it has been, only track and trace system can do that. Think of them as a sausage machine and you realise that RFID enables you to feed it with better meat than before!

4.3 Process Improvements

We implied above that the use of RFID would enable us to make improvements in our supply chain. "Improving" a supply chain often means changing the processes that are executed in order to gain one or more types of advantages. The next chapter explores this in more detail.

5. Supply Chain Efficiencies

5.1 Understanding Current Processes

As we briefly outlined in the section Improving Supply Chains, the secret to improving any process is to know what is going on inside that process. However, you can only do this if you already have an understanding of the process to begin with. When processes are first designed, there is logic to them and they set out to take an input and convert it to the output of that process. Sometimes the input and output are physical things as in the case of manufacturing, or they can be logical things such as ideas, concepts or intellectual property. In either case there always are three elements:

- One or more inputs into the process.
- The process itself, which is carried out.
- One or more outputs of the process (which often become input to subsequent processes in sequence).

In addition, there can be rules and data about the process which do not form part of the process itself but which influence when and/or how it is executed, including:

- Who executes the process.
- How long it should take.
- What should be done if the process fails.
- What is the next process.

While the RFID/EPCglobal combination can provide many benefits for process improvement, this will be difficult to achieve unless you have a clear and detailed understanding of your current processes in the terms set out above.

This is usually achieved by simply mapping out the processes that you use. You may find that your company already has its processes mapped out, particularly if they are ISO 9002 certified (it is a condition of that certification). If so, this will be a great help but it's probably wise not to just assume that these maps are up to date. A quick check against what actually happens in the operation could save considerable problems in the future.

If you do not have your processes mapped out then we suggest that you do go ahead and complete this. You may feel reluctant to do so and that is understandable as doing this from scratch in an existing operation is no small task. It will take time, persistence and an eye for detail. You will also need the cooperation of the people who undertake the process on the ground in the operation itself. There is no real substitute for doing this as documenting processes without actually seeing them will seem like a great shortcut until you discover those variances between what is "officially" done and what is done in practice. If you engage those who use the processes and make it clear that you value their expert input, you will have brought some key players on to your side. And later on, you might benefit greatly from including some of them on your team.

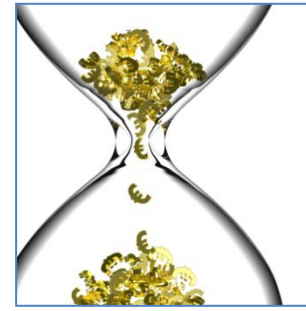
One small but advantageous by-product of doing this is the possibility that you get suggestions for process improvements that have nothing to do with RFID or EPC standards. One global company found many such opportunities just because they validated how the work was being done against some rather old process maps, which had clearly gone out of date some time before. Once you have a good understanding of your processes you are ready to see where the combination of technology and standards can help you refine and improve them.

5.2 Process Time

Tempus fugit is a phrase that can still be found on some clocks that mimic styles from the 19th century. It literally translates to "time flies" and it often seems to do just that when we are immersed in the bowels of processes, operations, targets and day-to-day issues.

But since “Time Is Money” is also true, then the time taken by our processes assumes some real significance. Why is time so important and why is it “Money”? The answer lies in what is happening as each and every second ticks away:

- The **people** you have employed will expect compensation and that reward is generally related to the amount of that time they have given you.
- The **materials** that you are processing had to be paid for. If you paid for them then you either used your own money losing the opportunity to use it for something else (“opportunity cost”) or you borrowed someone else’s money, in which case you’re paying interest to them for the privilege. The cost to use any of that money is directly related to how long you use it for, which in turn is related to how long your processes take.



- If you have given **commitments** to your customers that you will deliver something to them at a certain point in time, then you would want to do just that or customers will think you are unreliable. The longer your processes take, the greater the chance that something will occur which will prevent you from meeting your commitment.
- The **equipment** that you may be using in the processes also had to be paid for and in the same way that you paid for your materials. That equipment has to earn its keep and its depreciation is written off against whatever you use it for. Shorter processes mean putting a higher volume through such equipment, which in turn means less capital overhead being allocated to each unit.
- The same principle applies to **buildings and facilities** used in your operation. Reducing process time often means that a higher volume can be processed through a facility in the same time period. This can delay the point at which you need to commission new facilities, something which usually has a large impact on the bottom line.

You can see that there are some distinct advantages to executing processes in less time (often referred to as “increasing supply chain velocity”). RFID can help you achieve this in many different ways as described in the rest of this chapter.

5.3 Physical Activity Reduction

The first step is to take less time for the physical process itself. This is particularly the case where the processes involve steps to identify an item used within the physical process. An example of this would be loading a container or truck in a warehouse. If you wanted to verify that all 100 cartons on a pallet were present (they might be high value goods) then using bar codes you would need to scan each label using a handheld scanner. With experts carrying out this process this could be done quite quickly in relative terms, perhaps just a couple of minutes, but during that time the pallet would need to be stationary. The impact of this can be mitigated to some extent by scanning one pallet while the previous one is being loaded, but this depends upon the amount of space available and will still create a noticeable delay.

RFID can remove the need to scan all labels, or to stop the flow of the pallet at all. It will, however, depend upon the material on the pallet, as radio waves will not always penetrate all material (it depends upon the frequency and mode being used).

This technique works extremely well when there is a label (containing a tag) on the outside faces of the pallet for all items as there will not be any difficult material between the tag and the reader. So the elimination of the requirement to stop the pallet and scan every label can save considerable time.

5.4 On Board Data

Bar codes have advanced greatly in the last decade and it is now possible to store much more data on them than was previously possible, especially using standards such as DataBar. However, RFID tags can carry an order of magnitude more data than bar codes can. Even so, one has to be careful about how this capability is incorporated into your processes. If the object is moving then it will only be within range of the RFID reader for a specific and generally limited amount of time. And generally speaking, the frequency you are using will determine the speed at which you can get data to and from the tag.

Having data on the tag beyond that which is necessary to identify the item doesn't suit all industries or applications. Such tags do cost more, though for small amounts of additional memory that cost is small, relative to the overall cost of the tag. But having access to such "on board" data can often save time in a process as it is not necessary to be linked to some central system to retrieve the data that you need. This is also useful in circumstances where the central system may not be available. This can be very useful, for instance, where a third party rather than the original equipment manufacturer are providing a product warranty and/or repair service. The manufacturer may not want to grant access to their warranty database so the warranty entitlement data could be carried on the tag.

5.5 Rework Reduction

RFID based processes tend to be more accurate than bar code based processes. This is not the fault of bar code technology, as it is the human element that causes the issues. Take the example where a pallet is scanned before loading on to the truck. The scan told you that the pallet was at a certain position at a certain point in time.

It told you that the pallet was staged for shipping; however it cannot tell you that the pallet was definitely loaded onto that truck. The pallet could still be loaded onto the wrong truck, yet the "system" considers that it was put on the right one.

With RFID it's possible to minimise the chances of this type of error occurring. In this example positioning RFID antennas at the entrance to the truck would indicate whether or not the goods had indeed been loaded. Some trucking companies are fitting their trucks with readers for this very purpose – and of course the reader can detect if the goods are being removed from the truck, too! And readers are getting smarter, too, with some now adding the capability to determine the direction of the tag's motion as well as proximity.

5.6 Process Accuracy

When we talk about process accuracy, it is tempting to always think in terms of the supply chain. But as we shall see in the examples below, there are many instances in life where RFID can provide important benefits outside the office, factory or warehouse environment. Accurate processes are not just a means to less costly and more efficient supply chains, they can mean the difference between life and death. But we will start with a relatively simple benefit.

Whenever material or an item have to be stored, whether it is for short or long periods of time, it is important that they are put in the correct location. Actually, it's not really that important until such time as you need the item again and you go to the location where you think it is. So, "correct location" in this context means in the same location as the system managing the operation thinks the item should be. If this is not the case then, when you do finally go to that location to pick the item, you will be disappointed as it will not be there. RFID can be set up to detect what the item is and which location it is being put into and to raise an alarm if it is in the wrong place. An EPCglobal/GS1[1] standard can be

[1]Full details of GS1 standards can be found at www.gs1.org and EPCglobal standards at www.epcglobalinc.org

used to describe both the item itself and the location it is in.

It is possible to get into trouble long before an item is going to be put away. Imagine a scenario where two incompatible hazardous substances are brought together accidentally. There are some materials that will cause a very dangerous chemical reaction when mixed or even being in close proximity of each other. The ability to automatically identify accurately and quickly the substances involved, means that it is possible to raise the alarm to get them separated.

Sometimes it is equally important to make sure that the correct items are brought together. An example of this is component-based manufacturing where components or sub-assemblies are combined to produce the end product. Most computers and automobiles are manufactured using this method for instance. It is the standardisation of these components that has promoted the risk of using the wrong one in the assembly.

Let us stay with manufacturing of a computer to give an example of this concept in action. Computer disks today are physically within a standard range of sizes, but discs of the same physical size can vary greatly in their storage capacity and even rotational speed. So relying upon the physical form of a component is not an accurate method of making sure that the right component is being used. It is necessary to identify the exact type of component that is being included in the assembly.

Previously this was done by scanning a bar code on the component, which means either lining up a bar code scanner

with a bar code on the component or positioning the component correctly underneath a bench scanner. Both methods take quite a lot of time relative to the speed assembly. And if there are many components to be assembled, as there might be in the case of say server memory, this can take considerable time.

For serialised products, it is also necessary to scan the serial number bar code. Yet, RFID can eliminate all bar code scanning completely. Components can be identified, verified as being the correct unit, and have their serial numbers captured simply by bringing the component into the proximity of the workstation on the bench. All of this is automatic, accurate and very quick.

So far we have focused on bringing the right things together or not bringing the wrong things together. But let's look at the case where it is vital that the wrong process is not carried out on the right object or that the right process is not carried out on the wrong object. Think of hospital patients who are scheduled for the administration of controlled drugs or perhaps are due for a serious operative procedure. If you are that patient, clearly you would want to make sure that you are being given the right drugs or that your operation is the one that you are supposed to have. In the United Kingdom in 2005 a 53-year-old woman did not need the mastectomy that she underwent. The hospital had mixed up the biopsy tissues from two patients. In this instance, tagging of the samples may well have avoided this tragedy.

Identifying the patient could also mean being able to verify that it is the correct patient being wheeled into the operating theatre. Once there, the tagged blood bags would ensure that only blood of the right group is being given to the patient.

It is often possible within supply chains to establish that certain processes should take a certain amount of time. Indeed, there are instances where it is desirable to ensure that any deviation from timing is detected as early as possible so that action can be taken. Take the example of a truckload of valuable items embarking upon a journey that should take 14 hours. We would like to know if that truck deviates from its route-timing. It is possible to use a combination RFID to identify the truck, GPS to establish its position on earth and some form of communications to transmit the information back to a control point.

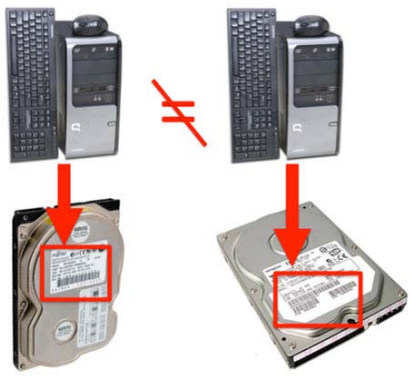
All of the above are examples where RFID and global standards, sometimes coupled with other technologies, are being used to greatly improve process accuracy. There are many more examples in life but in general it helps to know what something was, where it was, and when it was there, and RFID and global standards are a good combination to provide that.

5.7 Unnecessary Processes

Just as RFID can help make processes more efficient and accurate, it can also help to indicate where processes may not be needed at all. Some processes exist because of a basic lack of trust in the processes before them. Imagine a scenario in a warehouse that was receiving goods from the manufacturing plant next door. Two different companies were involved, the manufacturer and the logistics service provider managing the warehouse. As completed pallets moved along a conveyor joining the two buildings, people stood by ready to protect the interests of the individual company that they worked for. They took it in turn to scan everything on every pallet and their work was an exact duplication of what the other was doing.

However, once RFID was implemented into this operation no one needed to scan anything on the pallet and everyone accepted that the system would detect which items on which pallets had passed from one company to the other at exactly what time. The identification of the items originally done with bar codes meant the parties did not trust the other party to accurately record what was passing. They were, however, willing to trust a fully automated physical process which both of their logical systems could access. This is in addition to the benefit of no longer having to have two resources scan bar codes while the pallets were stopped.

5.8 Warranty & Repair



Warranty & Repair are two terms that are often used together and share something in common. However, in this context they refer to two different situations from the perspective of the customer, retailer and manufacturer. Warranty is the provision of repair services for which the customer does not pay. The cost of warranty is usually borne by the manufacturer,

however it is necessary to confirm that the customer is actually entitled to warranty services for the product to be repaired (warranty entitlement). Warranties also come with differing levels of repair, service to repair and periods within which warranty may be claimed. Therefore, it is important that the precise terms and conditions of the warranty are understood and can be confirmed before any work is undertaken.

The traditional method for achieving this was for the customer to be given a warranty certificate at the time of purchase and producing it at the time of claiming warranty service. In some industries this may also be supplemented by the ability to look up the warranty details by reference from the unit serial number. This latter method works well when manufacturers provide their own warranty service as they have details of their own records, however as this work is increasingly contracted out to third parties, this becomes far less convenient.

RFID can help to make this whole process both more effective and more efficient by carrying the warranty details on the product itself. Clearly, these details need to be protected in some way against unauthorised changes, but there are techniques available today to ensure the integrity of this data in the same way that such techniques protect the data held on disk in the manufacturer's records.

There is another aspect of warranty that is perhaps far more interesting and although not openly spoken about, is far more of a problem for those providing warranty services. Imagine a scenario where a company owns two identical PCs and that the disk drive in one of them fails. That machine is not under warranty but the other one is. It's a simple matter to swap drives in the machines and then make a warranty call for the machine that now contains a different disk drive to the one that was sold with it. The disk drive in that the machine is not under warranty but the warranty check will be done only at the PC serial number level. The manufacturer has now provided warranty on a component that was no longer under warranty.

There is already work underway, looking at the technique of storing the full configuration of such a unit on its RFID tag at the time of manufacture. This is commonly referred to as the "DNA tag" of the machine. It is then a simple process for whoever is providing warranty to read the DNA of the machine and to verify that all of the components that are being submitted under warranty are entitled to that service.

The clear link between warranty and repair is that warranty service would normally include some form of repair. Indeed, it can sometimes be useful to know what the original configuration of something was in order to diagnose possible root causes of the problems being experienced.

So you can see that the concept of the DNA tag can be very useful for the repair process as well. This concept can also be extended to indicating versions of firmware or software in electronics products and even for variations of the same part number.

In some industries the same physical part has a different reference for warranty and repair services than the one used for the original sale. This is a technique invoked to ensure that parts that have already been used or serviced are not used in the manufacturing process for new products. Sometimes for the repair process it is necessary to know not only what the original part was that was configured, but what the replacement part is as well. This is another important piece of data, which could be carried on the DNA tag.

In other industries the repair process is effectively a “refurbishment” process. Refurbishment can be required, either because something has gone wrong and needs repair, or because it has succeeded specific service parameters. This is explained in more detail in the next section.

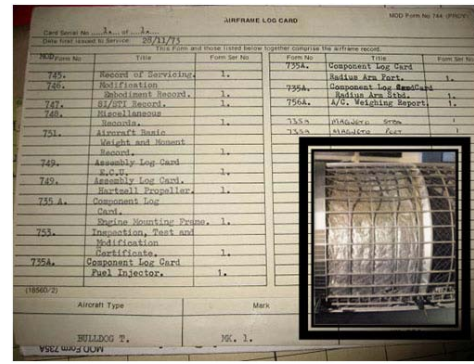
5.9 Part History

When something breaks it can often be repaired. But sometimes the consequences of a breakdown, often referred to as a component failure, can be so serious as to warrant practical steps to avoid any breakdown in the first place. Perhaps the best example to illustrate the need to avoid breakdown is in commercial aviation. Whenever we step onto that airliner we seem to have an expectation from the airline that the aircraft is not going to malfunction and put us in danger. The easiest way to achieve this is to simply replace a component long before statistics indicate that it may break. However, this would turn out to be a very expensive option.

A much better option is to “refurbish” the component part or the whole unit. Refurbishment simply means that the item is brought back to the condition and tolerances enjoyed when it was new. However, all refurbishment processes to some extent weaken the integrity of the original item, so in many cases limits are set as to the number of times that refurbishment can be carried out.

