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Anatomy of an RFID Pilot

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Introduction

While Radio Frequency (RFID) technology has been available and successfully used for many years, interest has accelerated recently, and then exploded in 2003 as announcements from Wal-Mart and the U.S Department of Defense meant thousands of suppliers to those organizations might have to comply with new RFID tagging requirements.

As companies look to comply with trading partner mandates and/or improve internal operations through use of RFID, the need to test or "pilot" the technology is a consistent theme that runs through every initiative. Indeed, much of the current activity by both users and vendors (consultants, tag and reader vendors, software companies, etc.) is specifically around taking a project through a pilot stage.

Despite this exploding interest in RFID and many emerging pilots of the technology, little has been written about the approach companies are taking to move the RFID-based systems from concept to pilot. SupplyChainDigest™ has recently researched RFID pilot activity in extensive interviews with end users, consultants and RFID technology providers specifically on the subject of pilots, and summarizes the result of that research here. Our article also includes a few RFID pilot case studies at the end. Participants in our interviews included Woolworth's, a retailer in the UK, several end users who wish to remain anonymous, and RFID vendors including Alien Technologies, ESYNC, HighJump Software, Intermec, International Paper, Manhattan Associates and Savi Technology.

While RFID has potential use in dozens of business applications, including consumer-oriented scenarios such as automated toll booths and customer-self service, we focused on four applications related to the movement of goods and traditional supply chain management. The applications are:

- **Compliance:** Tagging to meet the requirements of Wal-Mart, the DoD or other channel masters. These applications are just starting to begin in earnest – for example, Wal-Mart's top 100 suppliers have meetings with Wal-Mart in March-April 2004 to discuss their specific approach to meeting the retailer's specifications. Nonetheless, serious testing is starting to occur.

- **Distribution:** Using RFID to improve a company's logistics processes, in inventory tracking, warehouse management, and other areas. While Wal-Mart is asking suppliers to comply, and many suppliers will take a "bare bones" approach to meeting those requirements, Wal-Mart itself of course will use the tagged cartons and pallets to improve product flow in its own DCs and out to its stores. There are very few examples of full scale use or large scale pilots involving complete logistics automation using RFID:

International Paper's warehouse implementation, and another one by Germany's Metro Stores, are the two most prominent examples.

- **Closed Loop Manufacturing Systems:** Systems that use RFID to improve an internal production process. These projects can be integrated with distribution systems, and will increasingly be so as compliance requirements are fully met and other channel masters adopt similar initiatives, driving tagging back into manufacturing. Thus far, however, manufacturing and distribution systems have generally remained separate. There is actually, a large number of such closed loop manufacturing systems currently operating successfully. Often, these involve tracking of re-usable containers (e.g. a tote or cage) or a fixed asset (e.g. an automobile). These applications also include writing data to tags as well as reading them.

- **Cargo Tracking/Security:** This is another logistics application, but worth breaking out on its own because it is really distinct from compliance and distribution applications. These projects involve using RFID tags, sometimes in conjunction with sensors that monitor environmental conditions, to track containers of goods moving across long distances, providing increased visibility to those goods in transit, speeding processing between hand-offs of the container, and (emerging) providing increased security. The U.S. Department of Defense successfully used RFID to track materials during the 2003 Iraq war – other companies are starting to use/test RFID for both visibility and security benefits.

Key Observations

Conversations with users and vendors regarding RFID pilots has led a number of overall observations that should be helpful for companies starting to use the technology to consider:

1. Consistently, the total process from concept to working pilot takes longer than originally estimated. Do not underestimate the time to pilot and debug. This is in part due to (optimistic) human nature, and in part because RFID is still a relatively immature technology in many respects.

2. The time to pilot an application is especially likely to be extended if the vendor(s) you are using have little practical real world proof points with a very similar operating scenario. You will be part of the vendor's own "pilot project" – this will usually involve trial and error. While this should be expected at this stage of evolution, especially for compliance and distribution applications, this factor will diminish over the next two years, as vendors gain experience with more users.

3. There are a variety of great RFID vendors to work with, but users need to remember where they come from in evaluating their recommendations. A consultant is likely to focus on building an extended business case and systems integration; a software vendor on the details of the application software, etc. There is nothing wrong with this, but users need to look at the whole picture appropriately, understand their vendor's orientation, and act accordingly.

