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ITEM-LEVEL RFID FOR APPAREL/FOOTWEAR: THE JCPENNEY RFID INITIATIVE

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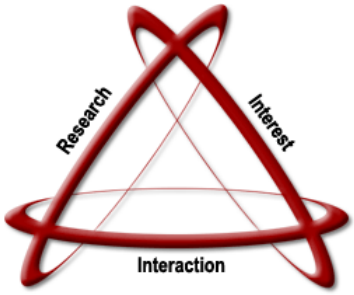

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ITEM-LEVEL RFID FOR APPAREL/FOOTWEAR: THE JCPENNEY RFID INITIATIVE

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EXECUTIVE SUMMARY

It has been proven that item-level RFID can improve many in-store processes for retailers. In particular, the business case for RFID for retailers looks promising. Previous studies have shown the benefits of RFID at the pallet and case level, such as reducing out of stocks and improving inventory count accuracy. Therefore, it seems logical that item-level RFID would provide even more benefits. In this study, we examine the use of item-level RFID at a major apparel and home retailer, JCPenney. Specifically, the use cases of inventory accuracy and inventory management using RFID replenishment reports are investigated, with incidental attention to cycle counting. This pilot's results support previous research, demonstrating the tendency for inventory accuracy to diminish over time, as well as the potential for improvement in inventory accuracy due to RFID. Improved inventory accuracy leads to fewer out of stocks, less safety stock, and better ordering and forecasting, among others.

As seen in previous item-level RFID whitepapers[1], RFID has the ability to quickly and accurately conduct cycle counting, rather than doing large scale inventories once or twice per year, thereby offering the advantage of keeping inventory accuracy high. Additionally, in pilots where RFID was used to evaluate loss prevention, RFID provides the advantage of knowing exactly what was stolen, when it was stolen, and from where it was stolen. Knowing exactly what was stolen allows the retailer to adjust inventory counts accordingly and order more product, as needed.

[1] A more extensive discussion of loss-prevention and cycle counting benefits offered by item-level RFID, as well as links to previous papers, is available in the appendix.

ITEM-LEVEL RFID FOR APPAREL/FOOTWEAR: THE JCPENNEY RFID INITIATIVE

INTRODUCTION

In previous item-level RFID for apparel pilots (first generation RFID pilots), we examined the benefits of item-level tagging and reviewed the data to see what benefits a retailer can realize from implementing RFID technology. Findings showed that RFID greatly improves inventory accuracy through reduction in cycle-counting time, thereby reducing out of stocks and instances of frozen inventory (see Hardgrave, 2009, for more detail).

In the JCPenney pilot – instead of focusing strictly on the improvements RFID offers in the areas of inventory management and accuracy – the intention was to evaluate *how* the improvements that RFID can help attain are changing the way retailers approach the introduction of RFID into their existing businesses.

Rather than launching a traditional pilot to determine whether RFID improves inventory accuracy and decreases out of stock situations, retailers are now more likely to use a "second generation RFID pilot" to obtain the internal data needed to:

1. Determine the best approach to using RFID in their particular business;
2. Provide senior management with quantifiable data about how RFID works in their particular business;
3. Determine the retailer-specific hardware and software needs.

Retailers already know that RFID *works*. What needs to be examined now is *how* this technology can be embedded into an existing business in the most efficient and non-disruptive manner. The RFID pilot at JCPenney is an example of how retailers are introducing RFID into their existing business.

Company Overview & RFID Use Cases

JCPenney is one of America's leading retailers, operating more than 1,100 stores throughout the United States and Puerto Rico, with an annual revenue of nearly $18.5 billion in 2008 (About JCPenney, 2010).

The primary use for RFID examined at JCPenney was inventory accuracy. In this particular study, item-level RFID tagging and physical inventory counting was investigated *in situ*, primarily to determine the effect of item-level tagging on inventory accuracy, which is known to cause other problems, such as out of stocks. Overall, the results can be used to provide guidance to companies as they investigate whether, and to what extent, to implement RFID.

Research Methodology

To investigate item-level RFID use cases, five stores were chosen: two RFID-enabled stores and three control stores. Two departments – bras (national and private brands) and shoes (women's, men's, children's, and athletic) – were examined in this study. Each test store's bra and shoe department was analyzed against a control department that was selected from one of the control stores. Table 1 illustrates the agreed upon matches between the test and control stores' departments.