Which leads on to when should the refurbishment take place? This is usually based upon one of two parameters, *elapsed time* and the *number of times the item has gone through a specific process*. If we stay with the airliner example, let’s consider the airframe itself and the landing gear. The airframe will be checked and parts will be replaced after a specific length of time because corrosion of the airframe is the major worry. On the other hand, landing gear is subject to extreme stresses every time the aircraft lands, regardless of the elapsed time within which the landings take place. Therefore, landing gear is invariably replaced and refurbished after a specific number of landings. These are often referred to as time-based and cycle-based parameters.

So how do RFID and standards help here? Someone has to track what has happened to aircraft parts that are refurbished, and this includes taking steps to ensure that any refurbishment limits are not exceeded. Today this is achieved with paper records stored with the part, in combination with electronic records with the manufacturer or owner of the part. Although this is effective, it is also a very cumbersome and time-consuming method of maintaining and tracking this information. The central records will always be the formal records, however imagine the efficiencies, which could be obtained if the part history was effectively carried on the RFID tag on the part itself. This is in effect an extension of the DNA tag concept outlined above and is under active development by the aerospace industry today.



5.10 Product Returns

Product returns are the problem child of modern supply chains. In North America in particular it is customary to permit consumers to return products that they have bought within a specified time limit without the need to show that there was anything wrong with the products to begin with. Such returns are often referred to as “convenience returns”, because they are simply there for the convenience of the customer.

But it is not just consumers and end users who return products. This is also a problem between other players in the supply chain before the end product is moved into retailing. Perhaps the most significant task within the returns process occurs at the very beginning of that process. It is the process of ensuring that what is being returned is exactly what was sold and shipped in the first place. This may not always be obvious, and there may be questions such as does that digital camera kit still contain an expensive battery or the desktop computer still contain the same memory and processor as when it was shipped.

The key to being able to do this verification is knowing what should be in the product to begin with, and since returns processing is often contracted out to a third party they may not have access to that information when receiving the return.

So you can see that the concept of that DNA tag which we have covered has another use. Returns verification can be a lengthy, cumbersome and expensive task. It is often seen as a second priority after the sale of new items (which generate revenue). But there is a sting in its tail, which is not always obvious. Since many companies will not credit the customer until they have completed this verification process, the risk is that the customer will wait a long time for their credit, leaving them with a sense of unfairness. Customers treated this way are less likely to retain their loyalty to the original supplier; therefore anything that can be done to speed up the returns process and lessen its cost is a good thing. The DNA tag concept can do just that. There is a secondary benefit to the use of RFID and identification standards within the returns process. This applies specifically to the way the item will be disposed of as a result of the return rather than being refurbished or resold. We deal with this in the section on The Environment later on.

5.11 Inventory Management

Raw Materials

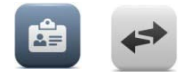
Semi-Finished Products

Finished Product

Inventory costs are incurred in many forms. The most obvious form is paying for the inventory received from the supplier. Provided that this inventory is then converted to sales the cost should always be recovered.

However, there are other forms of cost, which do not flow through to sales and, therefore, impact the bottom line. Those common forms are considered.

5.11.1 Obsolescence



Obsolescence occurs when the inventory is no longer attractive enough to be sold in its target market. It can also occur when inventory becomes outdated in terms of regulations. Such inventory has to be eliminated from the company's balance sheet (often referred to as being "written off") and disposed of. Sometimes it is possible to sell such inventory for a fraction of its original value, thus recovering some of its cost. But in extreme cases you may even have to pay for the inventory to be disposed of. The largest contributing factor to obsolescence is time. The longer inventory remains in your supply chain, the greater the risk of not being able to sell it or it falling foul of some new regulation. So, the trick to minimising obsolescence is to keep the inventory flowing through your supply chain, preferably on a "First In First Out" (FIFO) basis.

But in turn, the trick to keep the inventory flowing is to know where it has been, where it is now and where it should be, and how much of it you have. RFID, together with standards such as those that correctly identify locations, can help tremendously in this process by giving you automatic, timely and accurate information as to exactly where your inventory is, what it is, how long you have had it and what order you should use it in.

5.11.2 Theft

Everyone knows that theft occurs in shops and other retail operations. However, that is not the only place theft occurs - it also takes place in the supply chain itself. The most determined thief will always find a work around to any security system. However, for the casual thief RFID coupled with a standard identification system can be used to deter and even stop the theft. In addition, it is not always necessary to install additional infrastructure to achieve this. RFID detectors on receiving or shipping docks that are used for operations are equally useful for detecting the departure of goods that should not be being shipped.

5.11.3 Out Of Stock

Out of stock is another one of those terms which seems very simple at first, but which can hide many underlying issues. In its simplest form, out of stock means that you really do not have inventory of the item that you are searching for and it is not to be found anywhere in your facility. The mere fact you are searching for it implies that you need it. This would mean that you have not ordered enough of this item to meet the demand that you have. Many things can cause this situation, and balancing supply demand is a complex business, but one of the most common factors is an inability to see accurately the flow of inventory through your processes. RFID can give you extremely accurate and granular information about the flow of inventory in all forms throughout your supply chain. This will not guarantee that you will never have another out of stock, but it will contribute to better planned and managed inventory levels.

In retail operations, out of stock is a term often used for a situation where inventory is not on the shelf where the consumer expects to find it. However, this does not imply that there is no more of that item on the retail site itself. The item could well be in the back room or store and it is just not on the shelf.

This is a very serious situation for retailers, which has been well documented elsewhere (especially by Dr. Bill Hardgrave at the University of Arkansas). RFID can help in a couple of ways. Firstly, if RFID and associated standards are being used to manage the inventory in that back room, then you are very likely to be able to tell immediately whether or not you have inventory of that item to revenge to the shelf. This is in contrast with the situation today in many retailers where the sales associate cannot easily determine if shelf replenishment inventory is available.

Secondly, if RFID has been implemented at a shelf level then the absence of that item from the shelf can be automatically detected. Better still, the reduction of the inventory to the minimum shelf inventory level can also be detected, thus triggering a replenishment to that shelf in good time. The system can even be set up to verify that back-store inventory is available to reflect that replenishment and allow you to order the inventory if it is not.

5.11.4 Misplaced Inventory

Your warehouse management or stock control system has proudly informed you of the location from which you have to pick one or more items. You rush to that location and find that it is completely empty. The system says it should be there, but it isn't. What do you do now? Well there are various things that you can do to try to rectify this situation. You can look in the locations near the aisle, you could go back to the system to make sure that you were looking in the right location, you can ask a colleague if he has any idea where the item is, or you could even search the whole warehouse and even any trucks pulled up at your loading docks.

Unfortunately, the chances these actions resolve the problem is very small indeed, with perhaps the exception of searching the whole warehouse. However, there is another way of resolving the problem which is guaranteed to work - and that is not to have a problem in the first place. A combination of RFID, item identification standards and location identification standards can be used to ensure that the system always accurately knows where an item was put. Such a setup can also detect when an item is taken away from where it was and put somewhere else and where that somewhere else is. Even forklift trucks can be adapted to carry an RFID reader, which can then both identify items it is carrying and the location where those items are placed in. This is simple but extremely effective.

This technique does more than just make sure that an item is where you expected to be. In many operations the effort required to discover the misplaced item (i.e. where it is and where it should be) can lead to more inventories being ordered rather than making the effort to find the missing item. Over time this can build up into a significant problem of increased obsolescence or spoilage, impacting the profit and loss as well as carrying far more overall inventory than is necessary, thus impacting the balance sheet. Imagine the improvement to the customer service levels as well, now the customer does not have to wait until the missing item can be replenished from its source.

This clearly demonstrates that misplaced inventory is much more than just an inconvenience to the person trying to pick that particular item and the fact that their item can not be found can have serious ramifications beyond that mere inconvenience. This is an area where RFID technology, properly implemented, can make a significant difference.

5.11.5 Enhanced Put Away


Let us take the ability to automatically detect where the item has been put away to the next level of sophistication. In most warehousing systems it is the system itself that tells the operator where something should be put away. Historically there have been a couple of good reasons for the system to operate in this way. The first one is that the location must be chosen to be physically large enough and to have the right shape to hold the item being put away. The safeguard here is that any attempt to put the item away into a location into which it doesn't fit is a little obvious. The second reason has to do both with the frequency with which that item is picked and the distance to the most common point from which it has shipped. In a nutshell, you want your fastest moving parts to travel the least distance to outbound staging. Such parts are often referred to as "A" Class parts in the commonly used "ABC" parts classification system.

Both of these requirements must still be met, even with the use of RFID and automated location identification. But as stated above, it is obvious that you can't put an item into a location that is not large enough. So, what if the warehouse operator was permitted to simply find an empty location that was suitable and put the item in there? Of course this would require extreme accuracy in reporting back to the system exactly what was put where.

Since the identification of the item and of the location are both being picked up automatically and accurately, however, this requirement is met 100% of the time. The operator doesn't have to wait for the system to determine and communicate where the item should go which speeds up the receiving process. But this method would not really be suitable for classified parts as described above, unless the system is programmed to detect that a classified part is being put in an unclassified part location. This is another good example of the same technique using the RFID and standardised identification combination providing multiple benefits.

5.11.6 Inventory Carrying Costs

Many of the points outlined above have a direct impact on the level of inventory required to support supply chain operations. It is perhaps fitting that this is the case as inventory, or rather the volume and value of inventory, is the cost driver for so many costs within the supply chain. Inventory has to be received, checked, put away, reconciled, paid for, picked, sold, stored, protected, moved and kept in the right environment. Therefore it is not surprising that carrying inventory costs money, but all of these activities and cost drivers represent opportunities to reduce supply chain costs. As you can see RFID technology and applied standards can reduce those costs on many different fronts. The mistake made by many is to look at this on an individual cost basis instead of looking holistically at the impact on overall supply chain costs.

5.11.7 Efficient Infrastructure Use

Our last section on inventory highlights an impact that potentially has a far greater beneficial impact than the cost saving on the inventory itself. Imagine a manufacturing plant that is nearing its throughput capacity. Under these circumstances it would be prudent to start securing the next plant or other manufacturing facilities.

It is not wise to wait until capacity limits have been reached before doing this, firstly because securing additional facilities usually takes quite some time and secondly because volume growth may accelerate unexpectedly securing additional manufacturing facilities is a serious, time-consuming and expensive proposition. If the decision is to build your own plant then there is considerable capital to be found to fund the facilities' construction. In this case, or if the decision is to lease facilities, a long-term commitment on behalf of the company will be required.

However, there is a significant hidden adverse impact on profitability in going down this route. Suppose that the new factory doubles overall capacity, however the day you complete the new factory it is very unlikely that your sales volumes will have doubled as well. Indeed, it is likely that your volumes will have increased by only a fraction of the new capacity available. In turn, this means that the overhead in terms of capital invested and other general expenses for two factories must be assigned to the same or slightly larger volume of units produced. This has the impact of producing overall profitability until such time as unit volumes pass the threshold for the combined capacity now available.

The above clearly demonstrates that delaying the point at which you must introduce new capacity is a beneficial move. Yet, the only way this can be done effectively is by increasing the throughput using the existing capacity.

When implemented properly, the combination of RFID and standards can have just about the required impact. This ability to take less time to complete the process in the unit of production increases supply chain velocity, which in turn delays that point in time at which you need to consider additional capacity.

It is true that this is a nonrecurring benefit you will not be able to accrue this particular benefit again, but it is a sizeable benefit and one that could prolong current levels of profitability, so it is well worth pursuing.

5.11.8 Inventory – Summary

This concludes our sections on inventory. Hopefully you have learnt that using RFID within your supply chain enables you to achieve much more than just being able to identify something without using bar codes. Inventory is the key to a productive supply chain. You can have the most wonderful processes in the world but without inventory they are useless. You can have the most wonderful machinery in the world but without inventory they are useless. You can have the most wonderful customers in the world, but without inventory you have nothing to sell them.

Having the inventory of the right type in the right place at the right time is absolutely key. RFID technology and identification standards can do a great deal to help ensure that this is exactly what is achieved. And one should remember that the more valuable the inventory is passing through the supply chain, the more valuable the benefits this combination can provide.

5.12 Extended Supply Chains

The concept of manufacturing a product in one country for having it for sale in another is not new. However, when China joined the WTO in December 2001 it gave a whole new meaning to this concept. Many believe that the attraction for moving manufacturing to China was the extremely low labour rates compared to the rest of the world. This is only half the story: what really matters in the supply chain is the total cost from procuring raw material, through conversion to finished goods, movement into the target market area and finally positioning the goods for sale. You can see that these costs include not only the cost of making the item but also of transporting it, storing it, importing it and giving it to the point of sale, including any applicable duties or taxes.

China didn't attract half the world's manufacturing simply because wages are very low compared to other regions. It attracted manufacturing because the total cost of manufacturing plus positioning for sale, known as the "landed cost", was on aggregate cheaper than manufacturing elsewhere. But this scenario introduced made time and risk factors far more important than they had ever been before.

Let's imagine a scenario that more closely represents supply chains of 25 to 30 years ago. An upmarket department store in Munich is selling seasonal fashion clothes, and those clothes were made in Milan. Assume that the journey time by truck from Milan to Munich is in the order of 24 to 48 hours. If demand substantially exceeds forecast then the time to recover would probably be quite short (i.e. the time taken to run up the items if they are not in stock and the time taken to track them from Milan to Munich). So the chances of replenishing before the end of the season, and the subsequent lowering of demand, are quite good.

Now let's run that scenario again, but this time those clothes were manufactured in the city of Nansha on the Pearl River Delta in China. The margin on these items is not so large as to sustain the cost of airfreight so they have to be transported by ship. The nearest major port is Hong Kong where they will be consolidated and loaded into containers for shipment to a major German port.

Once at the destination port they must be imported, customs cleared, handed over to the trucking company and taken down to Munich. The chances are that they will actually go to some distribution centre, which is then responsible for sending items out to individual stores. Time to replenishment is probably not less than four weeks.

This example goes to show that the simple decision to move manufacturing to China has had a profound effect on the structure, mode and timing of the distribution and logistics processes within the supply chain. These scenarios show that when the manufacturing was moved to China a supply chain was considerably extended not only geographically but also in terms of elapsed time. But the supply chain was also made more complex as many more stages and modes of transportation were introduced. The combined effect of all this greatly increases the risk that some part of the process is going to go wrong. In general, the more processes there are in a chain the higher the risk of failure. So what can be done to mitigate this risk and minimise any negative impact.

The key to risk reduction and avoidance of negative impact lies in having the ability to see exactly what is happening at every stage along the way. And that visibility has to be frequent, timely and accurate. But what exactly do we mean by visibility? In its simplest form it consists of just three elements: what something is, where it is and when it was there. But as was explained in Chapter 2, to leave it at just these three basic elements would be a disservice to supply chains in general. To gain maximum benefit from having such visibility we need to include two further elements showing why it was there and even how it was. That equates to knowing:

- ***what*** something is
- ***where*** it was
- ***when*** it was there
- ***why*** it was there
- ***how*** it was (what condition it was in)

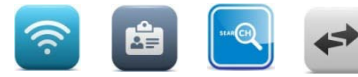
As we have seen earlier in this book, existing methods rely principally on the scanning of bar codes and the mere collection of data concentrate on just a few key steps in the overall process. RFID technology enables the automatic capture of the data much more frequently, more accurately and in real-time. The use of standards, such as those offered by GS1, in order to identify items, locations, commercial relationships, assets, etc, means that the data can be easily exchanged between trading partners and service providers (e.g. transportation companies) in a standardised way.

This standardisation acts as a key incentive for trading partners to participate in this exchange because, having developed a system to do this once, it can be re-used for any other player using the same standards.

In conclusion, extended supply chains demand much more attention to having good visibility all along the chain. This visibility enables companies to use this information to influence events and to manage the overall process. The combination of RFID technology and standards for identification provides a means to do this very effectively and to gain the benefits of knowing what is happening in your supply chain in a much more granular, accurate and timely way. But the benefits of doing this can extend far beyond simply knowing when something has just gone wrong. It is possible to use such an environment to accurately predict that something is going to go wrong. And it is this which enables a much more proactive approach to the management of supply chain issues.

Being able to proactively manage your supply chain issues means better managing how well you can profitably serve and retain your customer. *And isn't that why you are in business to begin with?*

5.13 Automated Process Trigger



As mentioned in the section on extended supply chains, it is possible to trigger corrective action based upon the visibility of where things are in your supply chain. Or, to be more precise, this is usually done based upon things not being where they should be. Take a scenario where goods are being trucked from the factory to a consolidation warehouse for loading into containers in time for the sailing of a particular vessel. With existing methods it is quite likely that we would not know if the truck would make the vessel sailing on time until the truck arrived at the port. But using RFID infrastructure, coupled to standard means of identifying the truck and its contents, it's possible to track the progress of the truck along its route from the factory to the port. Any delays en route can be automatically detected and alarms can be set to trigger in the system, with alerts sent to those managing the customer relationship.