4. There are a lot of preliminary business cases built without sufficient granularity in terms of the actual detailed workflows, tag reads and data flows, and ergonomics. The higher level "vision" is great to get executives excited and getting a initial feel for the possibilities, but making it work and really getting ROI (especially when comparing the technology to bar code tracking) requires more detailed process mapping and operations analysis to find the real benefits. Not all companies are doing this well.

5. You still need to factor bar coding into your thinking. This "co-existence" requirement will be a reality for years, as systems and capabilities phase in across the supply chain, but just as importantly in many cases bar code may be the right choice for some data collection as part of an overall RFID initiative. One automotive assembler designed a system from scratch that uses both bar coding and RFID where appropriate.

6. For basic product testing (how well your products will be read, tag placement, etc.), several vendors, such as International Paper and Siemens, are offering extensive testing facilities on an outsourced basis (there may be others doing this as well). While there are pros and cons to this approach, it's worth taking a look at.

Phases of a RFID Pilot

SupplyChainDigest has identified four primary phases of RFID pilot activity. This assumes that a company has already gained some basic familiarity with the technology and applications from conferences, trade journals, etc. and is starting to get serious about seeing whether it can benefit. Past this basic educational stage, companies generally move through four subsequent phases to get to a completed pilot. These are:

- Phase I: Application Definition/Business Case Development
- Phase II: Technology Immersion
- Phase III: Product Testing
- Phase IV: Production Pilot

The following sections describe the key goals, activities, times and resource requirement for each phase. Of course, there is no one model, and your particular experience will vary based on many factors, including your own internal resources, sense of project urgency and upper management support/interest, project complexity, etc. Nonetheless, the following sections should provide a helpful framework for understanding key project phases. This information is summarized in a **single table** at the end of this article.

Phase I: Application Definition/Business Case Development

A key objective of this phase is to define the new RFID-enabled process flows (generally using "As Is" and "To Be" process mapping techniques). As appropriate, the goal is also to develop an expected return on investment, though this step takes on a slightly different flavor in Compliance scenarios, where the focus is either on how to comply at the least burdensome cost, or to investigate whether internal benefit can also be achieved.

Evidence says that this phase generally takes between 1-3 months, and is often used in conjunction with one of more outside consultants, including the consulting arms of RFID hardware and software vendors as well as more pure consulting organizations. It requires at least one strong internal project champion.

Key Mistakes Companies Encounter in Phase I

- Doing an abstract business case that does not really reflect operational reality – there is a large gap between the highest "theoretical" models of what RFID can do and the practical realities of the shop or warehouse floor.
- Not closely tying pilot definition to business case assumptions. This is a related point – the pilot definition should be inherently linked to the business case, not divorced, as sometimes occurs.
- Underestimating the costs of integration and modifying existing application software in the business case.
- Unrealistic estimates of reader deployment. Sometimes, business cases are built on assumptions about how broadly reader networks will be deployed (e.g. that all dock doors will be automated) that just aren't realistic in terms of actual capital budgets.
- Underestimating change management issues, training and roll-out times. Early RFID adopters have nearly all cited this as a key issue that they wish they had given more attention to.

Phase II: Technology Immersion

In this phase, companies get a hands-on feel for RFID technology and how it works. Typically, this is facilitated by purchasing "starter kits" from one or more RFID vendors, and beginning to test how RFID works in an office or lab environment. The goal is simply to gain a baseline understanding of basic chip-reader technology, and perhaps a little about how different products/containers exhibit different read characteristics.

Some companies, such as in the pharmaceutical industry, have spent many months in the lab, trying to gain a more detailed basic understanding of RFID technology's capabilities and limitations. More commonly, this phase will last about a month.

Key Mistakes Companies Encounter in Phase II

- The most common problem in this phase is simply spending too long "playing around" with the technology and not expeditiously moving through it to more detailed product testing.

Phase III: Product Testing

In this phase, detailed testing is performed on the range of products or containers to be tracked with RFID. Of course, the "readability" of RFID tags can be significantly impacted by the type of product/material (e.g. liquid, metal), packaging materials, pallet configurations (lots of "buried" cartons"), reader/ antenna placement, and other factors.

