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The following is a commissioned study conducted by Forrester Consulting on behalf of the AF&PA and FBA

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RFID's Impact On The Corrugated Box Plant

Includes a cost/benefits model for a representative US Corrugated Box Manufacturer

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Table Of Contents

FBA Preface to Forrester Report

The following study was authorized by the FBA RFID Task Group, which was established by the FBA Board of Directors in November 2003. The Board recognized RFID as an emerging technology with potentially significant impact on the corrugated industry. Since the corrugated industry has a long history of being a supportive supply chain partner to its customers and end users, the board felt it prudent to create a task group to investigate the impact of RFID.

The RFID Task Group recognized that studies had already been done examining the impact of RFID on other portions of the supply chain, specifically retailers and consumer goods firms, but no work had been published regarding the impact on packaging suppliers. Therefore, the RFID Task Group partnered with Forrester Research, Inc., to develop the study in July – August 2004. The purpose of the study was to estimate the net effect on a fictional corrugated box manufacturer of supplying RFID-enabled transport containers. The scope of the study was limited to the converting operation.

Forrester created a costs/benefits model and supporting report for a representative US corrugated box manufacturer. All operational assumptions were based on plant visits, user interviews and industry data where available.

The study results do not reflect the impact for any actual facility or for any member company. Members are free to develop their own RFID strategies and determine the appropriate use of this study as part of their strategy.

The information contained within the study is sensitive, especially in regard to possible misperception of the industry by supply chain partners. Therefore, member companies should respect the confidential nature of the report by not releasing it beyond their company. Reference to the study during discussions with customers is considered an acceptable use of the document.

Executive Summary

With RFID a near certainty in the consumer goods and retail industry, it is very likely that soon customers will be requesting RFID tags on finished brown boxes. Therefore, RFID will bear a significant impact on a corrugated box plant over the next three years and beyond. To detail the impact, Forrester created a costs/benefits model and supporting report for a representative US corrugated box manufacturer. All operational assumptions are based on plant visits, user interviews and industry data where available. The cost inputs for implementing RFID were defined through vendor interviews, and assumptions on improvements in RFID technologies over the next three years. Please note that assumptions for RFID costs and the impact on productivity are difficult to verify given the limited number of deployments today.

General findings indicate that customer service benefits are high, since corrugated box plants that adopt RFID will potentially keep the business of customers with RFID requirements. However, internal operational benefits to a box plant are minimal for two reasons: 1) Inventory management is done at the bale level, not at the individual box level. Therefore, it is unclear that the tagging of individual boxes will provide additional operational benefits here; and 2) Warehouse management benefits like automated shipping, receiving, and order handling require RFID to be used on all orders, not just the orders for customers with RFID requirements. RFID costs are significant — topping $13 million over a three-year period. Categories of cost include: 1) tags at $7.4 million; 2) productivity costs at $3.6 million; 3) customer returns and waste at $860,000; 4) machine upgrades at $1.1 million; and 5) labelers and readers at $382,000. RFID costs are significant for XYZ Corrugated Box Corp., the representative US corrugated box manufacturer. From our analysis of XYZ Corrugated Box Corp., we expect that in most cases the RFID costs will exceed the current cost of a brown box.

Background

Why Should A Corrugated Box Manufacturer Care About RFID?

The Fibre Box Association, The Corrugated Packaging Alliance, and certain members of both view RFID as an important technology trend that US corrugated box manufacturers will face in the near-term. Forrester agrees. The probability is high that some customers will require RFID tagging of finished brown boxes in the next three years because of:

- **Retailer and government RFID mandates.** RFID tagging of cases is a near-certainty in the US consumer goods supply chain due to retailer mandates from Wal-Mart, Target, Albertsons, and, most recently, Best Buy, as well as the Department of the Defense (see Figure 1). The time-frame for complying with these mandates is aggressive. By 2007, these retailers expect pallet- and case-tagging by all of their US suppliers — from large consumer goods (CG) manufacturers like Procter & Gamble and Sony to mid-market firms like Faultless Starch and Welch's.

- **The high cost of implementing RFID.** It takes a lot of money for a consumer goods manufacturer to pilot RFID projects. Forrester recently estimated that a $12 billion food manufacturer would spend $9.2 million to implement RFID at three distribution centers and to tag nearly 16 million cases.[1] Factors that contribute to a hefty price tag include: 1) tag costs of $.30 of more, depending on order quantity; 2) operational changes, like adding warehouse labor to manually tag cases; and 3) custom software development and hardware integration. With costs this high, consumer goods manufacturers are eager to share the load with supply chain partners such as corrugated box suppliers.

