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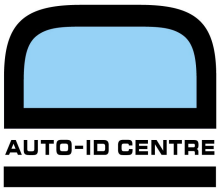

WHITE PAPER

Use Case approach for determining the impact of Auto-ID implementations on Business Information Systems

Humberto J. Moran, Duncan McFarlane, Timothy P. Milne

AUTO-ID CENTRE INSTITUTE FOR MANUFACTURING, UNIVERSITY OF CAMBRIDGE, MILL LANE, CAMBRIDGE, CB2 1RX, UNITED KINGDOM

ABSTRACT

Auto-ID technology offers a wide variety of potential applications at many levels in the supply chain. Many authors have written about the vast possibilities brought by this revolutionary technology, which goes from simple process improvement applications to radical innovations effecting entire business models. Nevertheless, the real impact of the implementation of most Auto-ID applications is sometimes underestimated, undervalued or simply disregarded. In particular, the impact of Auto-ID applications on existing information systems has not been researched in great detail, although it is believed to be important. This paper proposes using a structured approach to identify major changes required by Auto-ID implementations in operational procedures and their supporting information systems. This approach consists of:

1. finding representative use cases for either process or business improvement – in terms of current operational procedures, issues, and implementation possibilities;
2. contrasting their associated operational procedures – if any – with the proposed ones, and,
3. identifying the additional data and transactions required in their supporting information systems.

This white paper also provides examples in the form of a list of Use Cases, their generic supporting procedures and information systems, and the proposed procedure and system changes. It is part of a series of industrial studies under preparation in which the approach will be used to analyse in detail Use Cases and derive their implications on information systems.

WHITE PAPER

Use Case approach for determining the impact of Auto-ID implementations on Business Information Systems

Biographies

Humberto J Moran
Senior Research Associate

With more than ten years of experience in information system implementation, Humberto Moran has occupied relevant positions in leading corporations such as Unisys, Lafarge, Oracle, and his own entrepreneurial venture. He has studied Computer Engineering – "Universidad Simon Bolivar"/Caracas; a Ph.D. in International Economics – "Universidad Complutense de Madrid"/Madrid; and an MBA in the Judge Institute of Management, University of Cambridge.

Duncan McFarlane
Research Director Europe

Duncan McFarlane is a Senior Lecturer in Manufacturing Engineering in the Cambridge University Engineering Department. He has been involved in the design and operation of manufacturing and control systems for over fifteen years. He completed a Bachelor of Engineering degree at Melbourne University in 1984, a PhD in the control system design at Cambridge in 1988, and worked industrially with BHP Australia in engineering and research positions between 1980 and 1994. Dr McFarlane joined the Department of Engineering at Cambridge in 1995 where his work is focused in the areas of response and agility strategies for manufacturing businesses, distributed (holonic) factory automation and control, and integration of manufacturing information systems. He is particularly interested in the interface between production automation systems and manufacturing business processes.

Timothy P. Milne
Masters Candidate, MIT Lab

Timothy Milne received Bachelor's and Master's Degrees from Brigham Young University where he graduated with honors from the Department of Mechanical Engineering. At BYU he was involved in the Computer Aided Design (CAD) and Computer Aided Geometric Design (CADG) labs. His Master's thesis presented a new method for topologically mapping arbitrary N-Genus surfaces to single planar domains. Mr. Milne later developed CAD software for various industries including the Aerospace Corporation, Rhythm and Hues Studios, and Varimetrix Corporation. Most recently he worked for Corrpro, a corrosion protection consulting firm, writing a software package for corrosion protection management.

Mr. Milne will receive a Masters in Engineering from MIT in Spring 2003. His work at the Auto-ID Center includes the Physical Markup Language, which describes physical things in a platform neutral format that can be used by companies and people involved in all aspects of supply chain management.

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Contents

1. INTRODUCTION

1.1. Background

1.1.1. Business Information and Industrial Control Action Group

This research is part of the Auto-ID Centre's Business Information and Industrial Control Action Group activities. Combining both theoretical research and industrial developments, this group aims at identifying the impact of Auto-ID on business information and industrial control systems and developing frameworks, models and methodologies to deal with this impact and provide sound integration alternatives. The Business Information and Industrial Control Action Group deals with business activities supported by commercial and bespoke information systems, covering a broad area ranging from Auto-ID business strategy to Auto-ID use cases development and their impact on existing technology for business automation.