	Bras	**Shoes**
Test Store	**Control Store**	**Control Store**
1	A	B
2	B	C

Table 1: Matching Test Stores' Departments to Control Stores' Departments

For the control and test stores, inventory was hand-counted by a professional inventory services firm (using barcode scanners) three times during the study: at the beginning of the study, at the beginning of week six, and at the end of week 15. Week 6 signified the beginning of the

use of RFID in the test stores; week 15 indicated the end of the pilot. Weeks 1 through 5, therefore, served as the baseline period for the study. In the test stores, inventory was also counted two times per week (Monday and Thursday) by store associates using RFID. The Thursday count was used to update the stock ledger.

Initially, the stores were equipped with hand-held readers only. Portal readers were added at a later date to the stores' backroom to indicate arrival of product at the store. Cycle counting (i.e., physical inventory counting) was conducted with handheld RFID readers in the test stores and with barcode scanners, used by the professional inventory service, in both the test and control stores.

There were between 10,000 and 16,000 SKU-level items included in this study. In the initial stages of the pilot, items were RFID-tagged at the distribution center that supported both test stores. From there, merchandise was taken to the two test stores.

The baseline portion of the study was used to determine actual physical inventory counts at both the test and control stores. These inventory accuracy numbers (actual inventory) were compared to JCPenney's Stock Ledger (Perpetual Inventory or PI) for both the test and the control stores throughout the 15-week study. Once RFID was in place, the RFID inventory numbers were used at the test store for comparison to both PI and barcode inventory figures. Changes to PI were made weekly in the test stores during the study. During the course of the study, extensive metrics were gathered on inventory accuracy (what the system shows versus what was counted by hand or by RFID) and examined both to reaffirm the benefits RFID offers to a store's inventory accuracy (through frequent cycle counting) and the benefits of weekly PI updates using replenishment reports.

RESULTS

Inventory Accuracy

The baseline data for JCPenney had unusually high inventory accuracy percentages (far above the industry's average of 65%). Because of the high initial accuracy, drastic improvements to accuracy were not expected. However, at the conclusion of the pilot, it became clear that even retailers with high starting inventory accuracy numbers can stand to gain from implementation of RFID.

The results from examining inventory accuracy over time have been categorized into three areas: perfect inventory (physical inventory count = PI), understated inventory (PI < physical inventory count), and overstated inventory (PI > physical inventory count).

As expected, and typically seen in previous pilots, without using RFID or making adjustments to PI, the perfect category in the control stores declined over the duration of the pilot while both the understated and the overstated categories saw increases (as shown in Table 2). Perfect inventory is agreement between the inventory counted (using either barcode or RFID) and the inventory record. Any difference between the two numbers (e.g., the count and the record) is an inventory inaccuracy, either more actual inventory in stock than recorded by the system (understated inventory record) or less inventory in stock than recorded by the system (overstated inventory record). In both situations, where there is an understated or overstated inventory record, inventory is not managed to its full potential. Additional discussion of the implications of understated and overstated inventory can be found in the appendix.

Control Stores	*Pre-RFID*	*Post-RFID*
Perfect	Baseline	-4.48%
Understated	Baseline	+1.67%
Overstated	Baseline	+2.81%

Table 2: Control Store Inventory Accuracy

By contrast, in the Test Stores (see Table 3), inventory accuracy improved during the course of the study (i.e., the perfect category). Although the perfect category in the test stores increased by 2.62% over the course of the pilot, the real gains to accuracy are measured by considering the improvement in the test stores to the deterioration of accuracy in the control stores. When examining the decrease of 4.48% (perfect category in control stores) and the 2.62% improvement (perfect category in test stores), it can be concluded that the real benefit of RFID is approximately 7.10% (4.48% + 2.62%) improvement in the perfect category. Similarly, the real improvement to understated inventory is 1.77% (1.67% + 0.10%). Although the measured improvement in overstated inventory at the test stores was 2.52%, the real improvement is approximately 5.33% (2.81% + 2.52%). The improvement to inventory accuracy at JCPenney can be attributed to both the implementation of RFID technology and to the weekly use of RFID replenishment reports to make in-store decisions.

Test Stores	*Pre-RFID*	*Post-RFID*
Perfect	Baseline	+2.62%
Understated	Baseline	-0.10%
Overstated	Baseline	-2.52%

Table 3: Test Store Inventory Accuracy

The changes and deterioration to inventory accuracy are most pronounced when examining them on a timeline. Figures 1 and 2 compare inventory accuracy in control stores to inventory accuracy in test stores for the duration of the pilot. The shaded area represents data collected to establish baseline, the non-shaded area represents the time when Stock Ledger was updated and when RFID replenishment reports were used.