Customers do not like bad news, but in general they can manage if they know what is going on. On the other hand customers absolutely detest bad news which comes late, because you have effectively robbed them of any opportunity to contribute to improvement of the situation.

One has to remember that very often your customers have customers of their own, and they are in the same position (i.e. they want to correctly manage their own customers' expectations). If they are relying upon you to provide a service then they are also relying upon you for the provision of timely and accurate information about what is going on. In the above scenario knowing in advance that the truck would miss the vessel sailing enables you to proactively warn your customer of the situation and then offer to work with them on alternative courses of action. The customer gets the perception that you know what is going on, that you are actively managing the situation and that you really are concerned about the impact on them.

It would be misleading to say that this technique is not possible without RFID or that it is not already in use. However, as with many applications of RFID, it is the ability to feed more timely, more accurate and more granular data into this existing system that improves the usefulness and ultimate benefits that the existing system provides.

Proactive management of events, through the RFID /standards combination is not only useful hen things are going wrong. The automatic trigger mechanism that RFID enhances can also provide benefits when things appear to be going right. Let's imagine a factory in Chicago that runs on the JIT principle, in other words the manufacturing operation is extremely dependent upon the timely arrival of inbound material to be fed into the lines. Imagine a pallet of that material has been delivered on time at 7:30 AM one morning. Production planning at the factory is run once a day at 8:30 AM.

However, it is the middle of winter in Chicago and 30% of the warehouse staff has called in sick with flu and colds. Therefore, the pallet didn't get scanned into the system until 9:20 AM. This means that when the production planning run was done, the system did not know that the material it desperately needed for that day's manufacturing was physically on-site and available and could have been fed to the lines. As a result, production using that material was delayed not by the two hours of delay in scanning in, but by 24 hours when the system used it to plan the following day's production.

This is a classic case of something that supply chain managers never really want to see - the physical inventory position no longer matched the logical inventory position as seen by the company systems. This has other ramifications, too. For instance, the financial picture of the company no longer matches what is happening on the ground either.

The company effectively now has that material in its accounts except that the material is not actually reflected in those accounts. So how do RFID and identification standards help with this situation? When it is possible the RFID infrastructure should be positioned so that items being received, or for that matter shipped, are detected automatically as soon as they cross the company's threshold. In the example given above the system would have known immediately at 7:30 AM that the material had been received and was available. From an operations perspective this is the ideal situation, where physical, logical and financial inventory all match each other, and in turn all match what is actually happening in your operation. The added bonus is that you do not have to stop the flow of those goods to identify them, you merely had to receive them as part of the normal process.

5.14 Performance Monitoring

The scenario that we looked at in the section Automated Process Trigger where we were able to detect exactly when a pallet has been received also illustrates another benefit of this RFID/identification standards environment. Imagine that you had outsourced your warehouse management to a Logistics Service Provider (LSP) and as part of your Service Level Agreement (SLA) with them they were obliged to put away all items within two hours of receipt.

How then is this measurement typically managed today? How would you know if your LSP had kept to this aspect of the SLA? In most operations today the answer would be that you look at data extracted either from the LSP's systems or from your own. Many companies feel that this is an adequate and effective mechanism for measuring conformance to the agreement between the company and the person providing the service. But is it? To answer that, you need to look at what forms the basis for the data that was extracted from the system.

If you trace it back, you will find that its origins lie in scanning the bar code on that pallet. But was this necessarily done at the precise time that pallet was physically received?

The answer is "who knows", for unless you were personally standing there when it was physically received you have no idea of the gap between physical receipt and entry into the system (e.g. the logical receipt).

So the data, which both you and your LSP rely upon to indicate whether or not the required level of performance was achieved, does not in fact tell you whether it was or was not. It only tells you the time between logical receipt and put away. It does not take too much imagination or intelligence to figure out that a smart LSP, if short of resources, could delay that logical receipt until such time as they can be sure that put away would occur within the time specified in the SLA. This example scenario is not intended to imply that LSP's are a bad bunch, but rather is to point out that the existing environment is not as accurate as it could be, and that a more accurate picture of actual events is always desirable.

As illustrated in the Automatic Trigger scenario, the RFID/identification standards combination can greatly help to ensure that the logical picture more accurately reflects what is happening on the ground. It is the ability to do this that can greatly increase your ability to more closely monitor the performance of those providing services to you.

Conversely, it can also assist your service providers in situations where they genuinely have performed and others are claiming a different course of events has occurred. It moves performance discussions from a base of incomplete data and opinion to a base of fact and collaboration to improve the situation.

5.15 Process Improvements Summary

We hope that having got through this long section on process improvements you can see that the impact of RFID technology and identification standards goes far beyond the ability to identify an item. If RFID in the supply chain was only about a different method for identifying something and nothing else, then there would not be much to write about, nor would there be too much to get excited about.

This is not to say that every technique that we have gone into, and every scenario we have examined, is worthwhile on its own. This depends greatly on process, industry, materials used and the surrounding environment. It is certainly the case that today not all of these scenarios are cost-effective for every industry. Nor would each scenario necessarily be cost-effective on its own, though many of them are. What makes these techniques so powerful is that on aggregate they provide substantial benefits to supply chains. Perhaps the biggest single error that companies make when considering the use of RFID is to look only at one or perhaps two of these opportunities and conclude that this is not worth it for them. We have also found that in many cases companies do not necessarily see, and thus assess, the full range of opportunities. We will look at how to analyse these scenarios and to compile a holistic picture of the benefits that can be obtained later in the book.

Improvement	Better use of Capital	Reduce Cost	Time to Market	Reduce Obsolescence	Operations Efficiency	Customer Focus
Managing an Item		X			X	X
Managing Operation	X	X	X	X	X	
Managing Assets	X	X				
Managing Pipeline Inventory	X	X		X	X	
Managing Customer Service						X
Managing Processes	X	X	X	X	X	X

6. Retailing

6.1 What Do We Mean By "Retailing"?

Retailing is another term, which can mean different things to different people. In this book we take it to mean the operation of selling things to the consumer of those things. In other words the end user, or the person who's going to actually use what is bought and not sell it on to someone else. In most senses this would be taken to mean consumers as individual people rather than businesses. This is not always the case, however, there are many retailing operations who cater either exclusively for small businesses or for a combination of people and small businesses. In the United States, Sam's Club is a retailing operation that caters for both individuals and businesses, as does Office Depot. And then there are companies such as Amazon and Dell. Both sell to consumers on the web, but neither have physical retail outlets. And then there are retailers like is Apple, who both sell on the web and have retail stores. You can see that the definition of who, or what, is a "retailer" is actually not very straightforward.

In this section we are looking specifically at the processes carried out at a bricks and mortar retail operation where the consumer can go and buy and then take home the product. The process scope includes the receipt of goods at the back of the store all the way through to the customer leaving the front of the store with what they have purchased.

6.2 Store Receiving

The process for store receiving is in theory the same as that for receiving goods into a warehouse. However, for most stores the significant difference between the two is the number of dock doors and the receiving area. Stores typically have much smaller receiving areas than warehouses do.

Whilst it is true that stores have less goods to receive than the average warehouse, what they do receive can arrive in an unpredictable and uneven manner, thus putting pressure on those receiving to complete the task very quickly. This can be a particular problem during periods of high sales such as the period leading up to Christmas.

There are two common solutions to this problem, neither of which is perfect. The first solution is to specify a precise time at which each delivery can be made, often referred to as Time Definite Delivery (TDD).

This has the distinct advantage of evening out the flow of arrivals at the store receiving area. It has the distinct disadvantage of losing flexibility in the operation and losing the potential of having goods desperately needed on the shelves, as they are sitting in a truck in the yard at the back of the store waiting their turn to be received.

The second method is even more unpalatable, as it involves taking shortcuts in the receiving process itself by not checking goods as they arrive but simply moving them to a location in the back room, or directly to the shelf. It is the type of operation that does not have an actual back room. As a mechanism for pulling goods through from the receiving area into the store very quickly this has much to recommend it for. But it can have a very adverse impact on your inventory, customer service, overall operational efficiency, use of storage and financials as your logical inventory can then differ from your physical inventory.

The combination of RFID technology and identification standards can really help in this situation. The ability to automatically identify something as it comes through the dock door should really speed up receiving, just as it does in the warehouse.

If it is radio friendly material, then it is quite likely that you can automatically receive it right down to carton level.

But even if the material being received is an impediment to radio identification, it should still be possible to receive it at pallet level from reading the tag on the outside of the pallet. The ability to automatically confirm where the goods have been put should also speed up the put away process. While benefits such as inventory accuracy and being able to find things later on are important, it is the ability to significantly increase throughput at the back of the store that is key.

6.3 Shelf Replenishment

We use the term shelf replenishment to mean the planned replenishment of stock to a shelf, location or floor selling area in the store itself. It is the normal process of replenishing stock to replace those goods which have been sold and it is not the emergency situation of out of stock, where there are no goods at all left in the selling area.

Exactly when to replenish a shelf and to what level to replenish, depends on many different parameters, but in essence there are three basic parameters that drive this process. They are:

- The **current** level of stock on the shelf
- The **desired** level of stock on the shelf
- The **probable** level of demand in the foreseeable future

Current stock level can be determined by deducting sales of that item from the stock level at a previous point in time and then adding any stock that has been moved to the shelf since then. For this to work well, you must have an accurate count of what has been moved out of the back room and onto the floor/shelf. Using bar codes, this would be an expensive and time consuming process.

You would have to interrupt the flow of all goods between the back room and the shelf so that you can scan all of the bar codes to identify what has entered the selling area. Indeed, this is such an expensive proposition that is simply not done. However, it can be done automatically using RFID and identification standards, giving an accurate picture of the flow from the back room to the shop floor.

Unless RFID has been implemented at an item level on the shelf itself, this technique does not guarantee that the item has made it to the shelf, though it does guarantee that it left the back room and entered the shop selling area. Where item level tagging is in operation on the shelf and the individual items being put on the shelf are themselves tagged, this would indeed confirm the arrival of the goods onto the shelf. This has spin-off benefits as well, such as inventory accuracy and even process improvement based upon a time analysis of the replenishment process.

Most retailers have a fairly extensive and accurate understanding of demand patterns for the products they sell. These are usually based upon data collected at Point of Sale (POS) using bar code scanning.

Although this is usually accurate, it is still possible for this to provide unreliable information, especially at the self-checkout station. Imagine 10 tins of dog food made up of two tins of five different flavours. The customer is in a hurry, so scans one tin 10 times: you now have understated inventory on one product and overstated inventory on four others. You are in this situation because those tins of dog food do not have a unique identity, only an identification code that tells you what the product is. RFID based upon unique identification, such as in this case the GS1 GTIN, gives every item a unique identity.

6.4 Out Of Stock

Out of stock means that goods a customer wishes to buy are not on the shelf when they go to get them. It is perhaps the most sensitive and controversial subject in retailing. Customers buy goods that are on available on the shelf, so when those goods are not on the shelf they are not going to be sold. This has consequential effects, such as customer dissatisfaction and loss of revenue. Customers will not always go and shop with a competing retailer or chose another brand of the product just because something they want is not on the shelf, it greatly depends on brand loyalty, time available, distance to the competitor and a whole host of other factors.

But if the customer encounters this situation often enough, they will move to a competing retailer or brand. If they move to another retailer then the retailer has lost that revenue and potentially lost the loyalty of that customer. If the customer stays in the same retailer but moves brands then the result for the brand owner can be just as catastrophic, as the example below illustrates. And the consequences of that move may be completely out of proportion to the value of the item that was not on the shelf. Perhaps the best example to illustrate this is razor blades.

Razors do not in themselves generate much profit for the manufacturer. It is the razor blades that generate the most profit. And cartridge razor blades are not interchangeable.

The customer cannot substitute another manufacturer's blades or even blades from the same manufacturer for a different model. The real consequence of the customer migrating to someone else's razor is the loss of that annuity revenue associated with the ongoing need for blades to fit it. So that loss of revenue is not just associated with the present, it can have ramifications far into the future.

There are three basic issues causing out of stock:

- The item is not actually physically on-site, either in the shop or the back room.
- The item is in the back room but cannot be found.
- The item is in the front of store but cannot be found.

In the first situation the item that is not on the shelf is not physically on-site (either on the shop floor or in the back room). The most important thing to know here is that the item is not actually available at all and that therefore going to look for it would be a waste of time, effort and money. As we have already seen, often the logical inventory as perceived by the system does not always match what is physically in place.

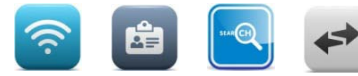
Next, let's look at the situation where the goods are on site but they are lost somewhere in the back room (i.e. when the associate goes to the location indicated by the system, the item cannot be found). The two most common causes of this issue are incorrectly putting away the items or the items being moved without the system being notified.

Again, as shown in the Inventory Management section, the RFID/standards combination can be used to ensure an accurate put away or to detect when items have been moved to another location. Some caution should be exercised here, however, because if the item is simply taken out of the correct location and placed somewhere on the floor, out of range of a reader, then the system is not going to be to able to detect where it is. If the goods can be found this way, then both the retailer and the customer will benefit.

In summary, you can see that the RFID and identification standards combination can be very useful in managing an out of stock situation. Naturally, if you haven't ordered enough of an item and you genuinely do not have it anywhere on site, this combination is not going to help you to suddenly create the item out of thin air and place it on the shelf.

We tackled the whole issue of inventory flows, forecasting and deliveries in the Inventory Management section.

6.5 Promotions



Promotions are a critical part of retailing and refer to the active marketing of products synchronised with a particular period of time. This can be either a specific period of time as selected by the manufacturer or retailer, or it could be a period of time related to a specific event in the calendar.

Perhaps the most obvious of these in Western culture is Christmas and the many promotions taking place in the period leading up to it. Promotions are not dominant in all cultures across the world, but they are dominant enough overall to make a real difference to the success of retailing in general. While promotions can mean healthy sales and profit for both the manufacturer and retailer, they are fraught with problems. Some of the issues associated with promotions are:

- Promotion material not reaching the retail store on time.
- Loss of opportunity if the item is not available on the floor during the promotion period.
- Items being on site but not being moved into position on time.
- Customer dissatisfaction when reacting to promotions, but only to discover that they cannot buy the item.
- Cost of promotion material discounted or written off because it wasn't sold during the promotion period and has clearly expired.

Collectively, these issues impact the three main stakeholders for promotions: the manufacturer, the retailer and the customer. A study at one Fast Moving Consumer Goods (FMCG) company in 2006 tracked RFID tagged promotion material from the manufacturer all the way to its position on the shop floor. Of the 19 stores involved in the pilot, only five managed to position material correctly on time. In two cases the material was only correctly positioned some days after the day of celebration that the promotion was linked to.

One study showed that in the US about 40% of sales involve some form of promotion. This means that stores are constantly receiving promotion material, and it may not always be obvious what the promotion is for, when it must be moved to the floor or even what event the promotion is tied to.

What is needed is a fresh look at the problem based upon the newer technologies that are available, such as RFID. What can the RFID/standards combination do to help improve this situation? Quite a lot! By breaking down the overall process in the sequential stages in which they are supposed to be carried out we can see where the combination can help. The following techniques also involve the use of an EPCIS compliant system. EPCIS is a set of GS1 open standards for exchanging event data regardless of how that data was captured or the design and technology of the computer systems involved.

But for now, it would help if you accept that EPCIS has the ability to let you know when a specific event, such as the receipt of an item into a warehouse, has occurred. The reverse, of course, is also true as the absence of confirmation that the event has taken place usually indicates that it has not yet done so.

The first step is to ensure that the promotion material actually gets to the store on time. You will have understood from earlier in this chapter that the RFID/standards combination is quite good at tracking where things are and where they have been. So the trick is to work backwards from what it is you want to occur at the time you want it to occur. Imagine that your promotion material must be on the floor by the 15th of March and that once received at the stores warehouse dock, it will take two days to position it on the floor. That means that the promotion material must have been received at the dock by close of business on the 13th of March.

In this case you would use EPCIS to let you know automatically if the goods have been received and have EPCIS trigger an alarm in your internal system based upon things not happening on time. Furthermore, if you are using EPCIS to track events across all of the players in the chain you would be able to see exactly where the promotion material had been delayed and where it was now.

Just receiving the promotion material at the dock at the back of the store is not enough. You also have to make sure that the promotion material is physically moved onto the floor on time. Positioning infrastructure to detect the movement of goods from the back room to the shop floor enables you to do this automatically. If you can see that the promotion material has arrived at the store, but that it hasn't been moved to the floor, action can be taken in time to correct the situation.