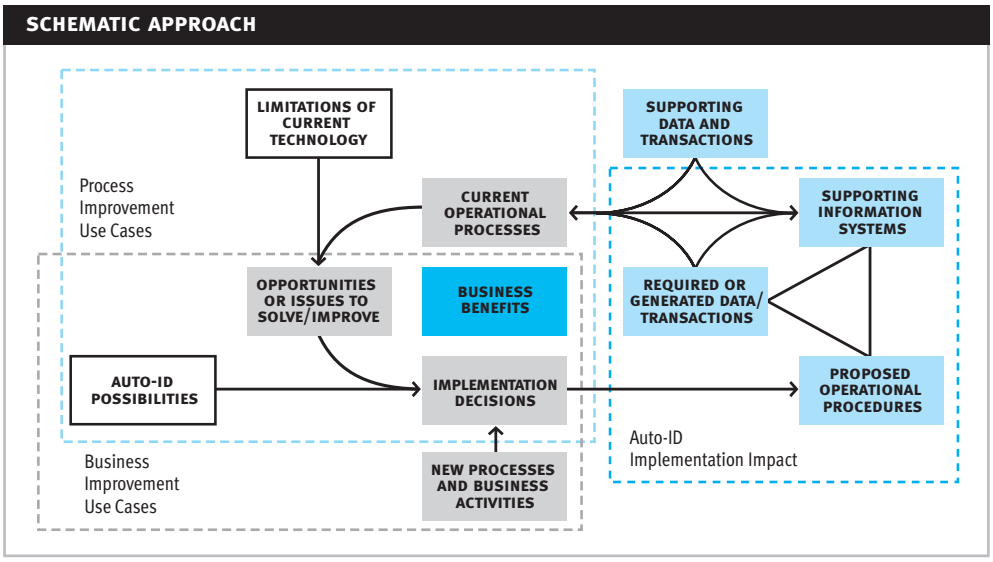
1.1.2. Previous Works

This paper includes ideas from other previous documents: Timothy Milne and Amit Goyal's "Track and Trace Shipping and Verify Receiving Use Case" (Auto-ID Centre – April 2003, unpublished to the day of writing this one), Timothy Milne's "Sub Group and Use Case Focus Group Methodology" (Auto-ID Centre – November 2002), Duncan McFarlane's "Auto-ID Based Control – An Overview" (Auto-ID Centre – January 2002), and "The Intelligent Product Driven Supply Chain" (Auto-ID Centre – January 2002, see references for list of authors), among others. Yoon Chang and Duncan McFarlane have also proposed specific methodologies to support the integration of Auto-ID and business information systems, and have provided a thorough classification for the last ones and an example of use case – see "methodologies for integration Auto-ID Data with existing Business Information Systems", Auto-ID Centre, November 2002 (see references for list of authors).

1.2. Document Structure

This document covers the concept and classification of Use Cases, their basic components, the required steps to identify supported information systems and related data and transactions, the generation of Auto-ID proposed operational procedures and required or generated data, and transactions. How all these elements link and interact with each other during the analysis is shown in the following illustration:

Figure 1



This diagram defines 3 sets (dashed outlines): process improvement use cases – light blue, business improvement use cases – grey, and Auto-ID implementation impacts – dark blue. Both use case types seek business benefits, though their components are slightly different. The rationale is as follows:

1. PROCESS IMPROVEMENT USE CASES
Their analysis is as follows:
a) the identification of the current operational processes, which serves to
b) identify improvement opportunities and/or issues to solve – which might be the consequence of limitations of the technology in use, and to
(c) make implementation decisions – which might be conditioned by Auto-ID possibilities.

2. BUSINESS IMPROVEMENT USE CASES
Their analysis follows these steps:
a) the identification of new business opportunities based on Auto-ID capabilities,
b) the design of their related new processes and business activities. These two elements serve to
c) make implementation decisions.

3. IMPLEMENTATION IMPACTS
Having identified and fully defined the Use Cases, the implementation impacts come from:
a) the identification of supporting information systems for current processes,
b) the identification of their supporting data and transactions,
c) the design of alternative processes and operational procedures, and
d) the identification of the required data and transactions to support these procedures.

4. RECURSIVE IMPACT
Finally, modifying the current data and transactions might imply modifying related procedures not directly benefited from Auto-ID which may generate important data to the previous processes or are indirectly effected by the main implementation. This link starts the cycle over and over again until all related procedures are modified.

2. USE CASES

Use Cases are applications of Auto-ID to an ongoing economic activity seeking direct or indirect business benefits. Like many other technological advances, Auto-ID should not be implemented for the sake of technology. It is its correct use which brings competitive advantages to business: Auto-ID implementations should be closely linked to and driven by the business strategy and the benefits they bring. Consequently, every Use Case should be closely examined and classified within the business needs and possibilities. In this sense, this paper proposes two major classifications for Auto-ID Use Cases: those aiming at improving operational processes within the business – Process Improvement Use Cases, and those aiming at improving the business itself – Business Improvement Use Cases. The basic difference between both is their scope and nature of benefits. That is, the benefits that result from process improvements use cases effect few actors, are normally clearly located and easy to see; whereas those that come out from business improvement use cases impact many more players – even beyond company boundaries, and are more intangible. Though in some use cases the border between process and business improvements is blurred, and every process improvement brings indirect business improvements at the end of the day, this classification helps to identify the required elements and steps to guarantee sound implementations and to determine the organisational impact of Auto-ID adoptions.

2.1. Process Improvement Use Cases

2.1.1. Definition and Classification

Process Improvement Use Cases are specific Auto-ID applications aiming at improving an operational process to directly or indirectly achieve business benefits. They aim at improving specific business operations. Consequently, they are limited in scope and objectives and focus on a particular area, department or activity. The nature of these benefits might vary, and can be classified with:

Cost reduction: direct cost reduction as a consequence of more automation, control etc. For example, reducing manual product scanning might reduce labour costs.