- **Negligible to modest returns for CG suppliers in the near-term.** Many consumer goods manufacturers recognize the potential for RFID, but most that we've interviewed do not see a positive ROI in the next few years. In the words of one executive: "We have a small number of DCs and have exploited bar-coding for over a decade, so we don't have a lot of problems with receiving, picking, or shipping. When we did the business case, we determined that RFID can knock out a half day of a supervisor's time. This will save something, but it's not a tremendous amount."


Figure 1: Retailer RFID mandates are aggressive
1
2
3
4
5
6
Time
2005
2006
2007
2008
1
•Wal-Mart, January '05: Top 100 suppliers tag cases and pallets for 3 distribution centers
•DoD, January '05: RFID tagging of some cases, pallets, and high-value items
2
•Target and Albertsons, Spring '05: Top 100 suppliers of each to tag cases and pallets for "select" distribution centers
3
•Wal-Mart, October '05: More suppliers and broader use in 13 distribution centert
•DoD, January '06: RFID tagging of more cases, pallets, and high-value items
•Best Buy: Major suppliers to tag cases and pallets
4
•Wal-Mart, end of '06: All suppliers to tag cases and pallets
5
•DoD, January '07: RFID tagging of all cases, pallets, and high-value items
6
•Target, Spring '07: All suppliers to tag cases and pallets
Source: RFID Journal and Forrester Consulting
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Methodology

The Forrester Model Created for the Fibre Box Association

Given the likelihood that customers will ask their corrugated box suppliers to participate in RFID efforts, the Fibre Box Association commissioned Forrester Consulting to evaluate the impact of RFID on a corrugated box plant.

Terms Of Use For The Model

Forrester created a costs/benefits model and a supporting report that detail RFID's effects on a representative US corrugated box manufacturer. The model may be used in its original form, or it may be customized using an individual company's information. The terms of use for the model and report are:

- Using the report and model in their original forms for internal use and external one-on-one presentations with other FBA members and customers. If you choose to use the model with current default values, then please keep the Forrester attributions such as the copyright and page headers. Also, please ensure that the model, report, and any supporting presentation materials contain the notice: "The following is a commissioned study conducted by Forrester Consulting on behalf of the AF&PA and FBA."

- Customizing the model for external one-on-one presentations with other FBA members and customers. This model may be customized in order to calculate RFID's costs and benefits for a specific box plant. If you choose to customize the model and share it externally with members and customers, then please remove all references to Forrester Research and Consulting.

How We Calculated The Impact Of RFID On A Corrugated Box Plant

Forrester created a corrugated box plant at a representative manufacturer, XYZ Corrugated Box Corp., in order to model the costs and benefits of RFID within a box plant. We chose this approach because costs and benefits depend greatly on a corrugated box manufacturer's operations. We used a five-step process to derive the impact of RFID on a corrugated box plant in which we:

1. **Defined the operations of XYZ Corrugated Box Corp.** We defined plant characteristics using visits to two corrugated box plants, user interviews with FBA members, and vendor interviews with equipment manufacturers and providers of RFID products and services. Many critical assumptions were drawn from industry information like the 2003 TAPPI/FBA Corrugated Productivity Waste Survey Report and the 2002 Fibre Box Association Key Performance Indicator Survey Of Corrugated Plants.

2. **Determined XYZ Corrugated Box Corp.'s RFID approach.** We focused on RFID tagging for finished goods (boxes), not raw materials (rolls). Given this, we did not look at the benefits and costs of using RFID in sourcing, inbound logistics, or raw materials handling. Why did we take this approach? Because many consumer goods manufacturers facing RFID mandates of their own want their corrugated suppliers to assume tag application and, potentially, its associated costs. In light of this, FBA members must determine the impact of RFID application to finished boxes and their reaction to likely customer demands.

3. **Detailed the potential benefits of RFID in corrugated box production and distribution.** We used visits to two corrugated box plants and conducted user interviews with FBA members to identify the key operational challenges of corrugated box manufacturers. We then determined which operational challenges could be addressed by more granular data (serialization), more timely data, and/or automated data capture (auto-identification). These are the operational challenges that can benefit from RFID. We then made assumptions about the degree to which RFID could solve the challenges.

