Robert Palevich

THE LEAN SUSTAINABLE SUPPLY CHAIN

How to Create a Green Infrastructure with Lean Technologies

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My book is dedicated to my loving parents,
Frank and Lucille Palevich,
for always believing in me.

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Foreword

Do it Best Corporation got its start back in 1945 as the vision of Arnold Gerberding. It was known then as Hardware Wholesalers, Inc. (HWI). Gerberding set out to build an entirely new way of serving the needs of independently owned hardware stores and lumberyards. From those humble early days of the co-op and just a few hundred members in the Midwest, Do it Best Corp. has grown into a $3 billion worldwide distributor of hardware, lumber, and building materials with close to 4,000 member locations and operations in more than 50 countries around the world. That growth would not have been possible without an industry-leading supply chain.

The company's first computer was purchased in 1964: an IBM 1401 with a whopping 8K of memory! It was out-of-date almost before it was turned on. Its capabilities were certainly limited, but it was an important investment in keeping up with the company's rapidly growing base of members. Its tasks were limited to maintaining a perpetual inventory, generating billings and packing slips, and other routine tasks. With upgrades to the "next generation" of computers, an IBM 360 in 1968 and an IBM 370 in 1972, the company soon realized that the new systems could be a powerful tool in the buying and replenishment function. The ideal system would be able to track merchandise movement, vendor performance, and customer requirements. At the heart of this was the need for an effective replenishment system that factored in lead times, customer demand, promotional impact, and seasonality to help maximize inventory turns and fill rate.

Enter Rob Palevich.

Rob started with HWI in August 1970. With his undergraduate degree in industrial management and computers and a master's in business administration, he was in the perfect position to take control of the company's inventory control efforts. Rob single-handedly developed the software for a unique automated order and replenishment system called FOURTE, or Forecasting and Ordering Using Regression, Time Series, and Econometrics. In 1981, HWI was able to put the FOURTE system into service as the industry's most sophisticated inventory control system, helping the company achieve fill rates of close to 95% in its then four distribution centers. The system analyzed data for every item, vendor, and line of merchandise handled by HWI. It took into account product seasonality, regional differences, store purchase history, and more. The program could also adjust to increase an order to meet minimum dollar, weight, or cube requirements, and it could factor in manufacturing and delivery lead times as well. This extraordinary system did much more, from aiding in financial control to pinpointing problem areas and analyzing cash flow impacts. In short, Rob Palevich's development of FOURTE revolutionized the manner in which purchasing and distribution would be managed going forward and gave HWI another considerable competitive advantage in the marketplace.

The steady advancement in computer memory and processing speed provided Rob with strong, new tools and an ever-expanding canvas to further his development of the FOURTE system. As HWI became Do it Best Corp. and the company continued its rapid growth, FOURTE enabled it to maintain a fill rate in excess of 96% on more than 65,000 items in eight distribution centers with accuracy in excess of 99%. Not a bad effort for a young man who started out in the data processing department at $3.12 per hour!

Throughout his career, Rob has demonstrated a thirst for learning. Name a programming language and he's most likely studied it and used it. In 1998, he spearheaded an initial entry into e-commerce with the launch of doitbest.com. In 2001, Indiana University–Purdue University Fort Wayne (IPFW) recognized Rob with their Distinguished Service Award for his engagement with the University. He's also the only person in the company's history to have used the tuition assistance program to study two years of Chinese...not a surprise if you know Rob. But his passion all along has always been in improving the supply chain.

After 33 years of service, Rob retired from Do it Best Corporation but didn't stay idle for very long. He began a teaching career at nearby IPFW with a focus on SAP, enterprise resource management, and supply chain excellence. He quickly put his background and experience to work in the development of long-range radio-frequency identification tags. Rob is the founding director of the Business Enterprise System and Technology (BEST) Institute at the Richard T. Doermer

School of Business at IPFW, a center for knowledge management and networking in Northeast Indiana. He also serves as CEO of RP Global Technology Solutions.

Based on a considerable measure of practical hands-on experience and focused through a lens keenly trained on the future, *The Lean Sustainable Supply Chain* provides an important framework for developing a world-class supply chain that is both lean and green. It moves far beyond the basics of "inventory" management to the exceedingly more complex and content-rich environment of "information" management, and it provides a GPS map for the road to the future of the global supply chain. Even while Rob is officially retired, his talents and expertise continue to feed the success of Do it Best Corporation as they raise the bar on supply chain initiatives and strive to make the best better.