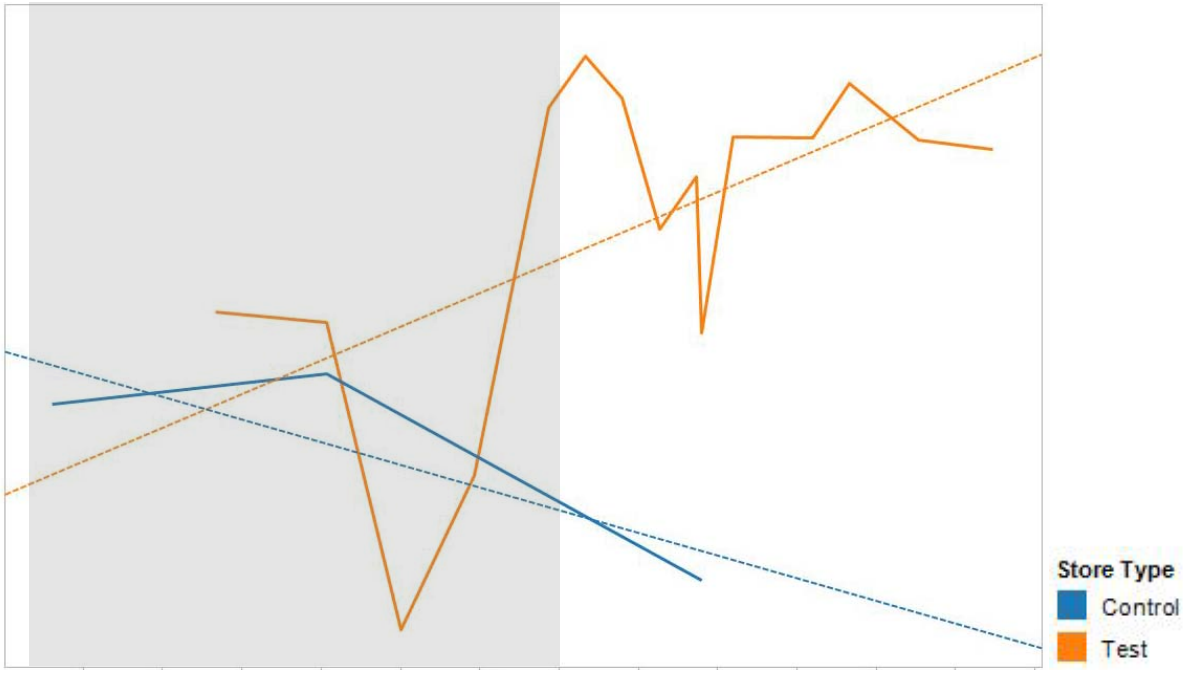

Figure 1: Perfect Inventory Trends over Time

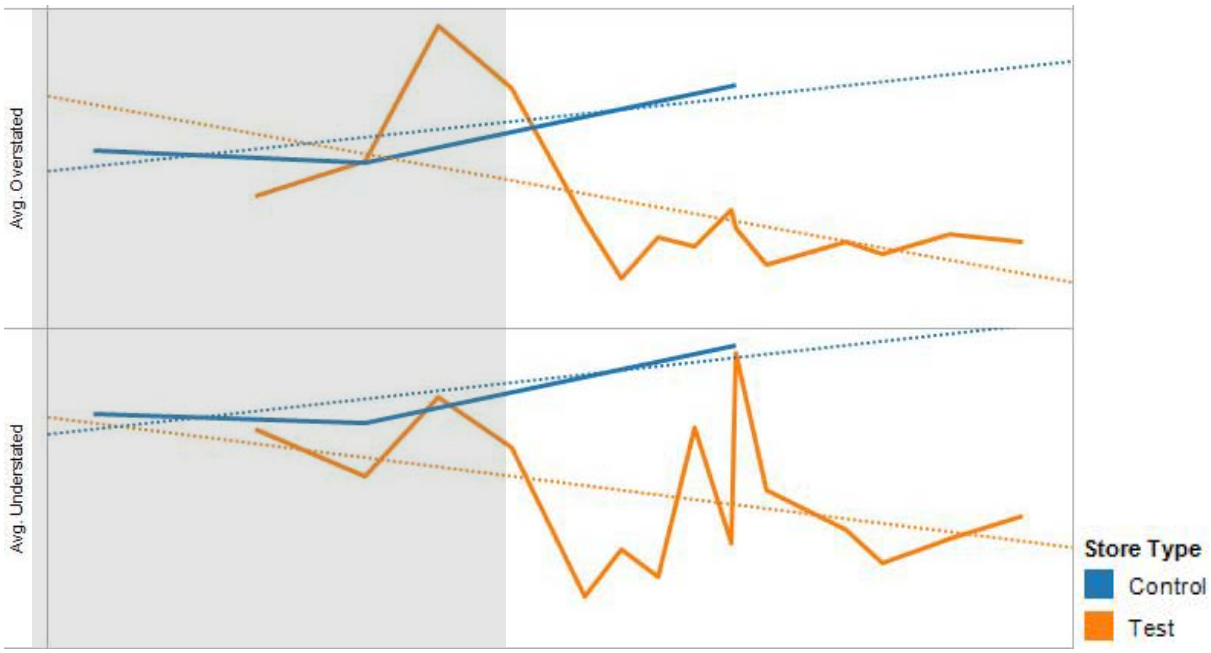

Figure 2: Understated and Overstated Trends over Time

Similar results are seen when examining the two departments (shoes and bras) separately, rather than as an aggregate. Figures 3 and 4 demonstrate the impact RFID and weekly updates to stock ledger (in the test stores) had on the bra and shoe departments (respectively).