One large FMCG company implemented these techniques and even went as far as setting up a management dashboard for promotions showing such important information as the number of stores that had received the promotion material, who was delinquent and who is the account manager to that customer/region. They even included contact details of a specific person in each store who should be called immediately in case there was a problem.

From this, you can see that the RFID/standards combination can help a great deal in ensuring that promotion material is where it should be when it should be, promoting the goods and supporting any advertising campaign that may be running in parallel. The customer gets what they expect to get when they expect to get it. The retailer makes the sale, reduces inventory and retains a happy customer. The manufacturer has made a sale and reduced the risk of having to deal with any returns, including the financial impact of having to do so.

6.6 POS / Check Out

The original reason for inventing bar codes was to speed up check out at supermarkets and there is no doubt that bar codes succeeded in doing this beyond anyone's wildest dream. If you are old enough to remember the days when cashiers keyed in all prices, then you're old enough to remember the time it took, the errors made and the time it took to check for those errors on the till receipt. Bar codes generated shoppers' trust and today sophisticated omni-directional scanners have sped up the process to the point where it takes just a quick swipe of each item across the scanning area to capture the identity of most items.

It is not a perfect process, but it is far beyond even what bar codes gave us three decades ago. We have a great deal to thank bar codes for, but that process still contains one significant weakness: that the process is still basically sequential, so now matter how fast you are, you can only scan one item at a time.

RFID has the potential to introduce a paradigm shift in this equation. Imagine bringing 15 items of apparel to check out, placing them on the checkout counter and then receiving the receipt or credit card voucher for them 2 seconds later. Sounds implausible? It is being done today all over the world.

Clothes that are RFID tagged can be scanned and identified in milliseconds even if bunched up into a pile on the counter. Indeed, the gating factor for checkout is likely to become the time that the sales associate takes to place those clothes into the bag. From a customer satisfaction perspective, this is a no brainer. Customers love shopping and hate waiting. Anecdotal evidence suggests that customers will even shop elsewhere if a store acquires a reputation for long lines at checkout.

This technique is particularly effective with items being sold that are made of material that is radio friendly. Apparel and footwear fall into this category, and there are many very successful implementations in this industry sector. But recent advances in technology mean that books, DVDs, metal parts and pharmaceuticals, all previously considered too difficult to use in this scenario, have all been successfully implemented.

The main benefit in adopting the RFID/standards combination in the checkout process is that of speed. At first glance, it would appear that items do not need to be scanned or read in sequence but this is not strictly speaking true, as only one tag can communicate with the reader at any one point in time. But the reading happens so quickly that, to human beings observing the process, it appears that all tags are being read simultaneously.

And there is a follow-on benefit from using this approach, which is that the same tag can sometimes be used for the purposes of theft prevention. The caveat here is that this process can't yet be carried out for all types of items within a retail store. Metals and water still impact some forms of RFID (such as far-field UHF) and other forms (such as near-field HF and UHF) have a limited range.

But every month new developments are announced that move the technology nearer towards overcoming these limitations. Process changes are contributing to this cause as retailers gain experience of using RFID technology combined with item identification standards.

Just because an item or part of the item may be made of metal or may contain water does not mean that the item tag cannot be read, especially if it is contained in a carton or similar packaging, which contains airspace around the tag.

We will go into this in much more detail in the chapters that deal with the technical aspects of RFID and how to overcome some of its limitations. Do not expect RFID to completely replace bar codes at checkout for some years. Remember that while bar codes replaced manual processes, that change did not happen overnight. Bar codes also had their teething problems when they were first introduced, and those problems were solved over the course of many years. You should expect the RFID teething problems to also continue for many years. As our experience of using bar codes increased and developments improved the technology, adoption became more widespread. This is probably what will happen to the use of RFID at checkout, too.

To sum up, the RFID/standards combination of RFID technology and identification standards can provide a significant benefit at checkout in terms of speed and accuracy and this in turn provides benefits in terms of efficiency and customer satisfaction.

6.7 Customer Information

One of the most frustrating customer experiences in retailing is to try and find out if something is in stock even though it cannot be found on the shelves. Have you ever found yourself in a similar situation? You then look to the nearest sales associate and ask them if the item is in stock? That means they have to stop what they are doing and go and look in the back room.

This situation could be improved without the use of RFID by simply having terminals interspersed around the store, which the sales associate could use to check if the item was in inventory. It is a technique that is actually used in many retail operations today, not so much in FMCG but more in retail operations of high value items such as shoes, fashion apparel, jewellery and electronics. This technique can even be extended to the sales associate having a PDA or something similar on which to make their enquiry directly in front of the customer without having to find the nearest terminal. This use, too, is spreading.

It is a good technique, but it has an Achilles heel. It relies upon the inventory system having an accurate picture of where the inventory is, but as you have seen earlier in this chapter, most systems today are not that reliable. So the techniques outlined earlier in the chapter that improve the synchronisation between the logical picture of inventory and the physical reality have a consequential benefit in that it improves the accuracy of the inventory picture that can then be applied to the problem of finding goods for customers.

This is an excellent example of improving the data that goes into an existing process without the need to change the process itself, because changing the process is not always necessary. In this particular example suppose that the sales associate now tells the customer that the item is in stock, that they know precisely where it is, and that it will not take very long to find it and return.

But there is another aspect of providing the customer with information that is perhaps even more important when the item has been found on the shelf. That information is not information about the stock situation, but information about the actual product itself.

Imagine, for instance, that the customer has picked up a bottle of wine and would like to know more about this wine and how it is produced.

If the removal of that item from the shelf is automatically detected then all sorts of information about the item can be displayed on a screen in that shelf area. If that display is a touch screen, then the customer can interact with the system to find out even more. Of course there is the possibility that two bottles are removed at once, more than one customer may be taking bottles and similar problems. But in many cases good process and technology design can overcome such issues, for example list bottles removed recently and ask the customer to select, which one is of interest.

But what if a customer does not like that particular year of vintage? What if the customer wants a wine that would go better with fruit? What if the customer likes the wine, but would like your suggestion for the dessert wine to follow? All of this can be done automatically and simply as a result of detecting what it is that the customer has removed from the shelf. In subsequent chapters we will deal with the technology aspects of how the system is able to focus down that one item, here we are focusing on the business benefits rather than the technology, but suffice it to say that this is a technique that has already been mastered.

The benefits of this scenario increase significantly if the item has many more characteristics, such as with a pair of shoes. The customer may have picked up a particular style of shoe in size 39 and brown. They may prefer to have the shoes in black in size 41. Does the store have this particular style, colour and size in stock?

Are the shoes somewhere else on the shelves or are they in the back room? If they are in the back room then where exactly are they stored? If you have included an option of an interactive screen for the customer to see all available sizes, colours and styles, then you are widening the chances that the customer is going to find what they want in your store and buy from you and not from someone else.

Before we leave the subject of customer information we should ask ourselves whether or not everything that has been described in this section could have been achieved without the use of RFID technology.

The answer is a resounding yes, that is to say it could technically have been achieved. You could have asked the customer to take the item to a bar code scanning station, or even use a hand-held scanner. Additionally, with the advent of camera phones and PDA's it is increasingly likely that the customer will be able to scan an item themselves, either by bar code or by radio.

They will not be linked to your system and their system may not have the information that you have in your inventory system, however since most of these devices can now easily and quickly connect to the Internet, it is likely in the future that they will be able to connect to a system that can give them product information. Prior to this, the customer would have had to use your bar code scanning equipment, which is perhaps long lines of customers waiting to use a scanner and some customers are not going to want to use the technology at all. You can deduce that, whilst it is possible to have done this through bar code scanning, it is extremely unlikely that anyone has gone ahead and done it.

So why is it that, while this works with RFID technology it is less convenient with bar code technology? The answer is relatively simple: the customer is insulated from the technology. They only need to know enough to take the item to a place where it is indicated that they can get more information. Better still, they could simply use their RFID enabled PDA to pick up the items identity and retrieve the product information from a reliable authorised source on the Internet. They do not need to line a bar code up to scan and indeed they don't even need to be aware that anything is being scanned to begin with.

It is rare to find processes which are enhanced with RFID, that were absolutely impossible to do with prior technologies and methods. The ability to identify something without the use of some optical method, such as human sight or having to line up an infrared beam, is indeed different from and impossible for previous technologies. But the fact is that bar codes have worked perfectly well for more than 35 years and continue to be improved. So what is the difference between RFID and other identification technologies? *The real difference is the ease and convenience with which that identification can be done*. Which means that it's now viable to identify items in many more points in the overall supply chain processes than was viable before.

6.8 In The Changing Room

Now let's move into the changing room, where customers try on clothes and other items before they buy them. Most often you cannot go into the changing room until an associate has checked exactly what it is you're taking in, as they would like to know that you're bringing out the same number of items and that you're either going to pay for or return all of the items.

Retailers put quite a lot of effort, time and money into ensuring that while customers can indeed go and try on clothes they might buy, they cannot walk out of the store with clothes that they have not paid for. If those items of apparel have been tagged with RFID and a standard form of identification, then things taken into the changing room can be automatically detected and logged. That same check can be made when the customer exits the changing room area. This is not completely a foolproof system, as it will still be possible for a determined thief to fool the system under certain circumstances, but this is a more efficient, and probably more effective, system than the one which preceded it.

Scanning the bar code of every item before the customer took it into the changing room is not viable, so many retailers opt for the system of simply counting the number of items that go in to the changing rooms and reconciling that with the number that come out. Clearly, there are some relatively easy ways in which to ensure that an expensive item went in and a far less expensive item was substituted for it on the way out. If the customer did accidentally leave an item behind in the changing room now the retailer knows exactly where that item is in the store.

Using the RFID/standards combination can save a lot of time and effort in managing the changing room area and it gets customers into and out of the changing rooms relatively quickly and painlessly. To stop there would already have achieved quite a lot, but it would not have achieved all that was possible. So let's now look at an enhancement to the changing room process, which could provide benefits to both the retailer and the customer.

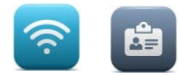
6.9 The RFID Mirror

Imagine that you have walked into the changing room after finding a pair of trousers that you really like and that you hope will fit you. Once you have the trousers on, you notice a mirror on the wall and you turn around and stand in front of it to see how the trousers look. Suddenly, a welcome message appears on the mirror alongside your image and it is congratulating you on considering buying that specific item which it names and confirms its size, style and colour. On the other side of your image a table appears showing all of the sizes and colours that are available in the store of that item. Underneath that table is a list of nearby stores that may also have other variations of the item that are not in stock where you are.

If you touch the little button on the mirror that says “alternative selection”, you now see the available sizes and colours of the item you are wearing reappear on the mirror. You touch the size and colour that you want, and a message appears confirming that they are in stock and that the item will arrive in your changing room shortly for you to try it on. Perhaps this sounds a bit futuristic, but actually everything that has been described above is already possible and has been implemented somewhere on the globe.

It is not really RFID/standards, it is just the intelligent combination and application of a series of technologies and processes that have been made to work together very well. This is yet another aspect of implementing RFID that we will cover in much greater detail in the section on Implementation. The greatest benefits can often be obtained not by implementing RFID technology in isolation, but by combining it with other technologies and even existing processes. Indeed, one of the most powerful combinations that you will come across is the combination of RFID technology, bar codes and global identification standards, which we will cover later in this chapter.

6.10 EAS



Electronic Article Surveillance (EAS) is a common feature of many retail operations and stores. It is a simple system designed to detect the removal of items, which have not been paid for, from the store. Most systems use a simple binary electronic tag, which is either on or off, which is detected when leaving the store through the main doors.

The majority of systems installed are from one of two major vendors, and unfortunately, these two systems are not compatible. There is no doubt that EAS systems work. However, there are some drawbacks to these systems:

- The tags can be relatively expensive, especially for high-value apparel items where some method of attaching the tag to the item must be found and which generally involves a large plastic attaching device.
- Deactivating tags requires equipment at each check out and that equipment can have an adverse impact on other electronic storage items, such as credit cards, if *they are placed* near the equipment.
- The checkout person has to remember to deactivate the tag.
- Since different retailers use different systems, manufacturers are often in a position of having to use both tags on items in order to retain the flexibility of the allocation of inventory.
- The tags serve only as an “on/off” system and carry no other data nor serve they any other purpose.

- False alarms at the store exit are common enough that employees and customers often simply ignore them.
- If the alarms go off for items that the customer had purchased then the retailer risks legal action by that customer if he is approached for having non-payment of items in his possession.
- If the customer is stopped and goods are found on him, which do not appear on his receipt he may claim that the goods have been purchased elsewhere.
- For non-serialised goods it is almost impossible to prove that they were not purchased elsewhere, and this can also be case for serialised goods if the serial number does not appear on the receipt or in the store's procurement records.
- In instances where the tags are intended to be reusable, for instance with high-value apparel, considerable time and effort may be required to detach the tags from the items being sold, thus slowing down the checkout process.

The combination of RFID and standard identification systems can definitely help in this situation. If the tag is used to identify the item at checkout, then the system can be automatically notified that the item has been sold and paid for. If it is a serialised item, and remember that the use of standard data on RFID tags makes it possible to serialise items that the manufacturer hasn't serialised, then of course the system can identify which specific instance of the item has been sold. So there is no need to deactivate the tag, as it doesn't matter if it is read when the buyer leaves the store.

The system knows which items have been sold, and which have not. Depending upon the type of RFID in use, it may also be possible to reduce the size of antenna. This subject is covered in more detail in the technical sections of this book. One other very important point to remember is that the tag has not necessarily been put on the item purely for the purposes of EAS. Since the tag contains enough data to identify the item, it can be used to provide benefits in all supply chain processes, often starting at the point of manufacture.

The tag is paid for once, but used many times in the overall processes. It is also worth noting that if open standards are being used for the RFID system and the data itself, then there is no need to tag product with tags from different systems as readers compliant to open systems can read tags from any other compliant manufacturer. This has the effect of reducing costs overall.

6.11 Product Recall

One of the most damaging things for a manufacturer to suffer is product recall. Usually a product recall is only executed when there is a serious danger to consumers of the product. Issuing recall can be very damaging to the reputation of the product and even to the reputation of the manufacturer overall.

Product recall can have very serious financial consequences, yet most recalls involve only a small proportion of the product, which is already in the supply chain, either on the retailer shelves or with a consumer. One of the most serious recalls in recent years was for Sony batteries that had been supplied to many laptop brands and used in the manufacture of their laptops. In fact,

Sony issued recalls for laptop batteries in both 2006 and 2008. In this case the recall was issued not on the battery serial numbers, but on the serial numbers of the laptops, because the battery serial numbers had not been captured and linked to the laptops during manufacturing. Had the batteries been tagged then perhaps the battery serial numbers could have been captured automatically without slowing down the manufacturing process at all.

But when a recall must be executed it is important that it can be executed quickly and effectively. Although there are some standard industry processes for recall, such as that found in the automotive industry, there is no general recall system today. A consumer who wishes to find out that the product has been recalled must rely upon the gathering of publications and web sites, and few are willing to trawl through all of this information to find out. With the ubiquitous spread of the World Wide Web and smart phones perhaps it is time for the creation of a universal product recall information service.

This could be a single portal, available in multiple languages, to which anyone can go to find out if a product is subject to recall. For this to work there would need to be universal agreement on the means of identifying products. Fortunately, such a means is readily available for most of what is sold in the world. If we take the example of the automotive industry, then the Vehicle Identification Number (VIN) is a universally accepted means of identifying a motor vehicle. Other industries have similar schemes, however not all industries have them.

Perhaps the most ubiquitous is the scheme used for identifying items sold by retailers and managed by the not-for-profit organisation GS1 (Global Standards One). Headquartered in Brussels, Belgium, it is a federation of 108 not-for-profit organisations around the world serving more than 160 countries. The GS1 system doesn't just provide unique identification for items in retailing. It is also a complete identification scheme for everything from a tube of toothpaste to a fixed asset to the location where something is stored. Where there is no existing industry standard for uniquely identifying items, then it would only make sense to adopt the GS1 system for this purpose.

Effective recalls rely upon accurate and timely identification of the product that needs to be recalled. As we explained earlier in this chapter, RFID-based systems enable this identification to take place at many more points in the overall supply chain processes, and the use of standard identification parameters means that this can be done in a common way across all supply chains.