4. **Quantified the incremental capital expenses and overall annual costs.** We used visits to corrugated box plants, public resources, and interviews with corrugated box manufacturers, RFID vendors, and equipment manufacturers to calculate RFID requirements and costs. These include: 1) RFID tags, 2) machine upgrades (including one-time costs of machine modifications, scheduled down-time, and commissioning time); 3) labelers, readers, and software used for inline tagging; 4) productivity costs (including setup, operational down-time, and headcount); and 5) and customer returns and waste costs (including setup, run, and tag waste).

5. **Computed costs on a three year basis, and then calculated costs by key financial metrics.** We chose a three year period to report costs because: 1) The RFID market will change significantly over the next few years, making it difficult for corrugated box manufacturers to plan their operations beyond a near-term time frame; and 2) Many of the capital expenditures made in Year One will depreciate over a three year period. We then calculated costs by key financial metrics including cost per: msf, ton, piece, truckload, and order.

Analysis

Overview of XYZ Corrugated Box Corp.

XYZ Corrugated Box Corp. is a corrugated box manufacturer with US gross sales of $60.55 million, and annual shipments of 676 million square feet. We created a large integrated box manufacturer in order to provide the fullest view of RFID's cost on plant operations. The model focuses on make-to-order brown boxes used by consumer goods manufacturers to ship cases of product to retailers. Because they are not yet part of RFID mandates, other types of boxes — such as stock boxes, bulk boxes, and retail packaging — and specialty items, like corrugated displays are not covered in the model. Key assumptions about XYZ Corrugated Box Corp. include:

- **Plant operations.** XYZ Corrugated Box Corp's plant is above-average in size (around 250,000 square feet) and services nearly 300 customers in a 200-mile radius. It employees 90 hourly employees and 35 salaried employees. It operates 260 days a year, with two, eight-hour shifts per day.

- **Converting equipment.** The plant's converting equipment includes rotary die-cutters, flexo-folder gluers, and specialty folder gluers. RFID will be applied during the converting process using flexo-folder gluers and a specialty folder gluer. Today, RFID tagging machinery does not work well with corrugators and rotary die-cutters. Based on plants of comparable size, we assumed four converting machines would require RFID upgrades (see Figure 2).

- **RFID upgrades by year.** XYZ Corrugated Box Corp. will ramp up its RFID operations based on increasing customer demands over a three-year period. The upgrades to one specialty folder gluer are enough to handle tagging in Year One. XYZ Corrugated Corp. will need to outfit more flexo-folder gluers to handle the dramatic increase in RFID orders in Year 2 and 3.

Figure 2: XYZ Corrugated Box Corp. upgrades four converting machines with RFID equipment

Machine #1

Flexo-folder gluer #1 (< or = 28 x 72")		
1000 sq. feet per total machine hour		39.6
Square feet per piece		6.4
Pieces per total machine hour		6,337
Pieces per run machine hour		8,750
Pieces per setup		10,555
Machine hours - run (annual)		3,000
Revenue per machine hour	$	2,078

Machine #2

Flexo-folder gluer #2 (>40 x 100", and < or = 50 x 135")		
1000 sq. feet per total machine hour		64.4
Square feet per piece		14.7
Pieces per total machine hour		4,504
Pieces per run machine hour		6,818
Pieces per setup		8,126
Machine hours - run (annual)		3,000
Revenue per machine hour	$	3,379

Machine #3

Flexo-folder gluer #3 (>50 x 135", and < or = 75 x 170")		
1000 sq. feet per total machine hour		45.5
Square feet per piece		23.0
Pieces per total machine hour		2,365
Pieces per run machine hour		3,242
Pieces per setup		4,659
Machine hours - run (annual)		3,000
Revenue per machine hour	$	2,388

Machine #4

Specialty Folder Gluer		
1000 sq. feet per total machine hour		13.5
Square feet per piece		11.0
Pieces per total machine hour		2,090
Pieces per run machine hour		2,834
Pieces per setup		1,530
Machine hours - run (annual)		3,000
Revenue per machine hour	$	708

Source: 2003 TAPPI/FBA Corrugated Productivity Waste Survey Report

RFID's Impact On Corrugated Box Plants Will Be Substantial

Our calculations indicate that RFID will represent a high opportunity in customer service, limited monetary benefits for internal plant operations, and significant costs over the next three years.