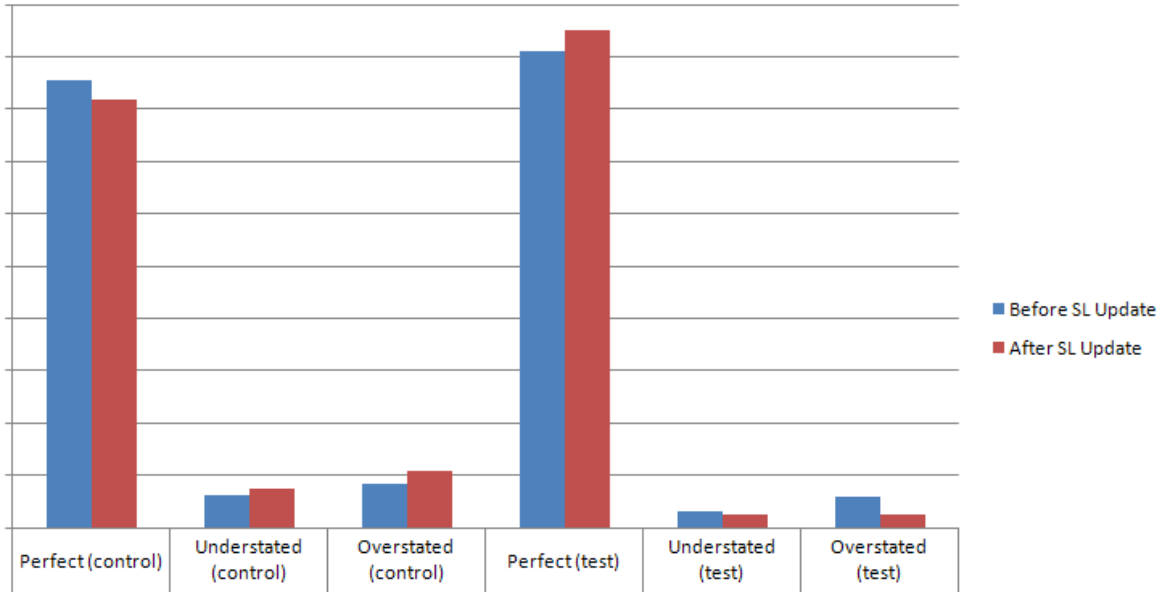

Figure 3: Bra Departments Before and After SL Updates

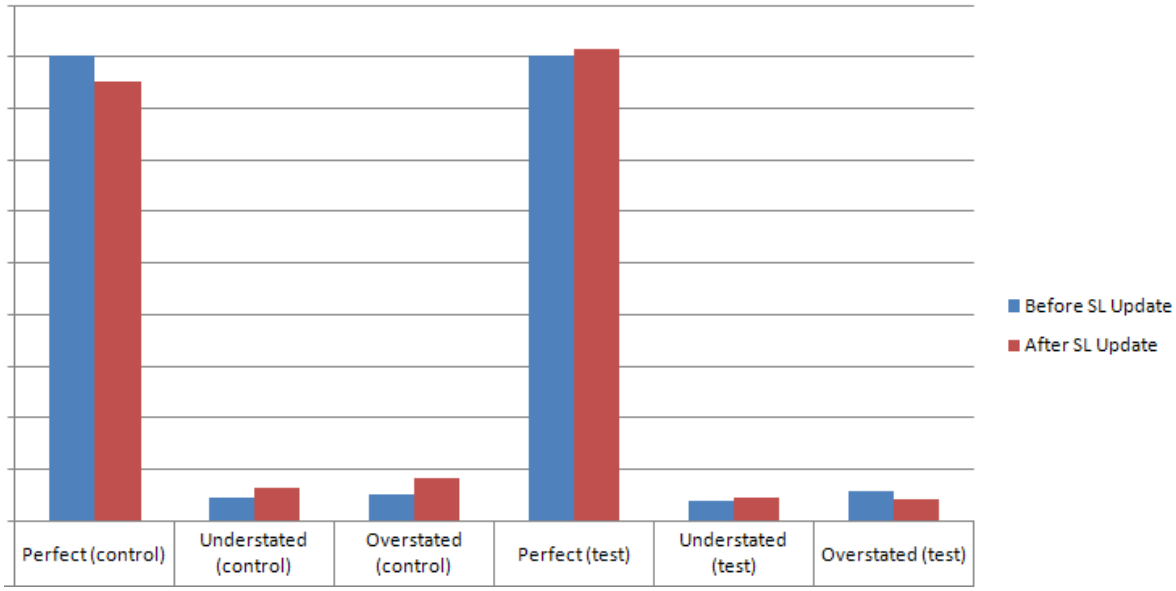

Figure 4: Shoe Departments Before and After SL Updates

Second Generation RFID Pilots

As previously established, RFID is known to make counting inventory easier and faster, which allows for more frequent counts and a more accurate (up-to-date) reflection of inventory on hand. The research conducted to date (first generation RFID pilots), by the University of Arkansas' IT Research Institute and others, demonstrates that RFID at the item-level improves inventory accuracy and decreases out-of-stock situations. Knowing which improvements RFID can help attain is changing how retailers approach the introduction of RFID into their existing businesses, creating second generation RFID pilots. This second generation of research has less focus on the efficacy of RFID and more on the questions and issues that have been identified in previous RFID pilots, including:

- **What is the best approach to using RFID in our business**? Issues range from which items to tag, which tags to use, where and when (in the supply chain) to apply tags, where and when (in the sales process) to remove tags, and how to make the use of RFID tags consistent with our corporate brand and image, to questions about existing inventory-of-record systems and how to integrate new RFID processes.
- **What data will our executives need to make a decision about moving ahead with RFID in our business?** Beyond the obvious questions to be answered about the costs (of hardware, software, and tags), more retailer-specific questions arise around quantifying the benefits to the business.