Robert N. Taylor
President & CEO
Do it Best Corp.

Acknowledgments

I am grateful for all the support I have received from so many people in writing this book. I credit Dr. Jim Moore from the Richard T. Doermer School of Business for encouraging me to participate in an International Symposium on the Green Supply Chain at Kent University. Winning the competition ultimately led to my decision to share my insights.

I want to convey many thanks to Jacqui Petersen, Bobbi Barnes, Cynthia Wilson, and Dr. Karen Moustafa Leonard for encouraging me to write a book and helping with initial editing. I also greatly appreciate the dedication of Renee Kosor, who worked tirelessly to complete the project.

I would like to give special acknowledgment to Robert N. Taylor, President and CEO of Do it Best Corp. I am humbled and sincerely appreciate the "glowing" foreword he penned for my book. I am indebted to his support and the opportunities I have enjoyed from working at Do it Best Corp. That background has enabled me to understand the intricacies of the supply chain command.

Last, but not least, I would like to recognize my wife, Bonnie, and family: Chris, Angie, Jessica, Rylee, and Maya. They have endured my long ordeal and interruptions even on vacation.

About the Author

Robert Palevich is a full-time professor at Indiana University–Purdue University Fort Wayne, Indiana (IPFW). His teaching areas are E-commerce and B2B, SAP and ERP, Lean Black Belt Six Sigma, Operation Management, Statistics, Discriminant Analysis Linear Programming, and Web Page Design. His research interests are Lean manufacturing and the Lean service industries, Six Sigma and process analysis, RFID, and the sustainable green supply chain.

He is the director of the Business Enterprise Systems and Technology Institute (BEST) at IPFW. The purpose of the BEST Institute is to inform, educate, and help existing companies attract new businesses and industries by creating a center for knowledge management and networking for all the companies in Northeast Indiana. With the cooperation of the BEST Institute and RP Global Technology Solutions, he received a $250,000 grant for the University from the Strategic Skill Initiative (SSI) for teaching the most relevant and current technologies.

Palevich is also President and CEO of RP Global Technology Solutions LLC. The company specializes in advanced technology for companies throughout the state. The technology includes RFID, Visual and Sensor Equipment, Six Sigma, ERP, Lean Manufacturing, Supply Chain, and CPFR technology.

Prior to teaching at the university, he has had 25 years of supply chain experience in logistics and enterprise resource planning at a $2.0 billion wholesaler (Do it Best Corp.) with 4,500 stores worldwide. His responsibility as CTO was to bring in all new Internet, Electronic Commerce, EDI, and Supply Chain Management (SCM) technology. He was involved with the development and integration of the Business Process Design (BPD) of the Supply Chain, Logistics, WMS systems, Knowledge Management (KM), Product Lifecycle Management (PLM), Supplier Compliance, and integrated workflow in Purchasing. He had collaborated with approximately 25 Fortune 500 companies in the process of developing certification standards between the respective companies and sharing technological innovations. He has also traveled in North America, Latin America, and Asia in consulting and educational roles.

Palevich programmed the entire Supply Chain and Inventory Control Forecasting Program, which was named FOURTE, for Do it Best Corp. FOURTE stands for Forecasting and Ordering Using Regression, Time Series, and Econometrics. The company used this program for well over 10 years to enjoy the industry-leading service levels and inventory turns.

His education and background are as detailed here:

SAS INSTITUTE CARY NC:

- Completed *all* their classes for statistics, ETS Statistical Analysis, ANOVA, MANOVA, Box and Jenkins, ARMA, ARIMA, Time Series, Correlation Analysis, Categorical Analysis, Factor Analysis, Regression Analysis, Polynomial Regression, Non Linear Regression, Neural Networks

INDIANA UNIVERSITY: MBA

PURDUE UNIVERSITY: post-graduate research in Advanced Mathematics and Statistics. Dr. David Bendixon

INDIANA UNIVERSITY: MSBA

PURDUE UNIVERSITY: BS in Industrial Management

Certified by CompTIA in 2008 as an "RFID and Supply Chain Certified Professional"

Preface

This book is a summary of the experiences I have had working with many Fortune 500 companies such as GE, 3M, National Manufacturing, Sherwin-Williams, Black & Decker, Manco, and others on collaborative processes. The rationale for this collaboration was that in today's global economy each company needed to work together to enhance corporate processes to become "Best of Breed." It is amazing what can be learned from each company during yearly technology sessions when best technologies are shared so that every company reaps the benefits. The ideas and strategies explored in this book form a compendium of those best practices and shared technology over the past 25 years.