In this phase, the objective is to gain a detailed understanding of the readability of tags on these different platforms. Typical variables include:

- Product itself
- Packaging configuration
- Pallet configuration
- Tag type (between vendors, active versus passive, etc.)
- Reader configuration and antenna placement
- "Dwell time" required for a tagged product to be encoded or read in the read zone (how fast can it pass by)

This can lead to a number of different combinations and "trial and error" cycles to get the right information. While sometimes this work is performed in a lab, ideally it is done in an environment identical to or very similar to the planned production environment. But, this can

cause disruption on the floor, which leads some to the “lab” setting, or to vendors providing outsourced test facilities.

Typically, there is both an operations and IT resource engaged in this phase. Depending on the range and challenges of the products to be tested, this phase typically last 2 to 8 weeks, thought many companies have certainly spent a much longer time in the lab. It is often necessary to purchase several different readers and tag types to conduct the test. Tags are frequently re-used in this phase.

Key Mistakes Companies Encounter in Phase III:

- Not testing in similar environmental conditions to production environment.
- Not meticulously recording test data. While some vendors offer automated tools to track actual read performance, many companies still use “clip boards” and spreadsheets. This is fine, as long as the results of each test are maintained in detail.
- Over or under testing product/packaging configurations. Some companies over test the same basic product types and configurations, perhaps beyond the real need to gain additional insight, though this is understandable at this stage of the technology. More commonly, companies under-test different product types, usually due to lack of dedicated resources or just the hassles of procuring test product.
- Not testing “read time” dynamics (“dwell time” in reader range required to get a good read or to write to a tag; especially critical for conveyor applications).

Phase IV: Production Pilot

This is the real “pilot” phase or the project, where RFID technology is used in a way that at least simulates the application in a real production environment.

The ultimate goal is to make a “go or no-go” decision on a broader deployment of the pilot. To get there, companies use this phase to validate and refine the preliminary business case developed in Phase I, validate that the process and workflow that was designed works in a live environment, and that the full range of the technology pieces perform as expected.

In general, companies rarely do a full integration with production software systems in this phase. Much more commonly, companies use a “bolt on” application and database to manage RFID data, simulating a true production process. A limited amount of actual integration to WMS, ERP or other systems may be done to test basic data flow issues, or if it is simply required to run the test.

Times vary wildly here, depending on many factors, but 2-6 months seems a common range, depending on project complexity and resources.

Key Mistakes Companies Encounter in Phase IV

- Focusing too much on the technology performance and not on business process.
- Not tracking quality of incoming tags – this is especially true if you are using tags within labels, where the label conversion process adds another step than impacts quality.
- Underestimating the time to tweak readers, antennae and tags to achieve acceptable results in live environment; again, this is especially true if yours is a new scenario for your key vendor(s).

RFID Pilot Case Studies

Company: Woolworth's, a British retailer

Pilot Application: Tracking of dollies, and the merchandise they carrier, from DC to store and back.

Time Frames: The project took over a year from design to completion of the pilot test, though this was a large scale pilot, involving the tagging of 16,000 dollies, integration with some production systems (e.g. the truck dispatch system) and equipping 15 delivery trucks and 30 drivers with mobile RFID readers and tracking software. On the other hand, Woolworth's was able to shorten some of the business case and technology immersion steps because it has already gained RFID experience in a previous project around item-level tagging for the stores.

Key Takeaways: Getting the tagging right for the dollies took much longer than expected – original tags/placements could withstand the handling. Had to develop a special housing, in part after adhesive first chosen didn't last. Getting reader placement at dock doors also took a lot of time. As this is a "closed loop" system, complex integration with production systems may not be required in some areas – the tracking system (for dolly tracking) may just operate stand-alone. Project was easier because the underlying data structures (items into totes, totes on to dollies) were already in place before RFID.

Company: U.S. Food Manufacturer

Pilot Application: Wal-Mart compliance, testing both dock door reading as well as reading on a conveyor.

Time Frames: The Product Testing phase is just wrapping up, but will take about 10 weeks in total.

Key Takeaways: Consumer products companies need to organize their SKUs into group based on similar tagging characteristics (base product, packaging, pallet configurations). This can reduce the amount of testing that needs to be done. Several types of tags/readers even from a single vendor were required for different products. Conveyor and dock door testing needs to be performed separately, and may have very different results. Performance at high rates of conveyor speed (e.g. >500 feet/minute) is still an issue.