- **What are the unique needs of our business and our operating model when selecting hardware and software**? Once the broader issues of approach and executive support are recognized, attention shifts quickly and dramatically to the details—and the learning opportunities—associated with an RFID pilot.

The Best Approach

Tagging

Tagging-related decisions – like the need for tags, which items to inventory (high cost, low volume), where in the supply chain should tagging take place, and the impact tag design and aesthetics potentially have on corporate brand and image – play an ever-increasing obstacle in efficient and smooth implementation of RFID technology.

a. Selection of items

The initial decision about which items to use for the RFID pilot is made long before the pilot begins and is most often a factor of retail cost (high), inventory volume (usually high), and, sometimes, speed of turnover (also high). Once the initial decision is made, the lurking details remain to be addressed in the pilot. Using footwear as an example, one lurking detail is whether to tag only the boxed shoes or to include shoes that have a hang display (e.g., casual sandals); the decision has repercussions for inventory management on multiple levels. Inventory is often managed in broad categories, such as "footwear", which encompass one-off items ranging from shoe polish to shoe laces; those are the types of details to be addressed (or tabled) during an RFID pilot—and the decisions will be business-specific.

b. Where (in the supply chain) to tag

The quickest approach to an RFID pilot is to put the tags on the individual items at the test store locations—it involves fewer parts of the supply chain and will, in theory, limit the impact to business operations of the RFID pilot. Most retailers start with stores and quickly realize the need to move to application of the tags upstream to the distribution center, even for the purpose of the RFID pilot.