The inspiration for writing this book began when I won the award of first place in the case study track at the International Symposium of Supply Chain Management held at Kent State University in 2010. My specialty focused on applications that clarified the newest technologies with Lean initiatives and how those technological advances affect the Green environment. The purpose of this book is to break down the processes used in creating a world-class company so that any manager interested in cutting the fat can implement the technological advances now available.

This book will demonstrate how to calculate a scorecard for the various enterprise Lean technologies introduced and will act as a Lean Savings Report and a Green Sustainability Report including environmental savings. The Lean Savings will show the increased productivity incurred from the usage of the various technologies. The Lean metrics will show how much each of these technologies saves in these areas:

- Personnel
- Paper usage
- Increased productivity
- Lessened building space, allowing for less utility usage
- Fewer miles traveled in the transportation system
- Better service levels

- Increased margins
- Lower inventory levels
- Better turns
- More efficient utilization of IT resources
- Better morale

The environmental Green Savings include the following:

- Less electrical usage due to the need for fewer employees
- Carbon savings as a result of the decreased electrical usage
- Smaller amounts of paperwork, translating into fewer trees cut down per year
- Lesser amounts of carbon dioxide being emitted and using fewer trees resulting from lean management styles and technology
- Fewer miles driven due to the use of the Transportation Management System lead to a reduction in the pounds of CO2 footprint in the environment.
- Less highway wear and tear as a result of fewer miles traveled
- Less space utilization, requiring less building expense and upkeep

Each technology is introduced so that the reader not only understands how to implement each improvement but can measure the successes through increased company performance as well as environmental Green Savings. The formulas are presented to calculate the annual decrease of carbon dioxide and conversion of gasoline from gallons to pounds of CO_2. This is shown in the introduction of each technology. At the end of the chapters, Appendix A summarizes the savings that points out each technology's effect on the company's bottom line and performance. The time has come to learn to adapt to new innovations and enhance shareowners' benefits and profitability.

1

Lean Sustainable Technologies

The supply chain is composed of all the parts of the enterprise and its associated trading partners. The Lean Green Supply Chain is made up of two major components: external and internal. There is a synergy between these two parts. The internal savings can, in some cases, be equal to the external supply chain savings. To exclude the internal improvements that supplement the productivity of the External Lean Supply Chain is to miss out on a major component of long-term sustainability.

The external side represents the suppliers and customers throughout the supply chain. Collaborative technologies and software can be used to minimize the cost of the organization and decrease the company's carbon footprint. Forecasting procedures reduce the variation in systems processes in their connection with suppliers and customers in the external supply chain. Improving forecasting methodology through the implementation of Gamma Smoothing increases accuracy in forecasting and stimulates savings.

The typical EOQ (Economic Order Quantity) considers mere receiving and carrying costs in the warehouse. The new EOQ model moves companies beyond current warehousing needs and into the external environment. Through the incorporation of inbound and outbound freight, the EOQ model increases forecasting accuracy, leading to cost reduction throughout the external supply chain.

The internal supply chain is composed of the technologies that can be used to make the corporation and its employees more productive. Implementation leads to lowering the amount of space and resources necessary to perform the job. This represents the definition of Lean and Green sustainability. The sustainability effort needs to incorporate workflow technologies and the use of software to minimize the use of paper and other costly resources.

Putting It All Together

Now it's time to enter customers and suppliers into the equation of collaboration. The most important consideration at this point is what is best for the entire supply chain. This can be emphasized only by involving the other suppliers and customers. What is good for one may not work for all. For example, 10% of the United States GDP (Gross Domestic Product), which was $14.26 in 2010, is involved with supply chain. Today's companies are realizing that the competition is not with their competitors but with competing supply chains.

According to a study by consultants A.T. Kearney, inefficiencies in supply chains can waste up to 25% of a company's operating costs. In companies with profit margins of 3% to 4%, even 5% improvements in supply chain efficiencies focusing just on material flow can double profit margins.(1) The supply chain is the greatest cost in today's industry and consequently has the best chance for the highest return if the process can be further improved.