There Are Limited RFID Benefits For Internal Plant Operations

Forrester explored the RFID benefits to corrugated box plant operations. We believe that the customer service benefits are high. However, the internal operational benefits are limited in the near-term. RFID's impact by category is:

- **High: Customer service and satisfaction.** RFID will provide a crucial benefit that can be measured using "hard" financial metrics: keeping the business of customers with RFID requirements. Corrugated box plants that apply RFID tags to finished boxes will perform a value-added service to these customers, thereby also contributing to "soft" benefits like improving the customer relationship. This benefit cannot be underestimated since it will likely drive corrugated box plants to invest in RFID despite the limited internal benefits.

- **Low: Customer returns.** RFID could decrease the number of customer returns by linking the identity of a damaged box to data about the conditions under which the box was produced (for example: equipment used, run speed, and production crew). This link, however, is often available at the bale level. Therefore, it is unlikely that linking this information at the box level would significantly improve traceability.

- **Low: Shipping.** RFID could improve shipping activities by decreasing shipping times (by, for example, automatically generating an advanced shipping notification, or ASN), and increasing the accuracy of shipments. However, ASNs are generated and orders are counted at the bale level, not at the box level. It is unlikely that automated counting of boxes will improve the speed or accuracy of shipments.

- **Low: Receiving.** RFID could improve receiving activities at off-premise warehouses by allowing all the boxes in a bale to be "read" simultaneously. However, there are very few instances where orders are counted at the box level. Moreover, most manufacturers ship direct to the customer from plants rather than using off-site distribution centers with receiving processes. Therefore, it is unlikely that simultaneous reading of individual boxes will improve receiving speeds for the corrugated box manufacturer.

- **Medium to high: Other benefits.** RFID can provide operational benefits to a plant when RFID tags are used on raw materials, plant assets, or bales/pallets of finished boxes. These benefits are outside the scope of the model since they require separate RFID deployments. Also, there are other potential benefits that

are currently difficult to name, but could become significant with broad RFID adoption in the retail industry. These benefits are explored in the "What It Means" section of this report.

RFID Costs Top $13 Million

The three-year cost of RFID for XYZ Corrugated Corp's box plant is over $20 million . The most significant costs are tags, productivity, and customer returns/waste. Costs by category, in order of significance are:

- **$7.4 million for tags.** Tag costs — which are only $304,000 in Year One — increase dramatically in Years Two and Three, to $2 million and $5.1 million, respectively. This is because customers will require corrugated box suppliers to tag finished boxes only after a critical mass of their own cases reach the point where they need RFID tags. In the first year, most customers will apply tags in their own distribution centers using a "slap-and-ship" approach, or in their own manufacturing plants using automated case erectors. As tag order quantities increase in Year Two and Three, the cost of an individual tag will fall from $.30 to $.20.

- **$3.6 million for lost productivity.** Three factors contribute to costs in these categories: increased machine set-up times, operational down-time, and line speed reduction. Set-up costs increase as crews will take a seven additional minutes to perform tasks like positioning labelers to work with specific box widths and loading rolls of RFID label stock. Operational down-time also increases due to additional tasks like labeler re-loading, and production glitches. Line speeds must run at a slower rate — particularly in Year One — as machine crews familiarize themselves with RFID operations.

- **$860,000 for customer returns and waste.** Customer returns will amount to nearly $802,000 as 2% of all RFID boxes are returned by customers. This high return rate is based on discrepancies between read rates at the customer's site and the box plant. Operational waste will increase as employees must remove boxes with dead RFID tags from the production line. Also, tag waste remains high due to unreadable tags — hovering around 15% today — although these costs will decrease in Year Two to Year Three as tag manufacturers standardize and improve EPC Gen 2 tag production processes.

- **$1.1 million for converting machine upgrades.** Machine modifications are expensive when major upgrades need to be made. A major upgrade can cost more than $150,000, including new equipment like folding rail extensions and miscellaneous conveyors, and installation resources for disassembly, rigging, and erection. This capital investment will depreciate over a three-year period, and so actual costs for upgrades in Year Two and Year Three extend beyond this model.

Production down-time and commissioning time, in which the machine is running at 33%, are other important costs in this category.

- **$382,000 for labelers and readers.** In order to keep pace with fast machine speeds, XYZ Corp. often requires more than one labeler per machine, even when these labelers are only applying tags. As such, the cost of labelers is the highest expense in this category. Today, it is very difficult for a labeler operating on a high-speed line to verify that a tag works. Therefore, XYZ must use an offline operation to verify that tags are readable. XYZ needs a reader further down the flexo-folder gluer that will verify that a tag is readable after it has been applied. It will also require RFID middleware to handle the multiple reads and filtering that occur on a high-speed line.