Company: Retail Distributor

Pilot Application: Tested use of RFID to drive carton tracking/sortation on the retailer's conveyor system. Tests began with empty (ballast) cartons to verify the tags could be read at high conveyor speeds (500-600 feet per minute). Tests were also conducted to verify other critical hurdles to prove RFID could work in such an application: speed, variable size cartons, tags on any 6 sides (orientation test), carton gap (including when one tag is on the trailing edge of the lead carton and the second tag is on the leading edge of the trailing carton), variable product densities, and most importantly discrete sequential carton reads.

Empty cartons were used for the first three hurdle tests, and then real product was used for the remaining tests. Products were chosen to reflect a wide variety of typical retail products, but emphasized product types to simulate worst-case product densities (i.e., motor oil, baking pans, water, cola cans, soup cans, shampoo, aluminum foil, etc).

Time Frames: All of this testing took about 8 weeks total. The test ultimately achieved consistently successful results, and led to clear requirements for developing a production system.

Key Takeaways: First, in this type of complex product test, an extremely methodical approach is required to control variables and minimize testing time. Our research has found other examples where less rigor was used, greatly extending testing time as tests were in effect re-performed. This risk expands dramatically based on the complexity of the range of products to be tested.

UHF frequency RFID tags were the right choice for high speed conveying. Focusing on data transfer rates during testing was crucial – at higher volumes the test placed some stress on the middleware to transmit data. The test identified the minimum required data transfer rates from the tag to the reader/middleware and the reader/middleware to the sort controller. There was considerable tweaking of the reader placement and actually cycling the antenna power was required to read

discrete cartons sequentially at high speeds with small gaps between cartons on the conveyor.

Start with the end in mind. This test was successful in part because there was a very clear definition of what the deliverable would be resulting from the test that was understood by the retailer and the vendor.

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RFID Pilot Lifecycle

Phase	Objective(s)	Typical Duration	Resource Requirements	Common Mistakes
I. Application Definition/Business Case	■ Define New RFID Process Flows (Compliance or Internal Benefit) ■ Estimated Return on Investment	1-3 Months	■ Two full or near full time internal resources ■ Often, use of an outside consultant	■ Doing an abstract business case that does not really reflect operational reality ■ Not closely tying pilot definition to business case assumptions ■ Underestimating costs of integration, modifying existing application software ■ Over estimation of actual reader deployment given costs ■ Underestimating change management issues and roll-out times
II. RFID Technology Immersion (often in parallel with Phase I)	Gain baseline familiarity with RIFD technology and options	2-4 Weeks	■ 1-2 internal technology champions ■ Vendor RFID starter kits ■ Dedicated "lab "environment" (optional)	Spending too much time in this phase "playing around"
III. Product/Platform Testing	Understand the specific interaction of tag types, tag placement, and reader configuration on individual SKU and containers to be tagged	2-8 Weeks	■ 1 operations resource ■ 1 IT resource ■ 100-10,000 tags, often several types ■ Readers and antennae – often, several types must be tested ■ Actual products/ containers – 1-2 pallets per SKU generally ■ Tag "printer" (optional) ■ Software that automatically measures and reports read results (optional)	■ Not testing in similar environmental conditions to production environment ■ Not meticulously recording test data ■ Over or under testing product/packaging configurations ■ Not testing "read time" dynamics ("dwell time" in reader range required to get a good read)
IV. Production Pilot	■ Validate technology performance in real world operating environment ■ Validate/fine tune process flow assumptions ■ Validate business case assumptions and likely true ROI ■ "Go or No Go" Decision	2-6 Months	■ Hundreds to perhaps tens of thousands of tags ■ Readers/encoders on 1-2 dock doors, sometimes on conveyors, wireless hand-helds or fork truck mounts ■ RFID "middleware" to manage RFID reader set up and operation ■ RFID tag printer (optional) ■ "Bolt-on" application to maintain RFID data and serve as point of integration ■ Limited integration to live production systems (optional)	■ Focusing too much on the technology and not on business process ■ Not tracking quality of incoming tags ■ Underestimating the time to tweak readers, antennae and tags to achieve acceptable results in live environment