Productivity increase: more efficient use of existing resources – indirectly related to cost reduction. Two good examples of these improvements are optimising warehouse space or speeding up the manufacturing line.

Service improvement: providing customers with better services such as up-to-date and accurate product information or faster attention.

Error reduction or detection: reducing or detecting errors in operational processes to reduce uncertainty and cost, comply with regulations, and improve efficiency – indirectly related to cost reduction as well. For example: detecting cross-contamination in the food manufacturing industry.

Information collection: enhancing the collection of operational information to support other business activities. For example, gathering information about consumer behaviour to improve marketing decisions – e.g. trolley tracking in a supermarket.

Reduction of negative externalities: reducing or avoiding undesired effects such as pollution or poisoning resulting from operational activities – e.g. using Auto-ID to enable selective package recycling.

2.1.2. Components of Process Improvement Use Cases

A Process Improvement Use Case is defined by the process or processes it improves, the issues to solve or improve, the implementation decisions, and the potential business benefits it has. It can optionally include a list of limitations of the current technology – as a way of justifying Auto-ID, and the Auto-ID possibilities specific to the Use Case. In the analysis, components should be detailed as follows:

Processes to improve: processes, actors, procedure steps, product and information flows, activities, level of automatism, decision points, contingency plans, and supporting assets – equipment, physical space etc. One example is the replenishment process in a supermarket, in which actors are employees bringing products to the shelf from the backroom after receiving replenishment instructions from a computerised report, and using specialised equipment such as wagons to carry the products and PDA to count them. To properly illustrate the Use Case procedures we suggest using the Use Case documentation methodology in Timothy Milne's "Sub Group and Use Case Focus Group Methodology" (see references for details).

Opportunities and issues to solve or improve: current areas of dissatisfaction, problems, and/or improvement opportunities. Some examples are shrinkage or product misplacement reduction in a warehouse, or the opportunity to adopt the one-touch replenishment approach in a supermarket.

Implementation decisions: different Auto-ID implementation possibilities solving the issues or providing the previously identified opportunities. Some examples of implementation decisions are reader location/types; complementing hardware such as warning lights, electronic eyes, robots, etc; and complementing software such as triangulation algorithms or the like.

Potential benefits: list of expected qualitative and quantitative benefits that result from the implementation. Sometimes quantitative benefits are hard to value due to the lack of quantitative data for the current processes, their dependency on implementation decisions, and the natural uncertainty of technology implementations. Nevertheless, this paper recommends collecting at least the qualitative benefits. Some examples of potential benefits are cost reduction consequence of reduced shrinkage in a supermarket's warehouse; increased customer loyalty result of improved customer check-out process in POS; etc.

Limitations of current technology: specific characteristics of the current technology which hinder the desired improvement or make it impossible. For example, the prohibitive cost of manual product scanning in order to improve inventory visibility in a big warehouse.

Auto-ID possibilities: specific characteristics of the Auto-ID technology that allow the proposed improvements. For example, the fact that Auto-ID does not require line of sight as an advantage in product scanning, or the automatic nature of Auto-ID readings. In general, the main Auto-ID possibilities leveraging process improvements derive from Auto-ID tracking, tracing and automation capabilities – its RFID capabilities.

2.2. Business Improvement Use Cases

2.2.1. Definition and Classification

Business Improvement Use Cases are applications of Auto-ID with major business consequences. This is, they provide new business opportunities or radically increment existing competitive advantages. For example, Auto-ID can be used to automatically track individual product items in the manufacturing line to enable full product customisation; generating significant competitive advantages in markets where a product differentiation strategy is a fundamental business driver. Another example is gathering information about consumer behaviour – e.g. in a supermarket, to sell it to specialised marketing companies.

The nature of the business benefits resulting from Auto-ID implementations which seek business improvements vary, and can be classified as follows:

1. **Product development/improvement:** using Auto-ID to dramatically improve existing products or develop new ones – e.g. fully customised products or intelligent products able to control their usage.

2. **Service development/improvement:** using Auto-ID to dramatically improve customer services or provide new ones – e.g. provide additional product information to consumers or enabling automatic shopping via internet based on stock-outs.

3. **Collaborative supply chain enhancements:** improve the supply chain planning and execution – procurement, manufacturing, fulfilment – based on inter-organisational cooperation and information interchange – e.g. enabling online Direct Inventory Management (DIM) by means of Auto-ID.

4. **Creation of new business models:** as the internet has changed the nature of business, Auto-ID can be similarly used to generate new business models. For example, Auto-ID implementations will generate valuable information about products in the supply chain, which could be traded or used to develop other businesses, and create disintermediation and re-intermediation opportunities in the supply chain – e.g. direct product delivery from manufacturers to consumers.

2.2.2. Components of Business Improvement Use Cases

A Business Improvement Use Case is defined by: the new processes and business activities; the opportunities it brings; the implementation possibilities; and the potential business benefits it offers. Optionally, they may include some key Auto-ID possibilities that leverage the business improvement.