Figure 3: RFID costs top $13 million over 3 years

Costs	Year 1	Year 2	Year 3	Total
Tags	**$ 304,184**	**$ 2,027,895**	**$ 5,069,738**	**$ 7,401,817**
Machine upgrades	**$ 109,972**	**$ 614,358**	**$ 401,813**	**$ 1,126,144**
Depreciation and amortization, machine upgrades	$ 49,500	$ 148,500	$ 198,000	$ 396,000
Scheduled down-time	$ 56,675	$ 436,606	$ 191,015	$ 684,296
Machine commissioning	$ 3,797	$ 29,253	$ 12,798	$ 45,848
Labelers and readers	**$ 62,700**	**$ 150,700**	**$ 168,850**	**$ 382,250**
Depreciation and amortization, lablers and readers	$ 62,700	$ 132,000	$ 150,150	$ 344,850
Software maintenance	$ -	$ 18,700	$ 18,700	$ 37,400
Productivity	**$ 307,242**	**$ 1,142,913**	**$ 2,221,953**	**$ 3,672,109**
Setup	$ 5,786	$ 143,874	$ 311,854	$ 461,513
Operational down-time	$ 187,027	$ 561,081	$ 748,107	$ 1,496,215
Line speed reduction	$ 65,033	$ 299,648	$ 964,406	$ 1,329,087
Headcount	$ 49,397	$ 138,311	$ 197,587	$ 385,295
Returns and waste	**$ 65,072**	**$ 388,833**	**$ 406,603**	**$ 860,508**
Customer returns	$ 16,725	$ 110,231	$ 183,719	$ 310,676
Dunnage	$ -	$ -	$ -	$ -
Set-up waste	$ 577	$ 5,073	$ 12,683	$ 18,334
Run waste	$ 2,142	$ 70,739	$ 108,806	$ 181,687
Tag waste	$ 45,628	$ 202,790	$ 101,395	$ 349,812
Total	**$ 849,170**	**$ 4,324,699**	**$ 8,268,957**	**$ 13,442,827**

What It Means

Broad RFID Adoption Will Bring New Types of Benefits

While outside the scope of this model, RFID can bring new benefits to a corrugated box plant when RFID adoption is nearly ubiquitous across the retail supply chain. Over the next decade, look for:

- **RFID data to improve demand planning**. RFID data will ultimately help consumer goods manufacturers predict the demand levels at retailers, thereby allowing them to become more efficient at inventory management and indirect materials sourcing. A customer with a better view of demand is less likely to hedge their bets by ordering an over-supply of boxes. This could reduce the inventory carrying costs of box manufacturers that warehouse boxes for their customers. Interestingly, the same effect could also lead to fewer brown box orders since the net inventory across a supply chain is lower.

- **RFID data to improve warehouse operations**. Like other auto-ID technologies such as bar-codes, RFID can improve warehouse processes like order-handling and inventory control, while increasing the productivity of warehouse staff. For example, in larger warehouses, inventory can get "lost" and must be discarded if it is an outdated spec or is damaged. Also, RFID can minimize over shipments to customers by verifying box counts on a truck. These processes require RFID to be used across all orders, and so they can be realized only when RFID is nearly ubiquitous across all customer orders in a box plant.

Appendix A: Supplemental Material

Related Forrester Research

See the March 1, 2004, Forrester Market Overview "RFID At What Cost?"

Other Resources

The companion spreadsheet is interactive model for corrugated box manufacturers to calculate the impact of RFID on their plant operations.

Companies Interviewed For This Document

Forrester interviewed seven RFID vendors and corrugated equipment suppliers. We also sought feedback from the Fibre Box Association's RFID Task Force, and four other corrugated box manufacturers.

Alliance Machine Systems International, LLC

Alliance Machine Systems International, LLC is a global source of products and services for the corrugated box industry. Alliance offers Specialty Folder Gluers and Automated Material Handing Products, with an aim to enhance efficiency and performance in the plants they are installed. The Alliance product line includes the J&L Specialty Folder Gluer, Prefeeders, Stackers, Bundle Breakers, Counter Ejectors, Pallet Handlers, Palletizers, Load Formers, and Robotics. For more information visit, www.tei.com.