One measure of the ability of a company to enhance its standing among the competition is the metric called Gross Margin Return on Investment (GMROI). GMROI looks at a company's quantitative ability to compete. GMROI is the gross margin percentage of a company multiplied by the inventory turns of that company. Turns are the term used to convey how well a company turns its inventory. Turns = while GMROI = GM × Turns. If two companies have the same gross margins, with one company's inventory turns being 50% better than its competitor's, the company with the higher turns is making more profit for the enterprise. For example:

> *Company A* has a gross margin of 20% and has 3 inventory turns. The GMROI throughout the year on their inventory investment is an average of 3 × 20% = 60%.
>
> *Company B* has a gross margin of 20% and has higher inventory turns of 4.5. Company B's GMROI is 4.5 × 20% = 90%.

Company B is making 90% on its inventory investment for the year. It is also making more money on opportunity cost because company B has 50% fewer inventories held as compared to Company A. This frees up capital or expenses if loans are involved. Company B can now afford to sell at a lower cost and also sell more expensive alternatives at lower prices.

Sustainability is meeting the needs of the present generation without compromising the needs of future generations. For every $1,000 spent on Lean Technologies, there is a Green payback of approximately $426, which includes savings in the environment. The greatest Green Savings is found in the transportation highway infrastructure yearly maintenance costs. Removing the cost of the transportation infrastructure from the scenario still provides for approximately $280 savings for every $1,000 spent on Green. The payback is well worth the cost, not only in dollars but also in sustainability.

Creating the World-Class Company

The following sections describe the initial components to create a world-class company. We begin with resource management, the management of resources to differentiate the company from competition. This is followed by the second part, which is forecasting the future enterprise inventory requirements. This is not just about the forecasting methodology but also integration and collaboration within the value chain. The term *value chain* is used to make notice of all the savings within the supply chain, savings that can separate your firm from the competition. The collaboration was made possible with VMI (vendor-managed inventory) and certification programs. The topics of EDI (electronic data interchange) and the various transaction sets are used for infrastructure integration and automation. At the end is a summary of the lean and green benefits.

Step One: Resource Management

The global competition is changing for the entire set of business paradigms. Today's companies need to be more competitive, flexible, innovative, and lean because of increased global competition. It is not a privilege to make a profit today, it is an expectation of stakeholders—employees, banks, government, and suppliers. The global recession has forced companies to cut costs and look for new, innovative ways to do more with fewer people. This has brought on the concept of Innovation Management, the need to think creatively and find better ways to be more productive. This differentiates a company from its competition.

How can a company remain innovative enough to separate itself from the competition? This was Steve Job's major mantra when he came back to Apple Corporation in 1997. Apple needed to catch up with the competition: IBM. At the time, people needed something different to overcome their fear of computers. Steve's comment to the team at Apple was, "Apple cannot keep trying to get one step better than their rivals. They must be innovative and make something different." This was the start of Apple's comeback with the introduction of the iMac.

The iMac was the first computer that looked friendly and came in bright, vivid colors. This simple change brought about the start of Apple's great growth pattern. The popular belief is that if Apple would have waited an additional year, they would have been doomed. Another example of Apple's innovative philosophy involved asking their employees to spend 20% of their time thinking creatively. The employees sat in a comfortable room, separate from their work area, to explore ideas that were new and innovative.

Charles Darwin said, "It's not the strongest species that survive, or the most intelligent, but the most responsive to change." Innovation Management is the concept of trying to create the most innovative atmosphere in the company that's possible. How do employers teach people to think beyond the box? One way to facilitate this is to have the managers go to one or two conferences focusing on areas where improvement is needed each year and then return to share their knowledge with the rest of the staff.

Staff training is a good time to facilitate affinity analysis. This is the concept of recording the ideas on a chart so that the information is easily seen by the group. The information flow can be categorized and prioritized by importance. An overriding theme for each innovative improvement is to improve the product by changing the playing field on the competition. Implementing an open training forum makes it harder for competitors to ramp up in a new direction. By the time they catch up, the innovative management team is already on the next playing field.

Innovation Management will not succeed without Talent Management. Creativity and innovation are viable only when the most talented people in the organization are placed into an atmosphere conducive to thinking outside the box. Google understands this concept and touts the practice on their Web site of creating "an atmosphere that, when they had hired the most talented people, they, in turn, did not want to leave. This not only refers to not leaving for another job, but also refers to wanting to spend more time at work. The employees actually enjoy being at work." Innovation Management drives talented people to companies that practice this method.

Employee retention requires a top-down attitude of Talent Management. Creating a desirable work environment might mean providing on-site health classes such as yoga, offering local gym memberships, or bringing in guest speakers to focus on personal and professional improvement. The benefit to the company includes decreased health-related absences, lower health-insurance costs, and increased camaraderie among the staff. For employees in manufacturing or distribution, injuries such as carpal tunnel syndrome are commonplace. The wellness program can help lower the incidence of medical claims.