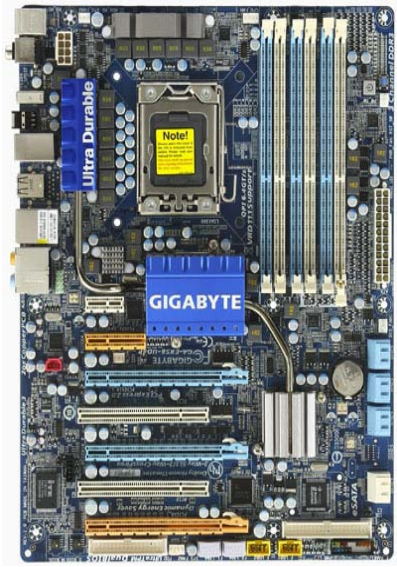
If recall details are available to the same systems that are making these identifications throughout supply chain, then it is possible to automatically intersect the flow of those goods and arrange for their return to the correct point for further processing. This makes it less likely that goods subject to recall will eventually end up being sold on to the consumer. It is even possible that this verification could take place at checkout itself, thus preventing such an error at the point-of-sale.

The ability to check for recall throughout all processes in the supply chain, to selectively recall based upon the real problem, and to gain information in a consumer friendly and easy manner is good for consumers, retailers and manufacturers alike.

It is even good for governments, as it would reduce the number of incidents that could potentially harm the health of the population. Finally, it is good for the environment because, with the ability to selectively recall, we would no longer be transporting and disposing of large volumes of goods that never needed to have been recalled in the first place.

6.12 Returns

Returns take place for many different reasons. It can be for the convenience of the customer, because something appears not to be working, the wrong thing is actually in the box or even that the item is subject to recall as outlined previously. Regardless of the reason for the return, there are usually certain processes that must be carried out when the return takes place.



The first, and perhaps the most important, is to identify accurately exactly what it is that is being returned. Today this is most often done by either observing some marking on the item or its packaging or by simply scanning a bar code. As with the flow of goods towards the consumer in the "normal" supply chain, if the item was tagged then it would be possible to pick up this information merely as a result of positioning the item within range of the RFID reader. This saves time and can greatly increase accuracy.

The second important thing is to make sure that the item still contains everything that it contained when it was sold. For some items, such as that tube of toothpaste, this is done visually. However, at the other end of the spectrum are items like PCs, where the skills required to remove half the memory are well within the average consumer's ability.

And if that PC was made to order, then the identifier of the unit as a whole can probably not be used to derive the bill of material and what should be in the unit. One possible way to overcome this would be to store a list of the serialised components of the item on the tag that also provides its identification. This would mean that the person processing the return did not necessarily have to have access to the system that was used to build the original item. Since the person processing return may not be in the same company as the original manufacturer this can be an advantage.

The next question is did this item actually come from the seller that the person returning the product claims it came from.

The difficulty with non-serialised product, sold through many retailers, is that it is impossible to answer that question. If the product is serialised and you are able to look up the seller's inventory system, then you can easily establish which seller is supposed to have sold the goods. This works equally well for both bar codes and RFID tags, the advantage of the tag being that the information is picked up automatically. You may even be able to verify with the seller whether or not the item was ever actually sold.

As we mentioned, some returns are specifically for the convenience of the customer and are often referred to as "convenience returns". Invariably the retailer sets a time limit within which the customer must return the goods under this provision. However, sometimes the customer will attempt to return the goods without the original receipt and if the seller feels that they must give the customer the benefit of the doubt then they could process returns that are actually out of time.

Registering the date of sale on the tag at the point-of-sale would overcome this particular problem, as the person receiving the return could then easily see the exact date on which the item is sold. There is still the issue of if someone tampered with the data on the tag, but we deal with this in the section on security elsewhere in this book.

Many things can happen to returns once they have been processed, including that they get sold again. Many countries and regional jurisdictions do have rules that insist upon the item being labelled as “refurbished” or something similar when being resold in the manner.

But what if the item is actually subject to recall? The return process is yet another point in the overall process chain at which there is an opportunity to highlight that the product is subject to recall. But before we leave the subject of returns it is worth pointing out that when processing returns you can use the advantages of RFID technology to record a couple of pieces of data on the item tag itself which could help to further improve the overall process.

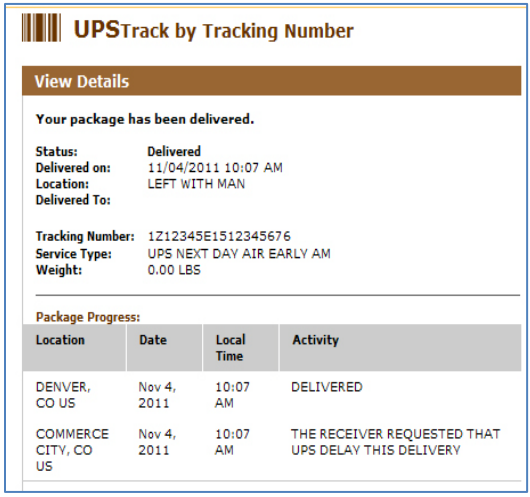
Recording the dates and times that the item was returned effectively records the start of the overall return process. If the date and time of subsequent key process points is also recorded then a complete detailed and trend analysis can be made of the overall returns process. It is most certainly possible to capture this data manually or using bar code scans, but doing it automatically with RFID removes the time and effort associated with doing so. You can see that there are various benefits from the use of this technology and standards for identification in the returns process. As most of the focus is placed upon getting things to the customer, rather than how you get them back or what you do when you have them back. Yet the returns process is interruptive, inconsistent in terms of what is being processed, takes more time than is generally more expensive than the equivalent processes in the forward supply chain. This is also the reason why the level of benefits to be achieved can be higher than their equivalent processes in the forward supply chain.

6.13 Track & Trace

Twenty years ago few people outside of logistics had heard of the term “Track & Trace”. Today, with the expansion of courier services around the world and the explosion of the World Wide Web this expression has accelerated into general use. But this has also led to the two terms often being misunderstood and used interchangeably, whereas they actually refer to some very specific and different activities. However, despite their differences, they both use the simple technique of knowing about an “event”. As discussed in various sections above, an event is:

- ***What*** something was.
- ***Where*** it was.
- ***When*** it was there.

It can also be very useful to know why it was there and even how it was (as in what condition it was in), but that is outside of the scope of this section on track and trace.



UPS Track by Tracking Number

View Details

Your package has been delivered.

Status: Delivered
Delivered on: 11/04/2011 10:07 AM
Location: LEFT WITH MAN
Delivered To:

Tracking Number: 1Z12345E1512345676
Service Type: UPS NEXT DAY AIR EARLY AM
Weight: 0.00 LBS

Package Progress:

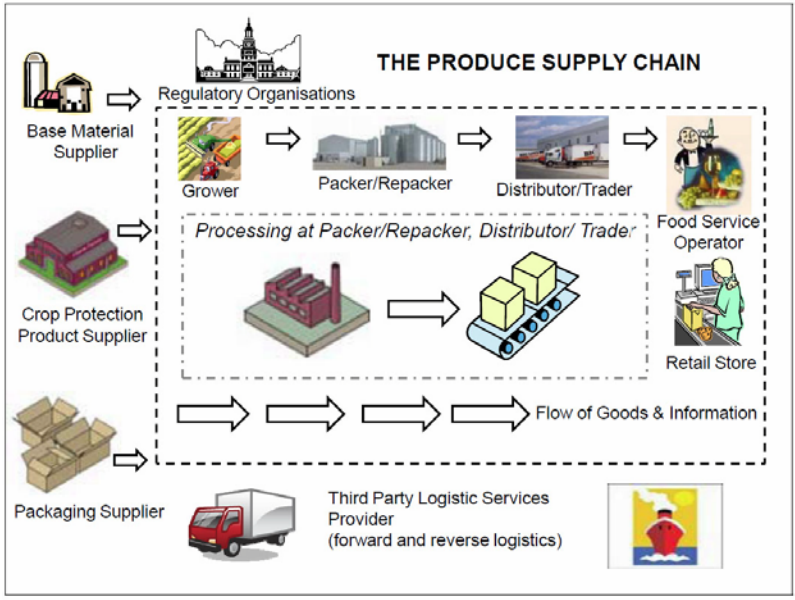
Location	Date	Local Time	Activity
DENVER, CO US	Nov 4, 2011	10:07 AM	DELIVERED
COMMERCE CITY, CO US	Nov 4, 2011	10:07 AM	THE RECEIVER REQUESTED THAT UPS DELAY THIS DELIVERY

Tracking something means establishing where it is now. In order to do this successfully requires the capture of data at key process points in the overall process chain.

But it is not necessary to retain such data beyond the last event captured, as that alone is sufficient enough to tell you where the item is now.

Tracing means establishing where an item has been since a previous point in time or in the overall process. It requires not only the capture of data at key process points but also the retention of that data and the means to access it. We are not concerned here with the issues of security and access control, but suffice to say that just because this is tracing something the rules of common sense of security still apply.

The common base for both processors is the ability to capture the event data, so the quality of the output of these processes is directly related to the ability to capture quality and timely data of the event and feed them into the process. As we have explained earlier, the traditional method for doing this was to scan bar codes. This method works and has been proven over more than three decades. As we have also described, the use of RFID makes it viable to collect event data at many more points in the processes, so the data tends to be more accurate, more granular and more timely. If you have a standard way of describing items, locations, etc, then such data can be more easily exchanged between the supply chain partners.



Tracing has become more important in our lives, especially for food and pharmaceuticals. Traceability of food poses some particularly complex problems. Imagine an outbreak of food poisoning is traced to a packet of beef sold in a particular supermarket. Where did that beef come from? Many supermarkets receive beef in bulk and cutting package it locally. So we need to identify the bulk beef that the packet was derived from. But that bulk beef was perhaps part of a whole carcass, so we need to identify the carcass too, and which farm the carcass came from.

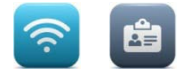
If we can do all of that tracing back to the farm we may be on to establish the root cause of the outbreak. Perhaps much more importantly, we can reverse trace whatever has left that farm and find out where its products are now and do something to minimise further risk to consumers. This is often referred to as “farm to table” traceability, and has been implemented by various regulatory bodies including the European Union.

Doing this successfully requires an ability not only to capture events data at every key process stage, but to link to that data in some form of hierarchy which establishes a parent/child relationship between all of the items involved. This can be done very successfully using bar code as the mechanism for identification of the item itself and its parent. Indeed, in environments where an RFID infrastructure is not possible or not viable, then this remains a very efficient and effective method for traceability. As with the other scenarios we have described, the use of RFID technology enables a high degree of automation in the process.

But technology alone is not enough. For these processes to succeed around the globe they must be using a global system for identification that is acceptable to all involved. The GS1 Traceability Program has established standards and recommended practices for this purpose, and as the GS1 system is already widely used around the globe it provides a much easier transition to being able to trace items at all levels in the food chain. You can find more details of this program at http://www.gs1.org/gsmp/kc/traceability . In some instances, companies are using a combination of bar codes, RFID and the GS1 traceability standards to provide the most complete solution possible to this problem.

Lastly, it should be appreciated that the data necessary to provide full traceability may reside with many different supply chain participants. This is particularly case for long complex supply chains. In theory it would be possible for all of these participants to all send each other all of their data, but you can see that would not be practical at all. So what is needed is a standard means of either exchanging data and/or a standard means of enquiring about data. There are many precedents for this already in industry, as can be found in the way in which banks around the world exchange data with each other in a secure and effective manner. Other industries, such as the airline, chemical and automotive industries, also have similar standards. What we are talking about here is not necessarily exchanging data about the transaction, but about the events surrounding the movements of an item or group of items throughout supply chain. This aspect of operations has very few existing standards. GS1 EPCIS standards were designed and developed specifically for this purpose by a group of supply chain experts and users. Bear in mind that successful traceability often relies upon the ability to exchange this type of data in a standard way.

6.14 Warranty



Warranty in this context is the service of repairing or replacing an item should it become defective within a specified period after sale. Warranty can be offered at different levels, such as the inclusion of labour required, whether the item has to be returned to a specific point for the service or even the period of time within which the repair or replacement must take place. The fact that the buyer is able to take advantage of warranty is often referred to as “warranty entitlement” and a specific combination of parameters that warranty is often referred to as the “warranty level”.

The most important thing to establish at the start of the warranty process is warranty entitlement, and that can be harder to do than it may seem at first. The normal process of establishing this entitlement is for the person seeking warranty services to produce the original receipt of sale or warranty certificate.

Of course these can get lost, which can lead to warranty being refused when in fact there was an entitlement. This can be a major source of customer dissatisfaction and ultimately could even make the customer move to another brand or retailer for their next purchase. These issues could be better resolved if certain details were available on the items themselves when they were presented for warranty service, it is a similar situation to that described for returns. Thinking first of actual entitlement, the manufacturer's standard warranty could be encoded onto the RFID tag and any warranty or warranty upgrade that was purchased by the buyer could be encoded onto the tag at the time of buying the additional services.

Note that it is not necessary to store details about the buyer, but only about the warranty entitlement and level that now applies to that particular item. This also means that the person carrying out the warranty service does not need to be connected to the manufacturer in order to establish warranty entitlement and level. This does not mean that such a connection shouldn't be used, just that both methods can be used without restriction.

For warranties that commence at the point-of-sale, the date of sale can also be registered. Again, the details of the buyer are not necessary as what is being established is the commencement of the period of warranty. Many manufacturers today will honour a warranty claim without the necessary paperwork, but this is often done by decoding the serial number or other data on the unit and then allowing quite a large margin of error since the manufacturer or the warranty provider cannot be sure when the unit was sold. Reducing warranty services down to those occasions when it is truly an entitlement would reduce the manufacturer's overall warranty costs.

Where a unit has to be replaced under warranty or during servicing, the manufacturer will often offer a refurbished unit versus a new one. It is important that where the part used for replacement is not new, there must be no chance to confuse the new and refurbished versions of the same part.

This is why items, especially electronics, automotive and other engineered products, often have a “replace with” reference for this purpose. This too can be carried on the tag. As with items returned for other reasons, it can also be useful to record the date and time that the item was submitted for warranty processing. In fact, it is often the case that the processes for returns, repair and warranty have much in common. This should not be a surprise, after all warranty provision requires making sure that everything has been returned and then finding out what is wrong with the unit.

There is one last benefit in using RFID technology for warranty, which is perhaps not so obvious. Some industries provide very long warranties and it is quite possible that an item would be returned under warranty more than once. Items repaired under warranty can either be resold as refurbished units or used as a inventory with which to replace other items under warranty. It can be very helpful for the person making the repairs to have access to the repair history for what they are repairing. This too could be carried on RFID tag on the item.

6.15 Customer Specific Offers

The secret to a successful marketing campaign has always been to address the campaign at those most likely to react to it. Traditional way of achieving this has been via marketing surveys, questionnaires, demographics, etc.

By selecting a smaller proportion of the overall population that appears to meet the characteristics of those we are targeting, we can aim our mail shots, TV advertising and messages at them in the hope that they will respond. But it is still a very hit and miss affair.

What if you could narrow that target population down to a single person? Imagine a consumer walking into a shop and seeing something that is of interest to them. They pick the item up, take out their smart phone and scan the item and then hit a button to get more information.

Imagine also that they have bought similar items before and the manufacturer or retailer wants to encourage them to buy this one. An electronic discount coupon appears on the phone offering a special price if they purchase that item now. No mass mailing or expensive TV campaign required. The consumer decides to buy by simply hitting a button on their phone and it transmits a very short-range signal to the store confirming the discount offered. All of the technology necessary to achieve that is available today. Mobile phones are available that will both scan a bar code and read an RFID tag at short range. The consumer could be identified through their phone if they have given their consent to this arrangement beforehand. The advantage of RFID in this scenario is it wouldn't be necessary to line up the phone's camera with a bar code on the item, but only necessary to get within range of the item to read the tag.

7. Asset Management

7.1 Introduction

Asset management, in this context, means the tracking and safekeeping of physical assets used within a business or organisation. Examples include manufacturing machinery, tools, computers, furniture, buildings and vehicles. These are also often referred to as fixed assets, because they are used to support the operations processes but are not transformed by them.

We have already covered assets in the form of products, work in progress, and raw materials in earlier sections of this book.

7.2 Identification

It follows that in order to track something you must be able to uniquely identify it, and that in turn implies some form of serialisation in order to provide uniqueness. Many companies have coding schemes to achieve this, though they tend to be unique within each organisation. If the asset never leaves the organisation then perhaps only limited benefits will accrue from using a standard system for identification. However, one of those benefits is avoiding the time and effort required to devise your own coding scheme.

Format of the Element String					
Application Identifier	Global Individual Asset Identifier (GIAI)				
	GS1 Company Prefix →		Individual Asset Reference →		
8004	N_1 ...	N_l	X_{l+1} ...	variable length	$X_{j\ (j<=30)}$

When assets are used between organisations then clearly it would be beneficial for those organisations to be using the same standards for identification.