It has been found that "a large scale operation, such as integrating RFID within a retail supply chain, requires a large number of RFID tags, and the cooperation of all the entities in the

value chain" (Huber, et al., 2007). Although the benefits of source-tagging are known, many retailers that embark on a pilot or a study of RFID try to minimize costs by focusing on specific departments or a specific line of products which forces the retailer to maintain both the legacy system and the new RFID system The RFID pilot is the best way to make the determination of the proper place (in the supply chain) to do the tagging based on the unique needs of a specific business model. No two retailers are alike at the detail level of their supply chain and how to integrate the use of RFID tagging at the item level should be a key finding of an RFID pilot. Generally, though, the further up the supply chain tagging occurs, the greater the benefits for all supply chain participants.

c. Aesthetics of tagging

The use of RFID at the item level in retail apparel is both a technical challenge and a tag design issue, sometimes to the surprise of RFID project managers. One of the biggest challenges to surface when RFID is examined as a retail solution is that of aesthetics and how to use RFID tags consistently with the corporate brand or corporate image. Women's lingerie, for example, does not lend itself well to brightly colored tags that may be efficient for managing an RFID project (highly visible tags make it easier for project teams to see where tagging is complete); the same is true for high-end merchandise where aesthetics are integral to store design and appeal.

Retailers need to determine whether hanging RFID tags (used for apparel items where a tag cannot be embedded into the item or a box) need to be redesigned to complement corporate image and identity. The RFID pilot is the first place where tag aesthetics are addressed, usually after the first round (or more) of proposed tag designs are deemed unacceptable.

Existing Inventory-of-Record System and Changes Required to Use RFID

Stand-alone RFID pilots are, in theory, the least disruptive to existing business practices and legacy systems, thus, most retail RFID pilots begin as stand-alone initiatives. The "Catch-

22" in this approach is that the RFID data must, at some point, be compared to existing inventory-of-record data, which may be gathered and/or reported using processes that have embedded (e.g., process) errors related to timing of shipments, method of receipt, and when inventory is considered sold. This makes apple-to-apple comparisons difficult. One key finding of most RFID pilots is that, whether intended or not, the existing processes around inventory management (including supply chain, when and how legacy systems are updated, and reporting requirements) must be documented and understood before progress can be made toward a sustainable RFID initiative.

Unexpected learning opportunities can be identified during the RFID pilot, including the extent to which business practices work around (rather than eliminate) cumbersome legacy and process issues. The cleaner and neater the RFID pilot, the less likely it has uncovered the issues that will plague expanding the use of RFID across the enterprise, including the need to educate employees on the use of data that is more accurate and more timely.

What Executives Need

In order to gain the support for integrating RFID into the business practices across the enterprise, executives need to be given adequate information to make informed decisions about how RFID will benefit their specific business. Quantifiable data about how RFID can improve the bottom line is necessary, though not always sufficient, to gain support for an enterprise-wide RFID solution. The RFID pilot can identify and address (or table for later discussion) the issues, questions, and opportunities that generated initial interest in a large-scale implementation of RFID technology. At a minimum, an RFID pilot should provide parameters about cost for hardware, software, tags, changes to legacy systems, labor reallocation, and changes to business processes (where identified). Increased sales and customer satisfaction are more difficult to

assess directly, but directional improvement in a positive direction should be associated with a successful RFID pilot.

Detailed Business Needs

Although every retailer of apparel has similarities in processes, business models, and needs, the differences are more relevant when considering the use of an RFID solution. Deriving success through competitive advantage suggests that each successful retail enterprise strives to be unique in one or more ways—and the use of RFID must accommodate. Once the decision and investment of an RFID pilot are made, the challenge remains in determining the unique needs of hardware (does it fit with our existing store designs? our legacy systems?), software (does it give us the data we need to maintain our competitive advantage?), and tags (do they reflect our corporate image?).

These specific challenges involve hardware and software providers who seek to offer value to businesses in the retail industry. While apparel retailers desire hardware and software that fits seamlessly with (in) their business, the providers of the hardware and software are disadvantaged by the afore-mentioned need for unique competitive advantage in each retail apparel business. The RFID pilot is the source of much learning—and, sometimes, frustration—as the needs of the retail apparel business are met—or not—by the hardware and software used for the pilot. The search remains for "The Little Black Dress" of RFID software that allows each retailer to accessorize as needed, to reflect the uniqueness of customer-driven competitive advantage(s).