The final piece of the Talent Management puzzle is the profit-sharing program. Profit sharing creates a personal stake in the success of the company, which increases employee productivity. Do it Best Corp. has instituted a profit-sharing program that led to one of the highest retention rates in the industry. Their profit sharing today is over 20% of employee pay, which has increased staff involvement in cost-cutting methodology.

After the talent is in place, the next necessary step is to spark the innovative talents of the staff by creating an atmosphere of Change Management. The key element in Change Management is continuous improvement through motivating employees to consider change a benefit and to embrace each one as a new challenge. This is done with the introduction of continuous improvement concepts. These improvements can be introduced to the employees in a discussion forum, which allows them to confer with others on the viability of each concept.

For example, the manager's job is to find the why and how of extra inventory problems. Employees have the answers and a good manager seeks those answers through the philosophy of Management by Walking Around (MBWA). Managers who are there to listen allow subordinates to be more open to sharing improvement ideas. Sometimes the best ideas come from informal conversations with employees. Employee objectives should be made visible through the use of scoreboards throughout the office and communicated through weekly meetings. The objectives are then used to create constant awareness in the way each step is taken in the supply chain.

Employees who are rewarded with incentives are more likely to consider corporate objectives and improved processes. Acknowledgement of critical milestones through the creation of public displays promotes the team players who can be imaginative. Companies that nurture the spirit of thinking beyond the box open communication and encourage and reward new ideas. The corporate culture of new idea generation requires constant nourishment. It also requires the right people who are self-motivated and willing to work with others.

An additional but essential part of Change Management is execution. There are too many CEOs and directors not clearly tied to their goals. Their pay and bonus structure does not reflect the performance and profitability of the company. To move with the times, execution must reflect from the top of the organization down to the production floor.

Companies have prospered through the generations with each technological advancement:

In 1910: Mass production

In 1960: Lean technologies

In 1980: Flexibility through computerization

In 1990: Reconfiguration

In 2000: Knowledge management

In the era of knowledge management, the leaders must grow creatively to unlock the potential of the personnel. The only way to perform this is through Execution Management. Steve Jobs of Apple Computers envisioned the Mac computer, iPod, iPhone, iPad, and iTunes. He knew how to execute the vision and make it happen. Allen Mulally of the Ford Motor Company turned Boeing around and then transformed Ford with its new styling and innovative models.

Execution is giving the personnel direction and a vision of what needs to be accomplished. A company can empower employees to succeed by enabling them to make the vision possible while motivating them to use their talents to execute the vision. Execution is making things happen that delight the customers and shareholders.

Technology is changing the environment, allowing companies to execute in an even more expeditious fashion. There are four trends that make this possible:

1. Development of an ERP (Enterprise Resource Planning) environment. All knowledge in real time and all from the same source. Information is more accurate and relevant, which expedites decisions and informs all interested parties of progress.
2. On-demand, which means going to the next-generation real-time management systems called SAAS, or Software as a Service. The user is billed and pays only for what is used. This software is more pervasive than the old-style ERP systems. It is assumed that the software will be downloaded from the Internet in a cloud, ASP (Application Service Provider), or App Environment. Now information analysis can be more readily available on all data realized from the ERP system above.
3. BI, or Business Intelligence, which is software that is inbred into a DSS, or Decision Support System. This expands the horizon of the two preceding steps. Analysis is achieved with the on-demand software, and the information received will translate to knowledge for the corporation through the use of Business Intelligence. It allows the intellectual capacity of the analytics system support to aid the managers in decision making and risk analysis. This difference is what separates the leaders from the followers.

4. On Device, or mobile, which means that the employee can be engaged anytime and anyplace. This has started the new generation of the always-on, always-connected world. These devices will transform the business industry. Now when decisions need to be made immediately, communication between management and staff will not be put on hold. The decisions can be made more expeditiously.

After the team is in place, the Lean Green journey can continue through the management paradigm and begin again with Innovation Management. Innovation Management works best when Talent and Change Management techniques are implemented in unison. For instance, when a new forecast system was needed to streamline the purchase of 55,000 items, innovative management sought out the most qualified employee and worked with him to allow his creativity to produce the technology necessary to create the system. He was permitted to leave the job site daily at noon and work at the location of his choosing for six months.