Enhanced processes and business activities: description of new processes and activities, specifying processes, actors, procedure steps, decision points, level of automatism, product and information flows, activities, contingency plans, and supporting assets – equipment, physical space etc. For example, the analysis of consumer behaviour in a supermarket would require strategically located readers, tagged trolleys and specialised information systems such as data warehouses and processes to collect the data and convert it to useful reports or files. It would also require trained personnel to review and analyse the resulting reports and transform them into innovative marketing strategies.

Opportunities: these are the business opportunities generated by the use case. For example, the creation of tradable consumer behaviour data by means of Auto-ID, or the penetration of new markets as a result of Auto-ID-driven product innovation.

Implementation decisions: different Auto-ID implementation possibilities that enable the opportunities previously identified. Some examples of implementation decisions are reader location/types, complementing hardware such as lights, electronic eyes and robots, etc.

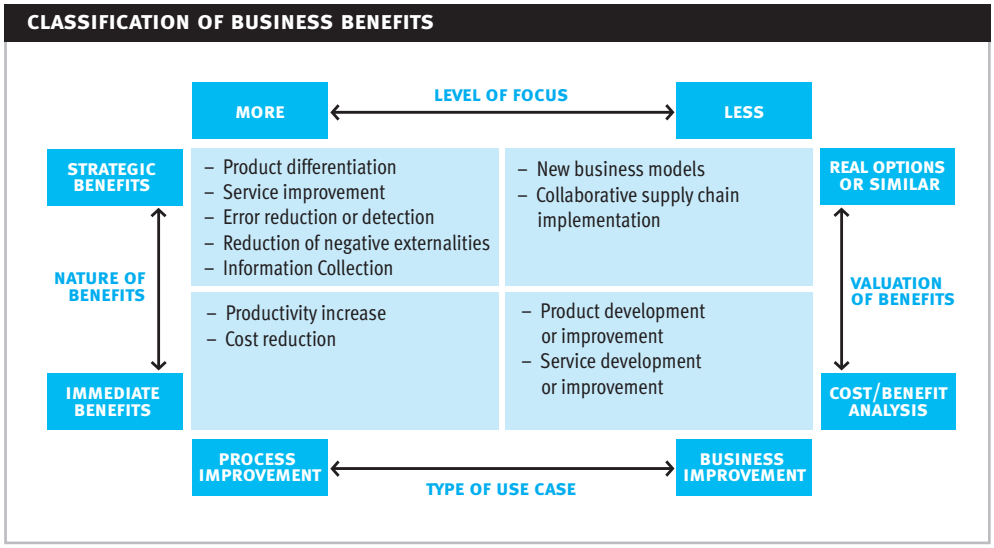
Potential benefits: list of expected qualitative, quantitative and strategic benefits result from the implementation. Sometimes quantitative and strategic benefits are hard to value due to the lack of quantitative data for the current processes, their dependency on implementation decisions, and the natural uncertainty associated to the use of leading technology. Nevertheless, this paper recommends collecting at least the qualitative benefits. Strategic benefits are more complex to value, and may require sophisticated managerial valuing tools such as Real Options Approach, scenario simulations or equivalents.

Auto-ID possibilities: specific characteristics of the Auto-ID technology that allow the proposed business improvements. One example is the existence of Auto-ID standards allowing interoperability among existing systems. In general, the main Auto-ID possibilities leveraging business improvements derive from the Auto-ID tracing and inter-organisational capabilities – e.g. for products' information interchange.

2.3. Classification of Use Case Benefits

The following diagram shows the usual relationship between use case types, the nature of the benefits they bring, and the way of valuing them (not covered in this paper):