The GS1 system has two standard asset identifiers: one the Global Individual Asset Identifier (GIAI) for individual assets that typically stay in an organisation for a period of time, and second the Global Returnable Asset Identifier (GRAI) for assets which often transfer between organisations as part of the supply chain process.

Format of the Element String				
Application Identifier	Global Returnable Asset Identifier (GRAI)			
	GS1 Company Prefix → ← Asset Type		Check Digit	Serial Number (Optional)
8003	0 N_1 N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10} N_{11} N_{12}		N_{13}	X_1 variable X_{16}

As with other processes, the advantage of using RFID is that it is easier to retrieve the information about the asset. A secondary advantage is that RFID tags can store much more data than bar codes typically can, so information (such as date purchased, date put into service, registered location, etc.) can all be retrieved directly from the tag.

There is also a third advantage to using RFID when an asset is transferred from one owner to another. Part of the standard identification indicates who owns the asset, and this will usually change on transfer of ownership. A bar code label would need to be replaced under this scenario, whereas an RFID tag would merely need to be updated. But whatever the medium used there would be no need to adopt a new coding scheme as the standard one would be applicable to both the previous and new owners.

Another advantage is the ability to accumulate data about an asset during its life. Imagine a production tool that must be serviced at regular intervals. Details of the first and subsequent services could be written to the tag as each service is completed, thus providing a complete service history of the tool simply by reading the tag, without the need to look up service records on a system or on paper. If the service interval is also recorded, then scanning the tag could also warn when an impending service is due or if it is overdue.

7.3 Asset Tracking

A fixed asset count is usually a long process that requires a great deal of effort, so for this reason it is not done very often. But as explained above, the use of RFID to identify the asset is usually much faster, even if it is still necessary to find the tag on the item and ensure a path for the radio signals to be exchanged. This can partially reduce the time taken to find and register assets in the count. In some instances it is also possible to use the asset tag to detect when an asset is being moved from one location to another.

There are scenarios where it is necessary to track items of lower value and in such cases the use of RFID tags may at first seem to be prohibitively expensive. But just looking at the value of the asset being tracked can be very misleading.

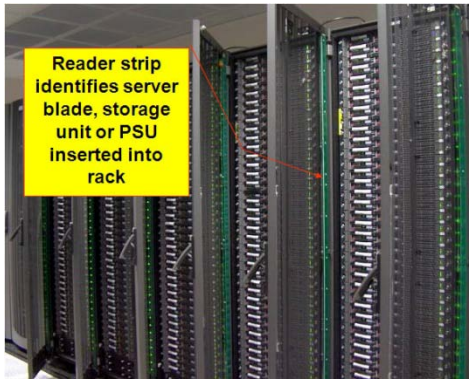
The critical factor to consider is not the value of the asset, but the financial consequences of not being able to find it when it is needed. Take the real life case of the Embraer aircraft assembly line in Brazil.

Certain precision jigs are required at specific points in the production process and these are not generally stored on the line. Not having such a jig at the right moment could delay progressing the build of what is already a very expensive item that earns no revenue at all on that line. Finding the jig is financially important out of all proportion to its own value. You should also consider the cost in time and resources of recording the presence of an asset during an asset check. If enough time is saved in the process, that the cost savings offset tagging every item, then it still makes sense to use RFID. This situation also occurs in other industries where key tools or equipment are moved around production lines. Examples include roll cages for parts in the automotive industry and surgical instruments and appliances in the health care industry.

Where such financial consequences or process/time savings do not exist and the item value is low then bar codes will almost certainly be cheap enough to be viable. In any case, it is not a bad idea to use the combination of bar codes and RFID tags together for asset tracking. If you do this, then should the tag failed any reason you have a backup at least for the identification in the form of a bar code.

7.4 Data Centres

Data centres are a special case when it comes to tracking assets. In many cases individual units, be they server blades, power units or storage, are inserted into slots in racks made specifically for this purpose. As there can be literally thousands of them in a large data centre, finding a specific unit then becomes a real problem.



By placing RFID tags on the back of of these items it means that they can be quickly scanned and identified in a fraction of the time it would take using bar code scanning (or worse, humans reading asset numbers). Some companies have even developed adaptations for racks that automatically detect what has been put in the rack and then send that information back to a system configuration tool, which can then build a map. Now consider what would happen if that tag was linked to a heat sensor near the exhaust fan of the server blade, we can automatically detect that a server is overheating, which one it is and where it is.

7.5 Returnable Transport Units

We can take our definition of fixed assets further, to a special case where assets are owned by one party but are hired out for use by another. This combination has different names, depending upon the industry and type of container involved. Some common terms are:

- **RTU** - Returnable Transport Unit.
- **RTI** - Returnable Transport Item.
- **ISO Container** - Generic term for sea, road, rail and ferry containers.
- **ULD** - Uniform Load Device, containers for use in airfreight.
- **Totes** - Generic term for smaller boxlike containers used in industry, especially used in fresh foods and consumer electronics.

ISO containers are perhaps the most widely known, but they take many different forms including pallets, dollies, cages, boxes, tanks etc. It can become very confusing trying to remember all of the terms used around the world, but the most important and basic thing to remember is that these are assets, which are owned by one entity and used by another.

While it may seem obvious that there is a need to track & trace these containers as assets, there are three other needs that are not so obvious, but which must still be met. We have dealt with the first need in the Track & Trace section, so here we will just deal with the other needs.

First, there is a need to understand what use the returnable asset is being put to. Imagine an ISO container being shipped from a port in Malaysia to the port in Rotterdam, Holland. Clearly that container is an asset, so it must be identified as such with details of the type of container, who owns the container, dates into service and so on. This data will never change unless of course ownership is transferred.

There is, however, also a need to track the container in the context of the journey that is undertaking. So we may need to know the bill of lading

number, the vessel it will go on, the shipper of the goods inside the container, etc. Before the use of RFID for transportation this data could not have been carried with the container itself. Today industry is working on a set of international standards that would set out exactly what data is carried and in what format.

Unlike assets that remain in the office, returnable assets are almost certain to leave their owners control and move elsewhere under the responsibility of the person using them. At the end of their journey the container may simply be put into a pool while waiting for the next assignment, or it may actually need to be returned to the owner.

To be more precise, it will probably need to be returned to a specific location of the owner.

While the visible markings on the side of the container indicate who the owner is, it will probably not indicate where the owner is.

RFID tags could correctly store the actual location that the container should be returned to at the end of the journey. Like us poor human beings, assets tend to suffer from wear and tear as they age. For some returnable assets it is important that they go through further processing specified periodic intervals. An example of this is the “totes” used in food processing. After being used to deliver food, it is imperative that they go through a very specific cleaning process in order to avoid any cross contamination or bacterial infection. Being able to automatically identify a tote means that should one be presented at the beginning of the filling process, the system can detect whether or not it has been through the cleaning process since it was last used to carry food.

And some returnable assets may not need to go through a special process every time that they are used, but it is possible that they will need to go through a special process after having been used a certain number of times, this is commonly referred to as “cycle limits” as the acid may only cycle through the process is a specific number of times.

Again, the ability to use RFID to automatically and accurately identify the returnable assets at every point in the process means that these limits can be strictly enforced. The GS1 system has standards that specifically cater for the track and trace of these returnable assets and industry groups are currently working on further extending the standards to cover the additional data required beyond just identification.

All of these processes depend upon the accurate and timely capture of key data about the returnable asset. The previous methods of capture this data included human reading, optical reading and bar code scanning. It is important to understand that these methods work, and they have done so for decades. RFID is an improvement on these methods, in particular in the way that data can be captured completely automatically without the need to stop the flow of the container or orientate it in a specific way.

8. Counterfeiting et al

8.1 Introduction

One of the fastest growing concerns around the globe today is that of counterfeiting of goods that are then for sale. Criminals find this activity to be less risky, and at the end they have in their hands money that is genuine and legitimate. It is for this reason that counterfeiting tends to focus on goods which have a high individual item value, which are relatively small (and thus easy and cheap to transport) and relatively easy to manufacture. The earlier in the supply chain process these counterfeits can be detected the less risk there is that the goods will eventually reach the market. Until now there has been no readily available effective and viable mechanism for doing this. And although we have used the term counterfeiting here, in reality we have included four separate activities, which are often grouped under this label.

8.2 Counterfeiting

The first activity is straightforward counterfeiting as it is generally understood by most people. This is when goods are made to look as if they were made by a specific brand owner. In reality they were made by someone else and certainly did not use the same original ingredients, the same care of manufacturing or even the same manufacturing process as the original brand owner.

Perhaps the most obvious example is pharmaceuticals that contain nothing more than coloured chalk. If this “medicine” is essential for someone continuing to live, then the consequences can be deadly. A traditional way of detecting

this type of counterfeiting was to look for obvious signs of poor quality, such as packaging on expensive drugs that is poorly printed and out of register. Unfortunately, the counterfeiters are getting better and better at mimicking the original and of course, the introduction of very cheap printers that can match the best professional image has almost eliminated poor packaging as a clue.

8.3 Adulteration

The second activity is adulteration of the genuine product. Imagine a bar owner who buys genuine bottles of whisky, empties some of the product into empty bottles so that he can sell it in his bar, and he then refills the genuine bottles with some other cheap liquid so that the bottle can be resold. That bottle of whiskey resold no longer contains what it states as the content is on the packaging or the bottle. This activity is much harder to stop since both the packaging and the container are genuine, meaning that detection can only be effected by a professional analysis of the content.

8.4 Overproduction

The third activity is unauthorised production. Many brand owners today have outsourced the actual manufacturing of their product, which means the outsource partners have all the correct materials, equipment and processes to make the genuine article. For products that have very high margins it is attractive for that manufacturer to produce the article beyond the quantities ordered by the brand owner. That very high margin means that the overproduction can be manufactured at the same cost as the brand owner, sold at a price that considerably undercuts the brand owner and still produce a handsome profit for the manufacturer.

8.5 Market Diversion

The fourth activity is market diversion, often referred to as grey market activity. This is where genuine goods are offered for one market but diverted to another market where the same goods will command a much higher price.

Market diversion as such is not illegal in most markets in the world (notably North America and the European Union) but brand owners typically take steps such as restricting the warranty to only the intended market, as diversion undermines their pricing strategy in the second market. But this relies upon being able to easily determine which market the goods were originally “sold” into.

8.6 Anti-counterfeiting Measures

Perhaps the most important thing to understand about anti-counterfeiting is that, like all security problems, there is no perfect solution. What one human being can construct and devise another human being, given enough time and money, can deconstruct and work around. Anti-counterfeiting measures, therefore, are aimed at making it more and more difficult for the counterfeiter rather than total prevention. In reality, it is a question of making the counterfeit process much more expensive in terms of time, money and effort that it is no longer economically viable.

So where exactly can RFID and standards for identification can help with these issues? The answer lies partly with the fact that what is actually recorded on an RFID tag cannot be seen with the naked eye. This means that without the equipment needed to actually read the tag you cannot be sure what is, or more importantly what is not, on the tag. Note that this is also true to some extent for 2-D bar codes that do not have associated information alongside them in human readable form. The most important step in countering a security measure is to know that it is there in the first place.

Many RFID tags have a special area in which the unique identity of the physical tag can be recorded. This identity often takes the form of a manufacturer identifier and a serial number combination. In the GS1 Gen2 standard this combination is the Tag Identifier (TID). When an item is manufactured its identification is then linked with TID. This can be as simple, but very effective mechanism for determining if an item is genuine.

Is it possible for chips to be manufactured that look like genuine chips? Yes, provided you have the same very expensive equipment that created the genuine chips. This does not make it impossible to overcome this measure but it does probably make it no longer viable.

This method is effective against counterfeiting, but it is much more difficult to use against overproduction. To be effective their brand owner would have to have implemented very strict and effective controls over the allocation and use of the original tags.

The second measure is centred on an effective track & trace mechanism to determine where an item has been since it was created. Imagine capturing this event data about an item for every process that it undertook from manufacturing through to being sold at the retailer. If you can access all of this data, you would in effect have a complete history of where the item has been and when it was there.

The trick with this method is to either see things that should not be happening or things that should have happened which did not. This is sometimes referred to as unusual process.

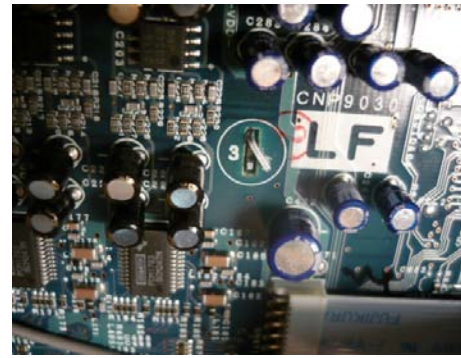
A practical example might be a Rolex distributor. Suppose we were able to look up the history of a particular watch and what we saw was the first event for that item was its arrival at the dealer. Why can we not see events for the watch being manufactured, dispatched from the factory or in transit? Simply seeing this data on its own, or rather simply not seeing it, doesn't tell us specifically what has gone wrong. But it does tell us that something almost certainly has gone wrong, which can be the trigger for further investigation to try to find out what.

Of course, this would require some mechanism by which all of the participants in the supply chain would need to be able to share event data up and down the chain. The best way to do this would be to have some standard method of achieving this. This is exactly what the GS1 Electronic Product Code Information Services (EPCIS) standards were developed for. These standards enable a common definition of events and business process underway, and exactly how to exchange this data.

They do not specify how the business application should actually work, leaving flexibility for those needing to use the data. But they do specify what the data looks like and how it should be exchanged in much the same way that the GSM system has done for mobile phones (that system does not tell you what to say on the phone, but merely ensures that what you want to say gets transmitted successfully).

In many ways this method is much harder for the counterfeiters to work around, as they would have to have access to the various supply chain participants' databases in order to launch false events in those databases. This is something that they are very unlikely to do.

One thing to note about this method is that it does not require RFID technology in order to work. The EPCIS standards work with any standard identifier within the GS1 system, and EPCIS is itself based upon XML, thus provides the capability of user-defined extensions to the data models. You could have captured the event data using bar codes, or even have keyed in data in yourself manually. However, RFID technology provides an automatic and accurate way of capturing this data.



The third measure has not, as far as we know, been put into practice although it is possibly a viable method. It relies on being able to block certain data into the tag so that it can not be subsequently altered or read by an unauthorised person. There are two ways of achieving this. One is by the use of a password, which is effectively a software lock. The second method is to use a chip, with part of the circuits possessing the ability to be written to once and then the physical ability to rewrite those particular circuits is removed. One method of doing this is to literally burn through part of the circuits. and this technique is sometimes referred to as “fuse link”. Once the circuits have been impacted in this manner there is no physical way of restoring them to their previous state so there is no physical way of rewriting them.

This technique has many potential uses and could include, for instance, writing the intended target market for an item onto its tag. That could then be compared to the actual market the item is found in. It can also be used to record the date of sale of an item so that warranty entitlement can be correctly established.

8.7 Conclusion

RFID does not provide a guaranteed way of preventing any of the problems we have covered under the general heading of counterfeiting. But it does provide various methods, which can help combat counterfeiting by detecting unusual movements within the supply chain and examining data carried on the tag and the data held elsewhere.

Not all RFID systems available today have the capabilities to enable this, but it is quite likely that as counterfeiting becomes an increasingly larger problem around the world more emphasis will be placed upon changing technology to provide more of these capabilities.

It should also be acknowledged that anti-counterfeiting techniques have been developed, or are being developed, that are far more sophisticated that those I have described here. In particular, the ISO Sub Committee 31 Work Group 7, with some of the best RFID and security brains out there, having been looking at this aspect of RFID. But those techniques are perhaps more applicable where extremely high security and level of protection against attack is required.

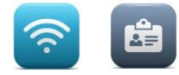
9. EPOD (Electronic Proof of Delivery)

9.1 Introduction

Now a business problem common to almost all businesses, the reconciliation of what is a supplier says was shipped against what the customer says was received. This process has many names, depending upon the industries involved, but for our purposes we shall refer to it as “receiving reconciliation”. This is a supply chain issue, so you may have expected it to have been covered in Chapter 5, but this combination of RFID technology, global standards and process innovation has such potential to improve supply chain efficiency and trading partner relationships that it warranted a chapter to itself.

The problem starts when a customer believes that what was ordered from supplier and what the supplier says shipped, is not what they received. There can be many reasons why the customer considers there is a shortage, ranging from an error on the part of the customer, such as miscounting, to theft in transit. We will not here focus on the reasons for shortages, but rather on a method to allow focus to be directed to instances when there really is a problem. I would also like to acknowledge the work done in this area some years back by Professor Sanjay Sarma and his team at MIT. Our team at HP conceived the possibility of using RFID this way without realising that Sanjay and his team had beaten us to it by a month or so. What follows below is based upon the work of both teams.