From a table at a local coffee shop, this employee coded the Forecasting and Ordering Using Regression, Time Series and Econometrics (FOURTE) system. When implemented, FOURTE allowed the company to differentiate itself from the competition by attaining the industry leadership in turns and service level. The system increased productivity by a factor of 16. The same employee was later offered the opportunity to design the only promotional forecast system in the industry using SAS as the analytic engine. Without an attitude of innovation, this company would have missed out on long-term sustainability and an unmatchable competitive edge.

Today's successful company involves each department in the corporation as well as customers and suppliers along the supply chain. Collaborative versions of technology software such as ERP II (Enterprise Resource Planning) and MRP II (networked closed-loop manufacturing requirement planning) are networked with accounting financials and other departments such as Human Resource, Distribution, and Marketing. The one overriding feature is that there are no more silos for independent enterprise software. The common thread in creating the world-class corporation is determining how each decision affects every point in the supply chain, as well as knowing what is best for the entire company.

Step Two: Forecasting the Future Enterprise Inventory Requirements: Best of Breed Forecast Systems and the Supply Chain

Vendor-Managed Inventory

Vendor-managed inventory (VMI) is an agreement between the supplier and the retailer of merchandise. The retailer must give the usages, on-hand and on-order information to the supplier so that they can take full responsibility for maintaining the retailer's inventory. This is usually in the form of an EDI (electronic data interchange) transaction set 852. The supplier now has the goal of balancing the demand and supply side of the equation for the retailer. A 3PL or third-party logistics provider can also be used by the retailer to augment the success of the VMI program by maintaining better control of the inbound and outbound traffic.

In the traditional relationship, the distribution centers stock their warehouse with products from the supplier and the orders are based on demand forecast from the supplier. The vendor could also stock stores in a similar fashion, in which case the supplier could bring in extra storage, displays, or promotions. The vendor may have to pay a slotting fee for storage in the retail store, but it is worth the time and expense because it increases sales and profits due to the added visibility of product. The product can also be delivered on a consignment basis, which means the product is owned by the vendor and the retailer does not have to pay for the inventory. This is great for the retailer because they garnish the sales from the additional product and pay for the items only when they are sold. The supplier, in turn, bases forecasts and inventory levels on past orders from the retailer.

In a VMI arrangement with the retailer, the supplier may take over the inventory functions that the customer managed. In this scenario, the supplier responsibilities include the following:

- Providing the racking or bins for the storage. This also includes all signage and advertising media.

- Determining how the merchandise will be displayed. Is it an end-cap or a dump bin?
- Determining the receiving schedule for inbound receipts. This needs to be approved by the retailer of the distribution site.
- Maintaining all inventory transactions. This needs to be very visible with the retailer and supplier.

In the traditional relationship, the customer has an incentive to keep inventory lean by placing small, frequent orders. This is called the just-in-time (JIT) concept. This ensures that the customer maintains an acceptable fill rate and a low inventory level. When this concept is used, it is necessary to be cognizant of the increased cost of added transportation and receiving.

With the Green variable for the supply chain, the vendor will not have to ship the product as often as the just-in-time arrangement from the retailer. This saves in mileage traveled by the manufacturer, and the extra inventory is stored in one facility, usually owned by the supplier. This facilitates smaller warehouses on the retailer's side and smaller supply chain inventories because it is not stocked heavily in many locations.

The onsite supplier (OSS) can measure the climate of each sale and get closer to the customer. This is very important when the vendor is looking for new product information or is looking for better information for a promotion. The keys to making VMI work is shared risk. Often if the inventory does not sell, under the VMI partnership the supplier will repurchase the product from the buyer (retailer). In other cases, the product may be in the possession of the retailer on consignment. This can dramatically increase the turns of the buyer's inventory. The general definition of turns is :

$$\frac{\text{Cost of Goods Sold}}{\text{Average Inventory}}$$

Let's say the average inventory is 1,000 units and sales per year equal 4,000 units. If T = 4 then there is an average of 1/4 of the year's inventory on hand:

$$\frac{1000}{4000} ? \frac{1}{4}$$

When inventory is consigned, it is written in the books as sold only when the sale takes place. If a business is open 360 days a year, the item is owned only for the day it sold. The turns for the consigned inventory equal 360.

Lowes has an agreement with its suppliers on large appliances to be the marketing representative of brands such as LG. After the customer buys the product, it is shipped out of LG's warehouse and delivered to the customer by Lowes. This is a great savings in inventory because the product is not stored in two places, it is stored only at LG's facility. This is a great savings in the total aggregate supply chain.