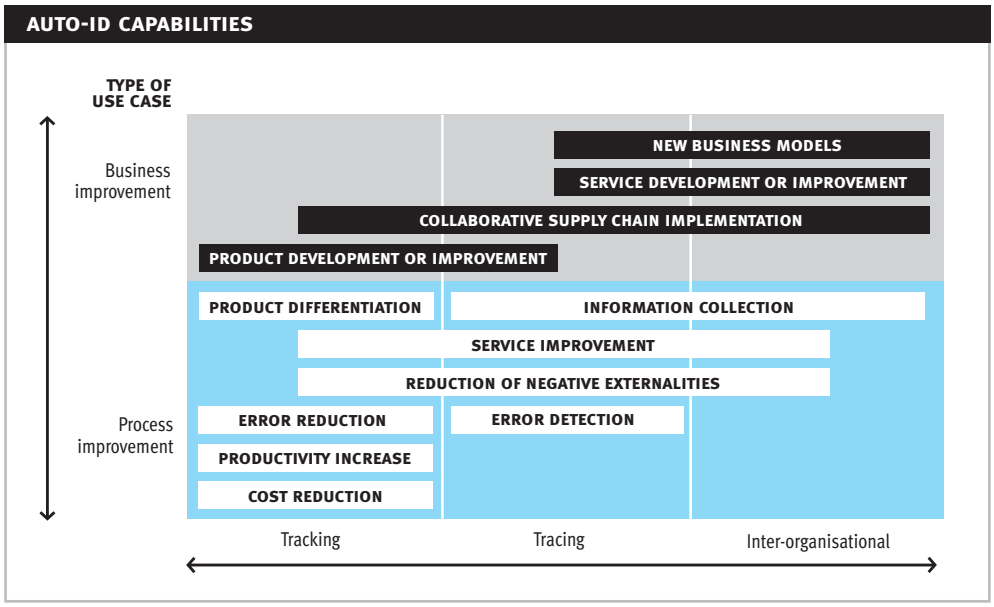
Figure 2



2.4. General Relationship between Use Case Types and Auto-ID Capabilities

Some Use Case business benefits are related more to specific Auto-ID capabilities. The following illustration shows their general position in reference to the use case type that brings them and the Auto-ID capability that leverages them:

Figure 3



The illustration shows a positive correlation between the business improvement use case types and the Auto-ID tracing and inter-organisational capabilities, and between the process improvement use case types and the Auto-ID tracking capabilities.

3. ASSESSING THE IMPLEMENTATION IMPACT

In this section we briefly define business information systems, suggest two classification possibilities – by information flow and by functionality, and explain the way of finding the impact of Auto-ID implementation on them.

3.1. Business Information Systems

Business Information Systems are the set of software programs that register, process, store and generate business information and/or data to support business activities. They complement and support manual processes by providing reports, transactions and specific information to humans performing the operations, and receive data from humans or specialised interfaces such as electronic eyes etc. They can also perform industrial control actions by controlling specialised hardware such as manufacturing robots, cranes etc. Business information systems can also support decisions by providing statistical information and forecasts to decision makers and planners, and even support a business' strategy by similar means.

There are several classifications for business information systems. From an operational point of view, information systems have two main functions: to support the operational activities or to trace them – supporting information systems and tracing information systems, respectively. Supporting operational activities means both gathering and supplying information from and to the processes to support daily decisions – bidirectional flow of information from and to operational activities. Tracing operational activities means gathering information to detect operational errors, unexpected events, or optimising business activities or operational processes – unidirectional flow of information from operational activities or other companies.

Most business information systems perform both supporting and tracing functions, although that depends on their specific functionality. For example, business intelligence or decision support systems are focused on information collection rather than on operational support, as opposed to manufacturing systems which aim at supporting daily manufacturing activities by providing pertinent information – e.g. manufacturing plans and recipes. Although not a general rule, supporting information systems are more related to process improvement business cases as they benefit the most from Auto-ID tracking capabilities. Tracing information systems are more related to business improvement use cases as the benefit the most from Auto-ID tracing and inter-organisational capabilities.

Business information systems can also be classified by functionality in: manufacturing; operations; logistics and distribution; financial; purchasing; sales; strategy; marketing; stock, asset, or human resource management; and decision support systems, among others. The classification process helps to identify the systems affected by the adoption of Auto-ID as it gives clue of what functions and business operations are supported by what systems.

Business information systems communicate with the operational world in terms of transactions, reports and queries, and information generated automatically by other hardware like sensors etc. Auto-ID is a special case of data sensing as it provides many different types of transactions and even inter-organisational ones.

3.2. Identifying the Affected Systems and Related Data and Transactions

In order to identify the systems affected by the Auto-ID implementation, the following use case elements should be reviewed and expanded:

Decision points within the existing procedures: points within the procedure flows where any manual or automated decision is made. In business improvement use cases the new procedures should be used instead. For example, the replenishment process of a retail company involves deciding what and how many products to move to avoid stock-outs and optimise warehouse space.

Information affecting these decisions: minimum information supporting the decision process, either in paper or electronic format. For example, forecasted sales and stock availability to support the replenishment process.

Transactions: formal description of the automated flow of information affecting the decisions. A good example is the sales transactions generated at the point of sale and feeding a warehouse management system to reflect new stock levels.

Information sources and destinations: manual or electronic sources and destinations of the aforementioned information. It is at this point where affected information systems are identified as sources or receptors of information and transactions.

Information flows to automated systems: information gathered from the processes themselves and fed into electronic systems to support other process steps or other processes. Apart from requiring information to support operational decisions, processes generate useful information which is frequently fed into information systems. That is, operational processes not only use information from information systems but also generate valuable input.