CONCLUSION

Inventory accuracy remains key to an effective and efficient supply chain, providing critical information about what to order and when. Despite the key role of inventory accuracy, past studies suggests it continues to be inaccurate about 65% of the time (Raman, et al., 2001). Previous studies have provided insight into RFID technology's ability to improve inventory accuracy, depending upon how the technology is used. This 15-week study investigated the use of item-level RFID to improve inventory accuracy in the shoes and bras departments at five JCPenney stores (two test stores and three control stores). Weekly updates to the Stock Ledger using RFID replenishment reports indicate that even in departments with already high inventory accuracy, dramatic improvement can be gained by conducting weekly cycle-counts using RFID and then using the gathered data on the in-store inventory to update Stock Ledger.

The growing body of research related to RFID and the subsequent improvements in inventory accuracy, out of stock, cycle counting, and loss prevention provides a solid foundation upon which specific actions can be identified and implemented to increase financial performance. Supply chain considerations (e.g., where in the supply chain to implement item-level tagging) have been resolved by some retailers and are still being addressed by others. The impact of process changes are becoming more apparent, as retailers are able to quantify the financial implications of more frequent cycle counts, more accurate identification of inventory location (stock room versus retail floor, for example), and process execution opportunities. Specific questions which can be addressed by the use of RFID inventory data include: Who moves the product from the stock room to the retail floor? How often? Using what set of information? How many items are in a frozen OOS condition? What is the cost of our frozen OOS? How much hidden excess inventory do we carry? At what cost?

The use of RFID in the retail space has potential benefits for customer service. Accurate and timely information about product order, delivery, location, and stock level allow retailers to have the products their customers want to purchase. Having what the customer wants when the customer wants it is critical to success in retailing.

As with all good research, the outcome generates additional questions, which retailers are addressing through second generation RFID pilots. The clarity of the questions being generated by RFID research into the retail space determine how well the benefits can be realized along the supply chain, up to and including the sales floor. Retailers who apply unique knowledge of their operating model to RFID inventory data will be able to develop and use models to assess, monitor, and improve financial performance. Gathering the RFID inventory data is quickly becoming the easier part of the equation.

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APPENDIX

This section includes the applications of previous research to the JCPenney pilot.

Introduction

"RFID in the apparel retail value chain is an item-level proposition, and the place to begin is in the store" (Kurt Salmon Associates). Our previous research on RFID in the supply chain and in the retail space supports the assertion that benefits can be found for both the retailer and supplier at the store level. While tagging pallets and cases as a stand-in for item-level tagging has demonstrated benefit, actually tagging at the item level within the retail environment can now be demonstrated to provide greater opportunities both for retailers and for their suppliers.

Item-level tagging is at the heart of nested visibility (see Figure A), described as the ability to track and identify products at various levels from production through sale. In the consumer packaged goods industry, the current state of product visibility is generally pallet and case level; therefore, product visibility is lost once case- or pallet-level product leaves the backroom for the sales floor and is removed from the case. By starting the investigation at the item-level, one is able to investigate the usefulness of the tagging for visibility at other levels (such as using the item tagging as surrogates for case and pallet tagging).

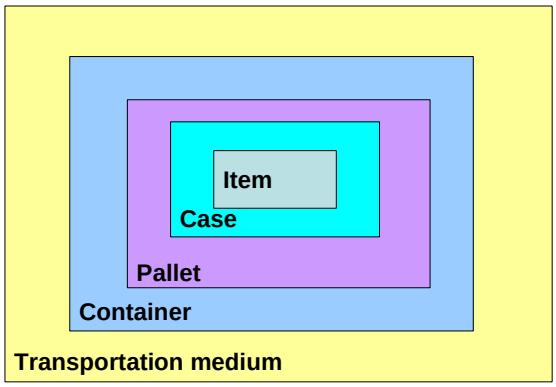

Figure A: Nested Visibility

Research into item-level tagging demonstrated that RFID benefits do not end at the store. If we begin the investigation of RFID benefits at the store, then both the tagging—and the benefits—can be pushed up the supply chain. Ultimately, the maximum value for RFID is realized when it is used throughout the supply chain in the places where it provides the most benefit for one or more specific business processes.

The research conducted at JCPenney is part of a larger research effort to demonstrate and quantify the business value of using RFID item-level tagging as part of the ongoing day-to-day business operations within a retail environment. JCPenney's leadership in the retail industry and their willingness to incorporate RFID item-level tagging into their existing business processes provided a unique and valuable research opportunity.

Inventory Accuracy: The Root of all Problems?