9.2 Accurate Receiving



Product receiving always implies that a standard is in use, even if only between the shipper and the customer. If they did not have a common way of describing the goods in their transaction then there would be no way to check what was shipped is being received. But equally, it makes little sense for manufacturers to agree to a separate standard with every customer that they have.

This is why industry tends to settle on a standard way of describing things across all parties, and the GS1 system standards were developed for just this purpose. The two most common standards in use for this are the Global Trade Item Number (GTIN) used to identify individual items and the Serialised Shipping Container Code (SSCC) used to identify logistics logical containers such as a pallet.

Imagine receiving a pallet that is physically secure in that it is wrapped and appears not to have been tampered with. It is also labelled with a SSCC and the shipper has already sent an Advanced Shipment Notification (or equivalent) message with the contents of the pallet. In most instances the process would be to scan the bar code pallet licence plate (SSCC) and then receive the pallet contents by using the SSCC to look up the contents in the receiver's system. This requires stopping the pallet and lining up the bar code SSCC so that it can be scanned. Should the SSCC also be in the form of an RFID tag, then this action is not necessary and the tag can be read automatically and 100% accurately as the pallet moves past the RFID antenna. But if the individual cartons on the pallet have also been tagged and it is possible to read all of those tags, then the pallet can be received and read automatically and accurately at carton level too.

Here the use of RFID combined with international identification standards can both speed up and improve the accuracy of the receiving operation. This also has another effect, which is perhaps not so obvious, that of improving inventory accuracy.

When receiving goes wrong it does not just have an impact on the relationships with the supplier, it has an impact on the receiver to. Imagine a pallet is received with six cartons of product A but it is received as product B in error. Your inventory management system will now tell you that you have six more of product B, and six less of product A less, than you physically have.

Over time, as the manager of any large operation will tell you, this leads to the wrong data being used for inventory replenishment orders end to the dreaded situation where you go to pick an urgent custom order only to find that you physically do not have the product. We have dealt with other issues for inventory such as obsolescence earlier in this book, but suffice to say that not having an accurate picture of your inventory is a terrible burden for any business. So the use of RFID technology and global standards in receiving can indirectly provide the benefit of improved inventory management.

9.3 Reduced Receiving Reconciliation

How does that improved receiving actually help to reduce the receiving reconciliation effort? The answer lies in the degree of automation that is possible using this technology. Assume that you are willing to consider goods to be received if the system correctly reads their tags. Now assume also that you are able to link the GTIN's and SSCC's to a specific purchase order that you have placed, or an invoice that your supplier has sent you. This is not as unusual as it may sound, as it is possible that the supplier included this information in his dispatch advice, or even that he has sent you details of his shipping "event" for these goods via the EPCIS standards (those standards include the ability to indicate the purchase order or invoice number).

Now it is simply a matter of setting up your system so that once it sees that all of the goods that should have been received against a purchase order have been received, then it just pays the invoice. This should vastly reduce the effort in both companies on the receiving reconciliation process.

If you wonder how bad that process can be, that picture of the pile of paper is what was sent from one global corporation to another as part of the reconciliation process for just one order.

Using EPOD enables both companies to concentrate on what appears to have gone wrong, rather than what is known to have gone right. Indeed, if the event information of the goods being received is shared with or accessible to the supplier, then the supplier could automatically raise the invoice knowing that everything has been received and that the invoice will be paid without any deduction for shortages or incorrect shipment. You can then fully automate the payment and reconciliation of the purchase order, invoice and payment all based upon being able to accurately and quickly confirm what it was that you received.

9.4 Improved Supplier Relationships

There is one more major advantage to be extracted from the use of the EPOD system, that of improved supplier/ customer relationships. Current receiving reconciliation processes are quite adversarial in their nature. You said that you send me "x" amount of goods and I'm telling you that I received "y" , and I'm not paying you the full amount until you prove to me be on any doubt that you did actually send "x".

What EPOD does is to reduce the problem down to the facts that everyone trusts. It does take a degree of trust for this to work, because any system could eventually be abused. However, the question you have to ask yourself is "is the financial risk that I take from using this system less than the amount of money they spend on the current one?". If the answer is "yes" then using EPOD make sense.

9.5 3rd Party Reconciliation Services

One last thought before we leave EPOD. What if all the event data for shipping and receiving, together with details of the purchase orders and invoices, was sent to a 3rd party who independently performed the reconciliation. Any discrepancies that appear to be genuine issues with the shipment could be referred back to the parties for further action, but any transactions that have gone smoothly would require no further action on behalf of the shipper or the customer. This is the same type of reconciliation service that is in use in banking, airlines and mobile phones.

10. Outside Of Supply Chain

10.1 Introduction

So far in this book we have focused on commercial supply chains all the way from raw materials through to sale to the consumer of the goods and back again for purposes such as warranty and repair. This could lead to the impression that these are the only places where RFID technology and standards for identification are used, and this would be misleading. We do not have space within one book to go of all the possible uses for RFID, but no book on this subject could really be complete without at least some reference to the many other uses to which RFID is put. Below you will find descriptions of just some common other uses for the technology.

10.2 Road Tolls

RFID has been used for many years in various parts of the world for the collection of road tolls. Initially, these systems used active tags with their own internal lithium batteries. In the last few years considerable progress has been made in the use of passive UHF systems for this purpose. Perhaps the most famous; and one of the oldest, systems of this type is to be found in the city of Singapore's Electronic Road Pricing (ERP). This system identifies every vehicle entering the city centre and charges a differing fee depending upon not only the time of day of entry, but also the level of congestion in the city at that specific point in time. In the USA there are many toll roads alongside the Interstate system and these too rely heavily now on RFID systems.

At the time of writing various toll authorities in the USA are testing systems that rely solely on cameras to record the vehicle licence plate and charge the toll according to the type of vehicle and owner in the system that records such details, usually maintained by the government.

10.3 Automotive Industry

The automotive industry has been using RFID systems for decades. These systems were typically proprietary and not shareable across different manufacturers. In today's financial climate the manufacturers seek and need every cost-efficiency advantage that they can possibly get, including the use of RFID. RFID systems are used to locate completed vehicles in the lot before distribution, and one manufacturer has been tagging seats that are delivered from a supplier to make sure that the correct seat goes into the correct vehicle. That last implementation has reduced the number of incidents of incorrect seat installation by a staggering 95%.

Almost all vehicle key fobs today are RFID-based, and they are sophisticated enough to prevent the code transmission to the vehicle being intercepted and reused. Imagine driving into your local vehicle service centre to be greeted by a sign and told which bay to drive your vehicle directly into.

That is because the system is identified your vehicle and it knows what you have come in for. Additionally, there has been some recent work in the automotive industry in Germany to look at using a global standard for the identification of parts. Many parts are made by an automotive supplier for more than one Original Equipment Manufacturer (OEM), and each OEM then asks that the part has a specific identification reference. From the OEM's perspective this works just fine. From the suppliers perspective it is very inefficient. Why not use just one identifier for each part made by a supplier that could then be understood and used by all OEM's.

10.4 Animal Tracking

LF (Low Frequency)RFID has been used for animal tracking for decades. It works particularly in the presence of water and animals of course have a lot of water in their bodies. Recent trials conducted by GS1 in New Zealand with UHF have shown that this too can be used successfully in tracking animals, particularly very fast animals such as deer, who pose problems for the relatively slow data transfer rate of LF. GS1 Denmark has also been conducting similar trials with pigs. Today, domestic animals such as cats and dogs often have a small RFID chip embedded under their skin. It is painless, and should they ever get lost and brought to a veterinarian the chances are that the first thing that the veterinarian will do is to see if the animal has a tag under their skin. Reading the tag is painless and there is no information about the owner actually on the tag itself. The veterinarian simply contacts a central registry with the code and is then put in touch with the animal's owner.

10.5 Military

The military have long had an interest in RFID. Indeed, it has its roots in a military application in World War II as a means to distinguish enemy from friendly aircraft returning home. The British implemented the first system which they called "Parrot" as it talked back to you. Today, pilots are still instructed by air traffic control to "squawk" their aircraft's identity. Active tags have been used to track containers for the United States Department of Defense since the early 1990s, a system that has also gone into commercial use. One of the worst experiences in any military operation is known in NATO parlance as a "blue on blue".

Basically, this is a military force mistakenly attacking itself instead of the enemy. Various measures are taken to prevent this, but the one that is most visible on the newsreels is the use of large markings on tanks, vehicles ships etc to enable their visual identification from the air. Sometimes this system simply does not work very well and mistakes are made, and such mistakes can result in death.

Another military application is the automated tracking of parachutes. Should an error in packing be discovered then it is very important that all chutes packed at the same facility at that time are quickly retrieved and taken out of service. Previously, a small slip of paper, contained detailed of when and where it was packed and by whom, was inserted into a pocket on the outside of the pack. Executing a recall meant extracting this slip and examining the details to see if that chute had to be withdrawn. Now many chutes can be checked at the same time by loading the target identifiers into a handheld and scanning.

Trials are also underway in various countries including the USA to tag individual weapons so that they can be issued from and returned to the armoury much faster than using manual processes. Anyone who has returned from exercise or deployment knows the aggravation of having to wait in line at the armoury until your weapon can be received.

10.6 Passports

Many countries in the world now issue electronic passports, and for some countries this type of passport is acceptable for entry. These passports contain a short range HF RFID tag, which contains details of the bearer of the passport and follow an international standard set originally by the International Civil Aviation Organisation (ICAO). The standard actually allows for the electronic recording of visas, which not yet implemented by any country, will be very welcome news for frequent travellers.

Back page of UK Passport with RFID tag visible

10.7 Child Safety

Child safety is always an emotional issue. After incidents where children were abducted from schools, one Asian country asked each child to wear a tag so that any departure from school in normal school hours could quickly be detected. The parents had to give their consent to this and it did stop further abductions.

10.8 Libraries

Anyone who has ever borrowed books from the library will know the tedium of waiting in line to either return or checked out books. One of the very first library RFID systems was installed in the Singapore Central library 14 years ago. Returning and borrowing books became a very simple process, which took hardly any time at all and did not involve another human being. Those early systems did have some drawbacks, and a decade of use and experience has led to significant refinements in RFID systems for libraries, including the ability to tag DVDs and CDs, once thought impossible because of their metal content. Hong Kong City University library is now run completely using RFID. The students are happy because they do not waste time in line and staff are even happier because they can do what they enjoy doing most, helping students with their book selections..

10.9 File Tracking

The last time you went to your doctor when you were standing at reception did you look behind the receptionist? If you did there is a fair chance that what you saw was rows and rows of filing cabinets. Most organisations have locations where the files are kept, and in very large organisations they often have special warehouse or other storage facility to keep files. The medical and legal professions, as well as the military and military suppliers, all tend to generate large volumes of files,

many of which must be retrieved on a regular basis. The old method of looking at writing on the file, often on a tag that sticks out, is very slow and very inefficient. What if you are able to use some form of electronic scanner, which, as you walked down between the filing rows, told you exactly where the file you are looking for was?

Such capability is available and in use today. A tag with a unique identity is attached to each file when it is created. The location of that tag can then be determined down to a very short distance by measuring the strength of the return signal from the tag. This can then be indicated by audible signals such as beeps that vary in volume and frequency in ration to the signal strength. This has made finding a file a quick and relatively painless exercise. The US Department of Defense has implemented such a system for one of the centres of family medical records, but such a system can be used almost anywhere that files are stored and need to be retrieved.

10.10 Toys

Let's finish this list with the most enjoyable of all of the examples. For many decades now children in Western countries have played with either Ken or Barbie, those famous toys for younger children. But wouldn't it be nice if Ken and Barbie had been able to greet each other as soon as they were in the same area? Well, now they can. Toys are being manufactured with both chips and small RFID readers in so that they can recognise other toys in the same family and then be prompted to say something interesting to them.

How long will it be before our domestic robot recognises us as soon as we come home from work and greets us in the most pleasant and relaxing manner.

11. The Environment

11.1 Introduction

There are numerous ways in which the RFID and international data standards combination can help minimise adverse environmental impact, both directly and indirectly. Some of these are considered below in the context of the generally accepted approach to environmental protection: "*RRRRD*". This is a useful acronym for remembering the basic steps of reducing environmental impact.

- **R**educe – reduce the use of materials that are harmful to the environment.
- **R**euse – reuse something already made instead of consuming more of the earth's resources to manufacture it again. This also avoids the release of greenhouse gases during manufacture and potentially reduces impact from landfill.
- **R**ecycle – recycle materials at the basic level, especially for material that is easy to recycle and which is also easy to separate for recycling.
- **R**ecycle – recycle materials at the elements level, usually where special processing must be undertaken to separate out harmful material for recycling or disposal.
- **D**ispose – material has no further use and cannot be recycled in any way.

11.2 Reduce

There are three basic ways in which to reduce the amount of materials used within supply chains.

11.2.1 Store Less Materials

The first is to reduce the amount of materials carried in inventory to manufacture an item. Manufacturing consumes raw or semi finished goods and that generally means holding an inventory. How does this impact the environment?

Materials that do not get used for further processing, or get bought by an end user, must eventually be disposed of and they would have produced some greenhouse gases during their own manufacture. The use of RFID and identification standards to make supply chains more efficient in terms of inventory levels reduces the level of inventory not used in manufacturing and which have to be disposed of.

11.2.2 Use Less Materials

Second is the reduction in material used to make each item. It is much more difficult to establish a direct link between the use of RFID and standards and the ability to reduce materials in an item.

11.2.3 Use Less Packaging

Third is the reduction in packaging that the item is transported and sold in. The most commonly transported commodity on the planet is probably *air*. A significant amount of packaging is there to prevent theft as illustrated by the packaging on Gillette Fusion® razor blades. What if a way could be found to detect that razor in the pocket regardless of how it was packaged? RFID coupled with GS1 identification standards has already been used as a replacement for older EAS systems. None of the EAS systems are perfect, and a determined and knowledgeable thief will outwit them all including RFID.

However, being able to use the same system for both identification and theft prevention is an attractive proposition for many retailers so it is quite likely that RFID developments will enable this. Should that happen then the need to package easily stolen items into large packaging units will disappear, which should in turn reduce the amount of material used in that packaging.

11.3 Reuse

Sometimes, there are limits to how many times something can be reused or on how long something may be used in service. An example of this is undercarriages for aircraft as they have limits for the number of take off and landing cycles, as well as on how long a unit can be in service without being overhauled.

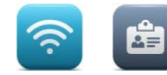
RFID and identification standards can help these controls by enabling the correct identification of the item every time and even recording usage on the tag. There are trials underway to test the concept in industries such as aerospace.

11.4 Recycle 1

The key to recycling is to know what an item is made of. Where an item consists of multiple components, then the same applies to each component. Knowing a bottle is made of plastic #1 means that it can be sent through the correct recycling process with other similar items. Today this is achieved by manually sorting the material to be recycled based upon a human being's visually inspection of the recycling code on the item. And this can lead to some interesting problems. Hewlett-Packard offers a free return service for used ink jet cartridges in North America, processing millions of them every year. They then recycle the cartridges based upon cartridge type, however as the plastic and metal content may vary they have to sort them visually. If the cartridges were tagged then they could

be sorted automatically at high speed. This technique could be applied to almost any item where identification is difficult and correct identification very important.

11.5 Recycle 2



In 2nd level of recycling is material that requires special handling and/or disposition that must be extracted from the item. This is different from 1st level in that it is more than just physically separating components that are made of different materials. The best examples of this are compact fluorescent light bulbs (CFL's) with their high mercury content, or lead solder that may exist on older printed circuit boards (PCB's). In both cases special processing is needed to carefully extract the material that is potentially harmful to the environment so that it can be safely reused or disposed of. An item that is tagged can be correctly identified automatically which aids sortation for processing in much the same way as it does for Recycling 1.

11.6 Environmentally Friendly Disposition

Data can be held on a product's RFID tag that indicates what type of material a product contains so that proper precautions can be taken to ensure that it is correctly disposed of. Of course this could be done by reference to the system that originally built the product, but there is no guarantee that the system is still available of can be accessed by the part carrying out the disposition.

11.7 RFID Tag Disposition

One further topic needs careful consideration and that is disposition of the RFID tag itself. Active or semi-active tags, both of which contain batteries, must be disposed of as with any other battery device. But these are usually very expensive compared to the value of most items tagged so do not form the majority of RFID tags within a commercial supply chain. Passive tags, which contain no power source of their own, form the vast majority of applications in such process chains. But passive tags still contain a silicone based Integrated Circuit (IC) or "chip", adhesive and a metal based antenna. It is these that could cause concern for contaminating the recycling processes for paper based packaging.