All this information should be combined in matrices to find all the interaction points between procedures and information systems. The following diagram illustrates the process outlined above:

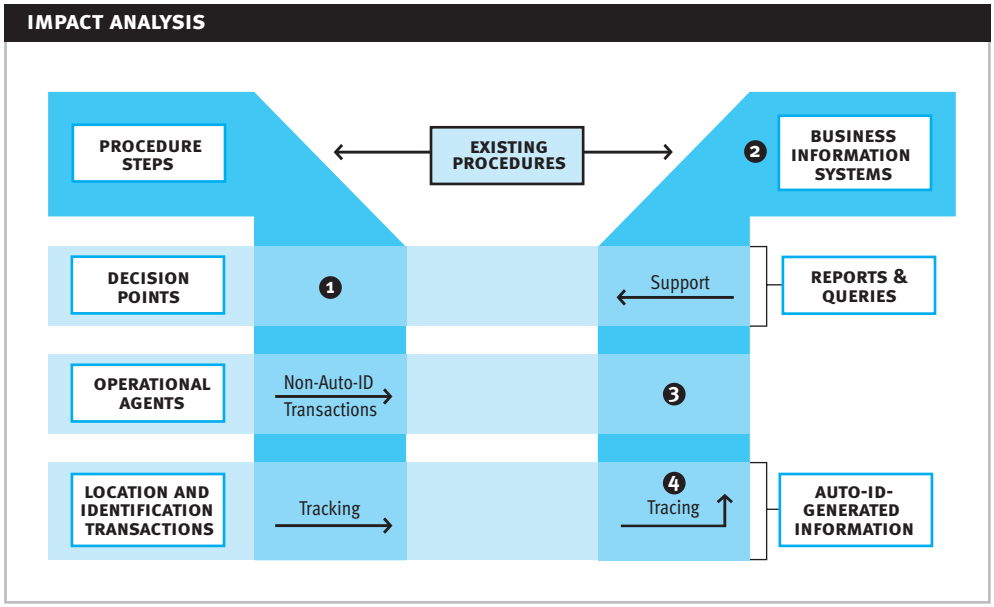
Figure 4:

1 Auto-ID will provide new valuable information

2 System will have to store new data

3 Existing transactions will be also changed

4 New tracking and tracing transactions



3.3. Proposing new Operational Procedures with Auto-ID

3.3.1. Leveraging Auto-ID Tracking and Identification Possibilities

Auto-ID can generate valuable online information to dramatically improve the way IS support operational procedures. The ability to seamlessly locate, identify, and track products can be applied to reduce manual intervention in all activities involving product manufacturing, handling or storage; from the very manufacturing to the end-user sale and even beyond the point of sale. Tracking capabilities provide operational processes with far more information than existing systems to support decisions such as replenishment, shipping etc. Designing the new operational procedures involves the review of both the automatic and manual decision points to make use of the new information. These decisions will evolve to be more automatic, precise, or to improve granularity – e.g. faster decision or decisions at item level as opposed to SKU level. Nevertheless, this redesign process should take into consideration the new Auto-ID characteristics affecting product or object tracking – e.g. lack of precision in certain readings, and provide sound contingencies.

3.3.2. Leveraging Auto-ID Tracing Possibilities

Auto-ID also offers offline valuable product and object tracing possibilities. Product recalls are a good example of these. The proposal of new operational procedures based on historic logs about the product life often implies reviewing related processes somewhere else in the company – normally early in the product life. The new procedures will leverage from modified procedures in which Auto-ID generates automatic product data, equipment or object tracing purposes. The proposal of new procedures to leverage

Auto-ID tracing possibilities involves modifying both the data generating and benefiting processes. The first normally does not require major modifications – except perhaps those necessary to generate the required data, which can be Auto-ID generated or not. For example, to improve the product return process in a retail store, the point of sale processes must be modified to gather the required information, such as EPC, price, customer details etc.

3.3.3. Leveraging Auto-ID inter-organisational possibilities

While the Auto-ID tracking and tracing possibilities are more related to its RFID side, the Auto-ID inter-organisational possibilities are based mainly on its software and identification standards. Having a common format to identify products – EPC, and a standard way of finding the related information, provides players in the supply chain with the possibility to exchange valuable information to improve their operations and business. Auto-ID inter-organisational possibilities extend its tracking and tracing possibilities beyond the organisational boundaries, thus reducing the need to generate some internal information that results from processes such as product revisions, quality tests etc. For example, the retail company can benefit from specific item level information such as expiration date, quality of ingredients, compatibility warnings, etc if this information is made available online by the manufacturers and inter-mediaries upstream in the supply chain. Similarly to the redesign of processes based on Auto-ID tracking and tracing possibilities, the redesign of processes based on Auto-ID inter-organisational capabilities should focus on decision points and their supporting information, though some of this information might come from other organisations, and measures should be taken to ensure its availability.

3.4. Impact of new Procedures on Existing IS

3.4.1. Tracking and Identification Possibilities

The reviewed process decisions will be either made by the systems or by operators relying on the new information, so these supporting transactions/reports should be enhanced to include it. The related information systems (IS) should also receive, store, and generate the required information and transactions. In the analysis every transaction should be identified and detailed, differentiating the previous information and the new one. For example, using Auto-ID to improve the product reception process in a warehouse implies receiving the related electronic EPC list and attaching it to the bill of lading (BOL). Some previous transactions may no longer make sense – e.g. manual recounts in a fully Auto-ID-wired warehouse might no longer be necessary. Decision supporting transactions and reports are more fragmented and required immediately during the operations, so scalability issues are important. It also means changing the way installed systems work – e.g. reducing the time frequency of reports or allowing ad hoc queries to support immediate decisions.