The amount of product retailers think they have on hand (also referred to as perpetual inventory or PI) is usually wrong. Many previous studies have shown the inaccuracy of a typical retail store's perpetual inventory count, for example 51% inaccuracy (Kang and Gershwin, 2007); 65% inaccuracy (Raman, DeHoratius, and Ton, 2001); and 55% inaccuracy (Gruen and Corsten, 2007). Subsequently, many decisions, such as ordering, forecasting, and replenishment are based on a number that most studies find is wrong more often than it is right!

When evaluating inventory accuracy, there are two basic categories of inaccuracy: overstated and understated. Research has found that about half of the time, PI is overstated (i.e., PI shows more inventory than is actually in the store, also known as phantom inventory), and about half the time PI is understated (i.e., PI shows less than what is in the store, also known as hidden inventory) (Gruen and Corsten, 2007). Both types of PI can have a detrimental effect on the retailer. For overstated, the most serious and directly related problem is out of stock; the

system thinks it has inventory on hand (i.e., phantom inventory), thus, fails to order new inventory. For understated, the most pressing problem is excess inventory (i.e., hidden inventory) because the system thinks it does not have as much as it really does, thus ordering unnecessary inventory. This unnecessary inventory potentially results in excess holding costs, excessive markdowns which impact margin, reduced turns, and breakdowns in store execution (which can lead to execution-related errors such as out of stocks) due to the inefficiencies created by the extra inventory.

There are several known causes of inventory inaccuracy (Gruen and Corsten, 2007; Kang and Gershwin, 2007; Waller, Nachtmann, and Hunter, 2006). Among the most common causes are theft, cashier errors, and incorrect manual adjustments. Theft leads to overstated PI. For example, the system thinks there are 10 items on hand, but three were stolen leaving a true on hand of only seven. Left alone, this error will grow over time as more items are stolen. Cashier errors can result in both understated and overstated PI. For example, if a customer is purchasing three items of product A and three items of product B, but the cashier mistakenly enters six items of product A, then the PI for product A will be understated by three units and the PI for product B will be overstated by three units. Finally, physical inventory counts can be incorrectly manually adjusted by employees. For example, when an employee believes the product to be out of stock, physical inventory count may be mistakenly set to zero when, in reality, product is in the backroom. Although there are other things that cause inventory inaccuracy, such as mis-shipments, improper returns, and damaged/spoiled products, the aforementioned account for most of the problems.

Companies can address inventory accuracy problems or errors in a variety of ways, as presented in Table A. First, companies can conduct physical counts frequently and adjust PI accordingly. Unfortunately, this strategy is very expensive and is less than perfect. Manual

inventory counts are rarely, if ever, perfect. Second, companies can let the system adjust PI automatically based on an estimated error rate. For example, if the company estimates that 2% of the items are stolen per month, then the system could make a 2% adjustment each month. The problem with this strategy is that the adjustment factor is difficult, if not impossible, to determine. Finally, the company can try to eliminate the source of errors by better inventory management, reducing theft, etc. Kang and Gershwin (2007) suggest auto-ID (RFID) as one method to help companies eliminate the source of errors.

Sources of Error in PI	Results in Overstated PI?	Results in Understated PI?	Solutions Available
Incorrect manual adjustment	Yes	Yes	Manual adjustments restricted and based on cycle count
Theft	Yes	No	Identify what leaves the store and where
Damaged	Yes	No	RFID identification allows segregation and subsequent removal from inventory
Improper returns	Yes	Yes	Handled automatically if RFID-enabled point of sale
Mis-shipment from DC	Yes	Yes	RFID receipt or cycle counting will modify PI accordingly based on actual
Cashier error	Yes	Yes	Handled automatically if RFID-enabled point of sale

Table A: Sources or Error in Inventory Accuracy

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Links to Previous Whitepapers

Does RFID Improve Inventory Accuracy? A Preliminary Analysis
(http://itri.uark.edu/91.asp?code=&article=ITRI-WP107-0311)

RFID Item-Level Tagging for Apparel/Footwear: Feasibility Study
(http://itri.uark.edu/91.asp?code=&article=ITRI-WP112-0608)

Item-Level RFID for Apparel: The Dillard's RFID Initiative
(http://itri.uark.edu/91.asp?code=&article=ITRI-WP146-0409)

Item-Level RFID for Apparel: The Bloomingdale's RFID Initiative
(http://itri.uark.edu/91.asp?code=&article=ITRI-WP147-0809)

For additional information please visit the following:

JCPenney (http://jcpenney.com/jcp/default.aspx)

Information Technology Research Institute (http://itri.uark.edu)