Apriso

Apriso offers enterprise software that allows corporations to define, operate, and monitor supply, production and distribution processes in real time. Apriso's software, known as FlexNet®, integrates into an enterprise's existing software infrastructure, and extends the scope of systems such as enterprise resource planning (ERP) into the furthest reaches of the extended production and supply network, as required. But unlike these systems, that are based upon a top-down, plan-driven operations orientation, Apriso's event-driven, process-based architecture accommodates any operational model that is based upon real-time collaboration between execution processes, real-time visibility into performance, or the requirement to define, refine, or immediately control workflows throughout the enterprise, and across borders. Apriso was founded in 1992, and now operates in 11 countries across the Americas, Europe and Asia-Pacific. For more information, please see www.apriso.com.

BlueQue Systems

BlueQue Systems offers the I-Que Manufacturing Suite. It is an integrated manufacturing system which combines the functions of ERP, MES and WMS into a single database system. The I-Que system tracks materials throughout all stages of the converting process, providing material traceability from raw material to end product. BlueQue

Systems' most noted project is the automation of Corrugated Supplies Corporation located in Chicago, Illinois, which has won various awards for it advancements in manufacturing. For more information visit: www.blueque.com.

MARKEM Applied Intelligence Solutions

MARKEM helps firms comply with RFID and Electronic Product Code requirements while gaining value for their own businesses. MARKEM offers product identification hardware, software, and business and integration services to the supply chain, including production lines, distribution centers and third party logistics providers. MARKEM has been in the business of product identification since 1911 and operates with subsidiaries in 16 countries, serving 34 more through agents and distributors. For more information, please visit www.MARKEM.com, email rfid@markem.com, or contact Don Parker, RFID Business Development Manager at dparker@markem.com or 800-258-5356 x5320.

MarquipWardUnited

MarquipWardUnited, a Barry-Wehmiller company, is an international provider of high-speed corrugating, sheeting, and finishing machinery for the corrugated paperboard and folding carton industries. MarquipWardUnited's engineering department is dedicated to integrating advanced electronics with innovative mechanical designs. With the goal of combining knowledge and creativity, MarquipWardUnited's engineers work on evolving technology to develop state-of-the-art machines and controls. For more information visit, www.marquipwardunited.com.

Smart Packaging

Smart Packaging, an International Paper business, offers RFID/EPC-enabled supply chain solutions from warehousing and transportation tracking to the retail shelf. International Paper is involved in the design, development and implementation of integrated RFID packaging and supply chain applications with an emphasis in the Electronic Product Code (EPC). IP's investment in RFID discovery has resulted in 38 provisional patents submissions. For more information, visit: www.ipsmartpackaging.com.

Texas Instruments RFid Systems

Texas Instruments offers radio frequency identification (RFID) technology including RFID tags, smart labels, and reader systems. With more than 400 million tags manufactured, TI has been involved in RFID applications including automotive security, automatic toll collection, retail refueling, wireless retail payment, livestock identification, sports timing and library asset management. Texas Instruments RFid Systems is an active member of standards organizations including the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and EPGglobal, Inc. For more information, contact Texas Instruments RFid Systems at 1-888-937-6536 (North America) or +1 972-575-4364 (International), or visit www.ti-rfid.com.

Appendix B: About The Analyst

Christine Spivey Overby
Senior Analyst

Christine works with Forrester's Consumer Markets research team and analyzes the impact of technology change on consumer packaged goods (CPG) manufacturers, distributors, and retailers. Her research reveals how new technologies can improve critical activities like offline and online advertising, promotions, consumer marketing, and collaboration between manufacturers and retailers.

During the past two years, Christine has led Forrester's research on RFID adoption in retail and consumer packaged goods. She is the primary author of Forrester's first RFID report, "RFID: The Smart Product (R)evolution," and she has helped dozens of consumer and industrial manufacturers with their RFID strategies.

Prior to leading Forrester's CPG research, Christine was an analyst on the eBusiness Organization & Services team at Forrester. She has produced research on a number of topics including the evolution of service provider business models, best practices for managing multiple providers, and an evaluation of the US technology outsourcing market. Her research has been cited in many publications, including
The Wall Street Journal, The Globe and Mail, The Boston Globe, and Fortune.

Christine began her career at Forrester as a research associate in Forrester's Software Strategies group. In this role, she drove Forrester's Fortune 1,000 research on a range of topics, including Java development, data analysis, and application integration. Christine conducted more than 250 interviews with IT executives to understand their technology strategies and wrote analysis on developer portals and Web-based document management.

Prior to Forrester, Christine worked for the US Department of Health & Human Services.

Appendix C: Endnotes

[1] See the March 1, 2004, Forrester Market Overview "RFID At What Cost?"