3.4.2. Tracing Possibilities

Similarly, IS receiving information and feeding logs to enable product tracing will have to be modified to receive, store and generate the new information. The time availability requirements of tracing information are far less relevant than those of tracking and identification applications, where information is not required to support immediate ongoing operations. Though Auto-ID tracing possibilities might not imply major changes in operation procedures, the impact of Auto-ID implementations for tracing purposes on information systems might be important in terms of required interoperability, storage, definition of new key performance indicators for the business etc.

3.4.3. Inter-organisational Possibilities

Perhaps the major modification in IS consists of on enabling the desired inter-organisational capabilities. That is, implementing PML servers and integrating them with existing databases and integrating the local Auto-ID infrastructure with the inter-organisational business information systems such as Supply Chain Management (SCM), Supplier Relationship Management (SRM) and Customer Relationship

Management (CRM) systems. As Auto-ID data is related to, and affects entities in these systems, and as these systems already perform some inter-organisational interchanges related to products; measures should be taken to fully integrate the new data and transactions, not only at an intra-organisational level but also at the inter-organisational one. This topic has not been researched in great detail, and it is definitely good material for another White Paper.

In a nutshell, the required modifications in business information systems include: (1) modification in transactions: to receive or generate additional transactions or more data within the existing ones. (2) Modification of storage capabilities: to be able to store more information about products and physical objects in general, and to a higher granularity – e.g. item level information. (3) Extensions in functionality: adding new capabilities to the system based on the Auto-ID information and capabilities – e.g. the possibility of locating objects immediately or seeking online product information in other companies' databases.

4. EXAMPLE OF USE CASE INPUTS IN THE RETAIL INDUSTRY

As it moves millions of goods both internally and externally, and deals directly with consumers, the retail industry offers many possible applications for the Auto-ID technology. The following list covers some of them:

1. **Inventory visibility:** use of Auto-ID to allow on-time visibility over shelf and backroom stocks.
2. **Differential product pricing:** use of Auto-ID to allow item-level pricing of similar products with sensitive differences such as the expiration date.
3. **Reverse logistics:** use of Auto-ID to support product devolution by customers and product devolution to suppliers.
4. **Accurate and collaborative planning and replenishment:** use of Auto-ID to improve visibility on customer picks as a way of improving the planning and replenishment procedures.
5. **Tracking of goods in logistics and distribution:** use of Auto-ID to improve the selection, shipping, transportation, and receiving of goods from and to the right place at the right time.
6. **Theft control:** use of Auto-ID to monitor unauthorised removal of goods from both the backroom and shelf.
7. **Interactive marketing:** use of Auto-ID to trigger advertisement procedures upon removal of goods from the shelf.
8. **In-store consumer behaviour analysis:** use of Auto-ID to gather shopper's behavioural information such as shopping route, product swapping or product put-backs.

4.1. Operational Procedures

Players in the retail industry perform several operational procedures involving the movement of goods suitable to be improved with Auto-ID. Two of them are developed here as examples:

1. **Order generation to suppliers (inventory visibility):** based on their sale and shrinkage forecasts and statistical variance, stock levels, delivery time and expected life, goods are ordered periodically from suppliers. Normally an automated procedure, the order generation is based on a combination of automatically and manually collected data from many different sources: sales from the point of sale system; stock levels from the Warehouse system and selected manual recounts; forecasts from either the Sales systems, manual estimates, or a combination; orders in transit from the Order Entry system; and historical statistical information from the Order Entry system or Product system such as delivery time and reliability, forecast variance, and product expected life.

2. **Order receipt – from suppliers into distribution centres (tracking of goods in logistics and distribution):** the order receiving procedure involves manual product verification and contrast with the expected goods; the update of the Warehouse system to reflect the new stock levels; and the storage of the new goods in the appropriate place or their immediate re-distribution if they are part of a subsequent order.

The same logic could be applied to the extensive list:

1. Generation of supply orders to DC.
2. Order shipping – from DC into shops.
3. Order delivery and transportation – from DC into shops.
4. Order receiving – from DC into shops.
5. Shelf replenishment.
6. On-shelf product recount.
7. Backroom product recount.
8. Individual price modification.
9. Movement of goods back to the backroom.
10. Product disposal.
11. Sale of goods.
12. Customer returns.
13. Transference of returned goods to DC.
14. Returns to suppliers.

4.2. Supporting Systems

The retail industry relies on many different IS to support the movement and storage of goods from the supplier to the customer, the reverse logistics procedures, and the sales activities. Although they might vary from company to company, the most important systems supporting these operations are:

1. **Point of sale (POS):** support selling and return procedures. Among the master files they host are the product, tills, cashier and special offers catalogues. The transactions they support are mainly sales and returns, registering lists of goods, payments, loyalty cards and cash. These transactions come mainly from the tills and most of their data is generated through bar-code scanning.

2. **Sales forecast (SF):** support sales forecast by store, region, season, time period, product or product hierarchy – groups of substitute or related products. Their main files include product and product hierarchies, their sales history in money and volume, and regions and stores. Their transactions come from the sales procedure through the POS.