The Paper Industries Research Association (PIRA) issued a report in December 2005[2] that concluded that:

> "The presence of RFID tags in recovered paper and board will increase metal contents of recovered fibre and increase adhesive contamination. Such loadings however are not expected to significantly increase overall mill quantities. Current mill procedures are expected to handle these increases."

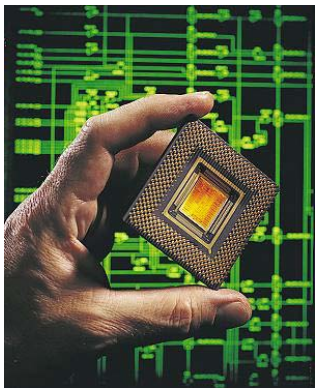
But some metals in recycling steel can be a serious issue. In 2007 the American Iron and Steel Institute concluded that at the very high temperatures of steel making, aluminium from RFID tag antennas would vaporise but that copper would be devastating for steel recycling, as the copper would irreversibly change the steel output to be too soft or hard for many uses. Even so, the use of RFID for controlling processes within the steel industry is increasing as indicated by the Falken Secure Networks project with Thyssen-Krupp Steel[3]

[2] "Possible issues surrounding the recycling of boxes with RFID tags", Pira International, December 2005

[3] Falken Secure Networks "RFID for the Steel Industry" Application Brochure 0823

12. Closed Loop Supply Chains

12.1 Introduction



And last but not least the closed loop operations. Left until last because it is perhaps the most interesting conundrum in any supply chain and also the least well understood.

The expression originates from describing supply chains, which were totally under the control of one entity. Today, outsourcing of parts, or even all, of a company's supply chain is common place. If you have a laptop then there's an excellent chance that it was not made by the company whose logo adorns its surface. Most laptops are made by one of a small group of Asian companies known as Electronic Contract Manufacturers (ECM's). But this is a relatively modern phenomenon, which has arisen in the last 20 years. Before then most brand owners owned and managed their own manufacturing sites and operations.

Digital Equipment Corporation (DEC) was a classic example of this closed loop structure. In the 1980's, long before its acquisition by Compaq Computer Corporation in 1998, DEC owned and managed operations literally from converting raw silicone into VAX or Alpha chips through building high end servers to installing them, servicing them and providing consumables such as tapes and disks. DEC had control of the entire process from start to finish. They relied upon no one else except their raw material suppliers and had a truly closed loop environment.

12.2 Outsourcing Takes Hold

Much has changed in the 25 years since the environment described for DEC. DEC was acquired by Compaq in 1998 and Compaq in turn was acquired by HP in 2002.

Today HP manufactures only high end servers with all other manufacturing having been outsourced along with all logistics operations. Let's now turn to the apparel industry. Many retailers label their apparel with the international Global Trade Item Number (GTIN) from GS1. This ensures that a product has a unique identity worldwide and that no other product will ever have that identity. But some apparel retailers, including some major brands, use their own identification systems and specify exactly what the supplier must do in terms of

- Identification system used.
- What form the physical identification will take (on garment, hanging tag, combined price and identification tag etc.).
- Where the tag should be placed or attached to.

To quote one major chain executive from my meeting with him a few years ago:

> "We don't need standards, we have our own. Our supply chain is completely closed loop and we are big enough to tell our suppliers exactly what we want and expect them to do precisely as we say".

Was he right? After all, they really did have control of the supply chain from raw material to finished goods at the point of sale.

12.3 From The Supplier's Perspective

From the perspective of that chain store everything is just fine. Our suppliers do what we tell them or we drop them. Being one of our suppliers is considered a huge plus in the industry so we are never short of suppliers wanting to do business with us.

But what if that supplier is supplying other companies too? And imagine that they too demand that things are done "our way" and that the various forms of "our way" are all different. From the suppliers perspective there is nothing closed loop about what is happening, there is only the frustration, time and cost incurred in:

- Intervening in standard operating procedures to apply a different process for a customer.
- Carrying different forms on material inventory for labels and tags.

- Maintaining multiple Bill Of Materials (BOM's) for the different product configurations.
- Training employees on differing customer dependent processes.
- Carrying different forms of the finished product inventory.
- Loss of flexible in assigning finished goods inventory to customer orders.
- Risk of customer dissatisfaction through incorrect application of customer dependent processes.

So, one man's perfect closed loop supply chain is another man's nightmare open loop supply chain. As long as the supplier is supplying multiple customers then the inward looking view that because our suppliers do what we tell them then we have a closed loop supply chain is a fallacy. All of these costs have to be recovered somehow from someone and when this was pointed out the executive was clear that it did not impact them because:

> "We don't permit additional costs to be added to the price quoted".

Let's assume that all of a supplier's customers took this stance. Does that mean that the supplier continues forever accruing costs that are never recovered? If they did then of course they would go out of business. The fact is that a company will recover its costs somehow or it will not survive, and it will usually do so by building that cost recovery into the base price. If all suppliers do this then the industry has no choice but to pay for that cost recovery. The notion that just because you can't see the cost called out on an invoice means that you aren't paying for it is another common fallacy.

Global standards were created to help industry avoid just these types of situations and to remove unnecessary costs, time and effort from the supply chain processes. Perhaps one of the best examples of what happens without global standards is the "travel adapter" for making sure that the electronic equipment you take with you

can be supplied with power in another country. The number of possible formats for electricity plugs and sockets is simply staggering.

12.4 If it's Really Closed Loop....

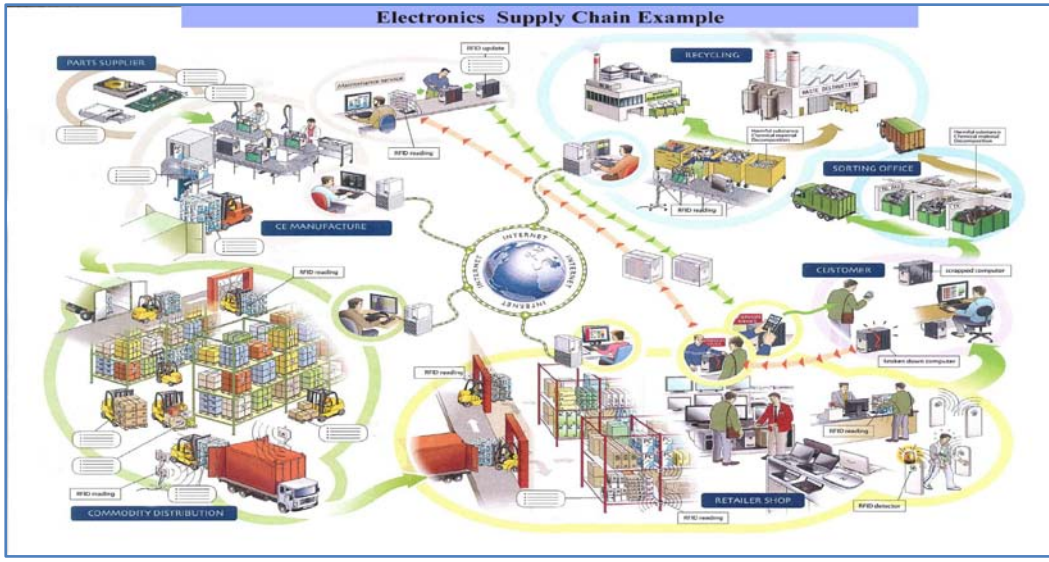
When it is really closed loop then in theory you do not need external standards but you might want to use them anyway because:

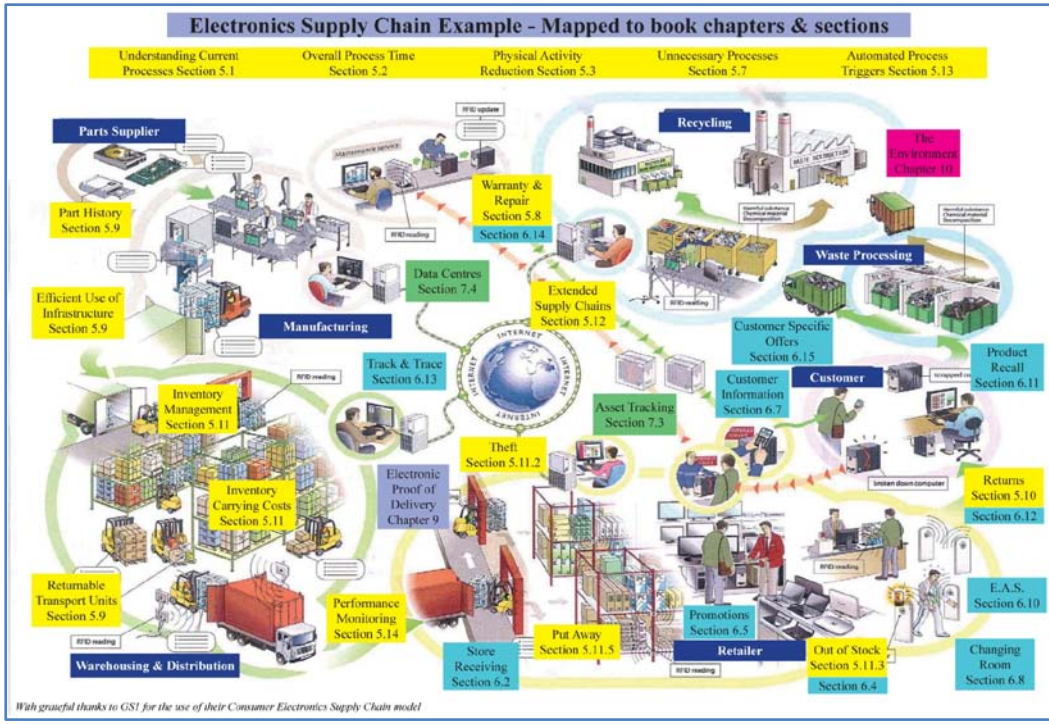
- There is little point in reinventing something that somebody else already has working.
- Development of those standards is usually done by a collection of industry members collaborating together for their mutual benefit, and many minds working on a problem are usually better than just one or two.
- If your company expands into multiple sites then standards help both the commissioning of the new site and ongoing operations.
- Different cultures/countries have a tendency to be different in how they tackle the same problem even when a common approach would work perfectly well. Adopting and using global standards can counter this tendency.
- If you ever decide to outsource part or all of your operation then standards will ease the transition and avoid costly set up on the part of your outsourcing vendor.
- Participating in the development of standards presents an excellent opportunity to meet others in the same industry and even others in different industries who execute like processes. The cross pollination of ideas from this can result in serious benefits in terms of process improvements and benchmarking.
- Closed Loop operations sometimes become Open Loop once those managing the closed loop operation see the potential benefits for the chain as a whole obtained from sharing information across the chain in a standard way. If you use standards in your closed loop operation then the transition is painless and quick

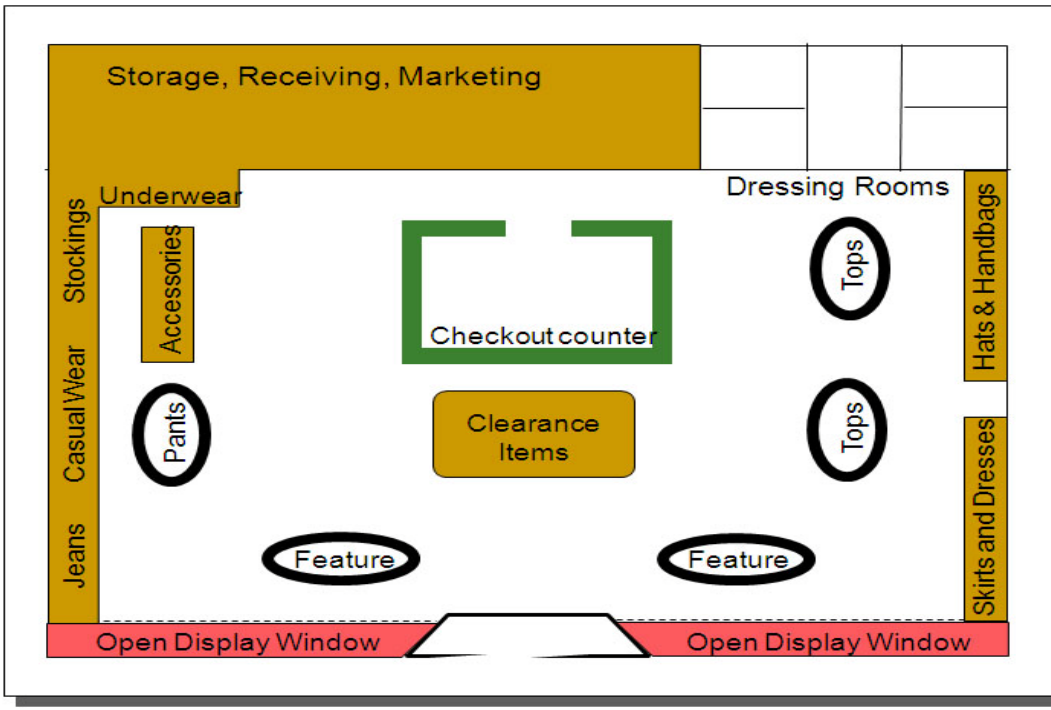
Appendix A RFID & Barcodes Comparison

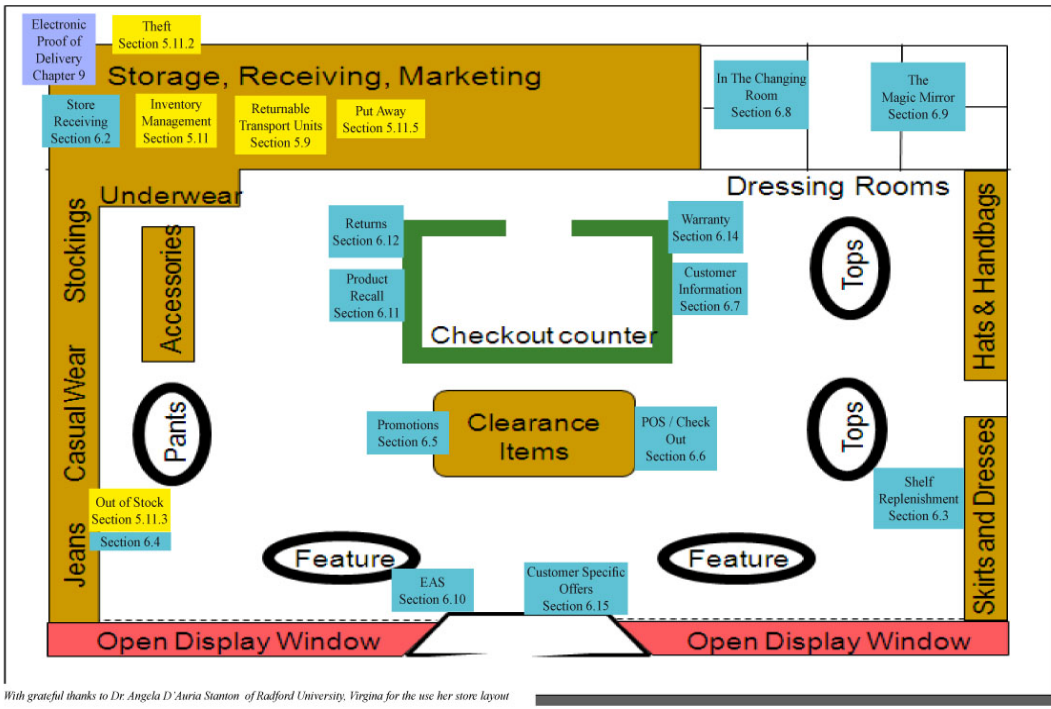
Characteristic	Bar codes	RFID
Data transmission	Optical Infra Red / Photograph	Electromagnetic / Wireless
Reading capability	Requires line of sight <> azimuth for Beam return	Requires energy path but not line of sight
Reading sequence	Linear - One at a time	Linear - high speed so appears instantaneous
Reading speed	≤ 80 per minute	≤ 500 per minute
Read moving objects	Yes - Generally requires conveyor system to move object being read	Yes - no special equipment required
Data modification	No - Write Once Read Many	Yes - Write Many Read Many
Data capacity	≤ 100 bytes	1 bit - Megabytes
Access security	Low, possible if barcode hidden	Can be high
Anti-collision	Not applicable since read is linear	Yes - Depends upon protocol used but most have anti-collision
Tag/Label Cost	Very low	Depends upon tag type but as low as US 6 cents in high quantities
Infrastructure cost	Varies from low for handheld to high for 3D conveyor scan systems. Generally < RFID	Varies from low for handheld operation to substantial for large areas such as ports

Appendix B Process Maps









With grateful thanks to Dr Angela D'Auria Stanton of Radford University, Virgina for the use her store layout