3. **Stock control (SC)**: keep track of the stock levels by product type, store, deposit and shelf, aiming at optimising stock levels, avoiding stock failures, and reducing waste result of unsold perishables.

Their master files include products, deposits, stores, and shelf and backroom spaces. Their transactions come from sales, deliveries, returns, transfers, waste and recount processes through the LD, POS and OE systems and manual recount procedures.

4. **Logistics and distribution (LD):** support internal shipments between deposits and stores, aiming at optimising transport operations. Their master files include deposits, trucks and stores, and their transactions come from internal delivery procedures and supply chain (SC) systems.

5. **Order entry (OE):** supports the process of ordering from suppliers, aiming at guaranteeing continuous supply of products at the lower cost. They host the list of suppliers, products, hierarchy of substitute and related products and historic and agreed delivery times. Their transactions come from the SC and SF systems and manual instructions.

4.3. Other Use Case Components and Impact on Information Systems

The following table summarises the remaining components that form a use case for the examples:

Table 1

USE CASE COMPONENTS AND GENERAL IMPACT ON INFORMATION SYSTEMS		
Use Case	Use of Auto-ID to improve the order generation process as a result of better inventory visibility in the warehouse management	Use of Auto-ID to improve the product receipt process as a result of better product tracking in the logistic and distribution activities
Actors	planning managers, warehouse managers, forecasters, buyers, suppliers	suppliers, transport companies, employees receiving the products
Steps	combine stock and sales forecast to generate an order for each product; choose suppliers; send electronic orders to suppliers	receive the order, contrast with expectations, verify the order, accept/reject products, store products, generate payment
Information flow	from the warehouse – stock levels, POS – sales, sales systems – forecasts, to the Order Entry system, which supports the order generation process	bill of lading from transporters, order from Order Entry system, product status information from verifiers
Product flow	all warehouse movements: receipts, transfers, sales, waste, losses.	products come though the dock, and are either returned to the supplier or moved to the warehouse
Supporting assets	PDAs for manual recounts, barcodes, automatic warehouses, forklifts, wagons, physical space	trucks, forklifts, barcodes, PDA, wagons
Contingency plans	manual recounting in case of unreliable stock levels; finding alternative suppliers in case of product unavailability; communicating by phone and fax instead of using electronic orders	accept unexpected products, what to do with excess deliveries or missing deliveries

Continuation of Table 1

USE CASE COMPONENTS AND GENERAL IMPACT ON INFORMATION SYSTEMS		
Decision points	scheduled reorders, product stock-outs, new product introduction	order and/or product, acceptance/ rejection, storage place, communication with suppliers in case of incomplete or missing delivery
Opportunities and issues to solve	avoid stock-outs, minimise required space warehouse	order/delivery match, optimise storage, easier supplier dispute settlement
Implementation decisions	reader's covering area and granularity in the warehouse, use of readers in the POS or shelve	tagging granularity (pallet, case, product level), reader type and location (mobile readers, docks, warehouse entries, corridors)
Potential benefits	better service result of product availability and fresher products, reduced stock management costs	receipt efficiency, error reduction, quality improvement
Supporting systems	Stock control, POS, sales forecast, logistic,order entry	Stock control, logistic, order entry
Auto-ID capabilities	Tracking capabilities	Tracking and inter-organisational capabilities
Auto-ID impact	Modification of recount processes and generated transactions, Integration of location information to the existing systems, Integration of POS Auto-ID-related data to stock control systems	Inclusion of Auto-ID identification data into the Order Entry, logistic systems, and stock control system. Requirement for the integration of all these systems to share Auto-ID data, Modification of the receipt procedures to leverage Auto-ID in the verification step

5. CONCLUSIONS AND FUTURE RESEARCH

It is believed that we only have seen the "tip of the iceberg" of the software side of Auto-ID and its impact on installed business information systems. Developing Use Cases for Auto-ID should take into consideration these factors as key drivers to gain real business improvements. The implementation of Auto-ID does not end in tracking and tracing the physical world, but in using this information and capabilities to leverage business activities. Moreover, the implementation of Auto-ID requires significant modification of business information systems, which is frequently disregarded in most use cases. This approach suggests an easy and methodical way of identifying these modifications, and suggest general ideas for both the valuation and full implementation issues. Focusing on operational improvements and business improvements provides a top-down but comprehensive approach that guarantees sound Auto-ID implementations in most existing business.

The recommendation for the future is to perform research in the following areas:

Practical application of the Use Case Approach: to perform the specific study to analyse, document, and design Auto-ID-enhanced procedures for selected Use Cases in real companies, preferably in the retail and manufacturing industries as leading discrete SC players.

Valuing strategic decisions in Auto-ID implementations seeking business improvements: one of the major difficulties of Auto-ID Applications is to value their benefits, particularly in these in which most of the value is strategic. The development of business cases should take into account not only immediate cost/benefit gains, but also the strategic value product of managerial flexibility. The recommendation in this sense is to use Real Options, modelling or similar managerial tools.

Auto-ID and Business Information Systems integration models: integrating the data generated by the physical world, the Auto-ID inter-organisational data, and installed BIS involves challenges asking for an extensive research.

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