Consigning inventory is expanding into industries such as the HVAC (Heating, Ventilation, and Air Conditioning) industry. The HVAC service companies have the parts inventoried by the parts distributors in their warehouse. If the HVAC company gets a job, their service representatives go to the appropriate distributors to pick up the product and then go the customer to fix or service their heating or air-conditioning systems. This saves the HVAC company from having to store its distributor's entire inventory in the warehouse.

If they did store the material, there would be a duplication of inventory in the supply chain. Companies may enter into an arrangement with the suppliers that 20% of the items that represent 80% of the sales could be stored with HVAC's distributors. This could represent 50% to 60% of the HVAC's inventory. The VMI partnership helps foster a closer understanding between the supplier and the manufacturer by using EDI formats. EDI software and statistical methodologies are used to forecast and maintain correct inventory in the supply chain.

Vendors benefit from more control of displays and more contact to impart knowledge to employees, thus enhancing the growth of the partnership. The retailers benefit from reduced risk, better store staff knowledge (which builds brand loyalty for both the vendor and the retailer), and reduced display maintenance outlays. Both vendor and retailer or distributor benefit by the usual once-a-year technology meeting in which both partners share their knowledge of the best-of-breed technology in the companies. The overriding theme for these conferences is that both parties realize that if they help each other the whole will become better than the sum of the parts.

Consumers benefit from knowledgeable store staff who are in frequent contact with manufacturer (vendor) representatives when parts or service are required. Employees with greater knowledge of the products offered by the entire range of vendors have the ability to help the customer choose from competing products for items most suited to them. This actually increases the manufacturer's sales because the retailer's employees are more knowledgeable about the supplier's product line. They can suggest items that they had no knowledge of in the past. In a VMI partnership, manufacturers stand to increase sales by 3% to 4%.

An additional reason to use VMI is to add compliance and optimization into the supply chain. There are a number of technologies available, but the main issue is to optimize collaboration between trading partners. Vendor Managed Inventory will also minimize the "bullwhip effect." The bullwhip effect is variation in demand caused by poor communication between the retailer and the manufacturer. Its name originated with Wal-Mart and PG's VMI program.

Do it Best Corp. has about 5,000 vendors and approximately 4,000 customers. The VMI vendors were chosen using the Pareto approach, considering which vendors had the biggest bang for the dollar: the 20% that contributed 80% to sales. These vendors are usually the most sophisticated and able to enter into long binding partnerships with the company. In most cases, an EDI network is needed to make sure that the data is sent and received in real time and accessible by all parties involved.

Certification programs will become more and more necessary when entering into these long-range contracts. They help in establishing standard operating procedures (SOP) among trading partners. This is essential to realizing the truest form of economy of scale with manufacturers. There must be a grading scale to guide future progress and maintain balance with numerous VMI trading partners. A sample document for the VMI or VMI partner response to the suppliers is shown in Table 1-1. This form is to be used in the certification process for the suppliers. It is a list of rules they must follow to be included in the certification program.

Table 1-1 The VMI Partner Document

XYZ Distributor Vendor Managed Partnership Form The Supplier Portion	
VENDOR NAME ________________	RDC SHIPPED TO: _____________
VENDOR NUMBER _____________	VENDOR SHIP POINT: ___________
EMPLOYEE NAME _____________	DATE SHIPPED: ________________
	CARRIER: ______________________
1. UTILIZE A GOOD QUALITY, SOLID HARDWOOD OR PLASTIC PALLET FOR MERCHANDISE.	
2. SHIPMENT PRESORTED AND SEGREGATED SO THE SAME SKUs REMAIN TOGETHER.	
3. MERCHANDISE SHRINK-WRAPPED.	
4. PALLET MARKED/LABELED: “DO NOT BREAK SHRINK WRAP.”	
5. MIXED CARTONS ARE IDENTIFIED WITH MANUFACTURER’S NUMBER AND QUANTITIES ON THE OUTSIDE OF THE CARTON. ALL SKUs SHIPPED IN CASE PACK QUANTITIES WHEN QUANTITY ORDERED PERMITS.	
6. PALLET CONTENTS IDENTIFIED: ITEMIZED ON PACKING LIST OR PLACARD ATTACHED TO THE PALLET.	
7. PACKING LIST ATTACHED TO FREIGHT.	
8. THIS QUICK-RESPONSE COMPLIANCE FORM ATTACHED TO CARRIER DELIVERY DOCUMENTS OR PLACED INSIDE A HIGH-VISIBILITY ENVELOPE & ATTACHED TO PALLET #1.	
9. SECOND PACKING LIST PROVIDED WITH CARRIER DELIVERY DOCUMENTS OR PROVIDED TO ACE VIA EDI (ADVANCE SHIP NOTICE).	
10. CARRIER BILL OF LADING PRESENTED AS: “SO MANY PALLETS SAID TO CONTAIN SO MANY CARTONS.”	
11. MERCHANDISE SHIPPED ON A PREFERRED CARRIER.	
12. PALLETS CONTAINING MIXED SKU MERCHANDISE STACKED TO A HEIGHT OF 60" OR LESS (FROM FLOOR TO TOP OF MERCHANDISE).	
13. PALLETS CONTAINING SINGLE SKU MERCHANDISE STACKED TO A HEIGHT OF 42" OR LESS (FROM FLOOR TO TOP OF MERCHANDISE).	
XYZ RETAILER PORTION	
RECEIVER I.D.: ________________ _______________	No. OF POs: _____________________
DATE RECEIVED: ______________	ACE PO#: _______________________
NONCOMPLIANCE ISSUES:	CHECK IF LOAD WAS BROKEN DOWN BY CARRIER:

The Savings of EDI

Electronic data interchange (EDI) is used to transfer electronic documents or business data from one computer system to another computer system. In the following explanation, data is exchanged from one trading partner to another trading partner without human intervention.

The Internet provides a means for any company, without regard to size or location, to become part of a major supply chain initiative hosted by a global retailer or manufacturing company. Many companies around the world have shifted production of labor-intensive parts to low-cost, emerging regions such as Brazil, Russia, India, China, and Eastern Europe. Web-based EDI, or WebEDI, allows a company to interact with its suppliers in these regions without the worry of implementing a complex EDI infrastructure.

In its simplest form, WebEDI enables small to medium-sized businesses to receive, turn around, create, and manage electronic documents using only a Web browser. This service seamlessly transforms data into EDI format and transmits it to the trading partner. Simple prepopulated forms enable businesses to communicate and comply with the trading partners' requirements using built-in business rules. Using a friendly web-based interface, EDI transactions can be received, edited, and sent as easily as an email. No third-party software installation is necessary. The only requirement is an Internet connection. WebEDI is accessible anywhere in the world and does not require a dedicated IT person to manage software.

Some examples of the processes automated by EDI are represented by a term transaction set. The transaction set is the data formatted and sent for a particular process. The different transaction sets have a numerical name such as 810 for an invoice. Some of the examples of the common transaction sets used are the following:

- Purchase order is sent electronically with a transaction set called an 850. This will allow the sending of all purchase orders electronically to the supplier. Paperwork is minimized and employee productivity enhanced.
- Invoices are sent electronically through transaction set 810. All invoices can be sent back from the supplier electronically. These invoices are from the electronic purchase orders received at an

earlier date. The invoice is also considered a turnaround document. (A turnaround document refers to the time period after the purchase order is sent to the time the data is turned around as an invoice, the document that follows the purchase order. An invoice follows the purchase order after its receipt and the advance shipping notice is created after the purchase is loaded onto the truck for shipping.) The purchasing invoice cycle is now done electronically.

- Advance Ship Notice (ASN) is sent electronically through the transaction set 856. Receiving can be planned in advance due to the advance ship notice of what is coming in from each supplier using the ASN. Some products are hard to put away and need a specialized staff. With the ASN, it is easier to determine which trucks contain the vendor products, so staffing becomes easier. Second turnaround documents are used when a supplier receives the purchase order electronically. After a PO is received, the supplier turns around and sends the other two documents. They then ship the product and send the ASN electronically, allowing companies to reduce the paperwork requirements.
- Transportation Carrier Shipment Status Message is sent electronically through the transaction set 214. This transaction set is used to schedule a carrier into the dock. The carrier will use the 214 transaction set to notify their arrival, making arrival time approximately 90% accurate to the hour. Now a closed-looped environment has been created. Each truck is identified by the Shipment Status transaction and given a status of their location and time of delivery. Receiving is now scheduled proactively.
- Payment Order/Remittance Advice is sent electronically through the 820 transaction set. A remittance advice is a letter sent by a customer to a supplier to inform the supplier of invoice payment. If the customer is paying by check, the remittance advice often accompanies the check. Remittance advices are not mandatory; however, they are seen as a courtesy because they help the supplier's accounts-receivable department match invoices with payments. The remittance advice should therefore specify the invoice number(s) for which payment is tendered. Modern systems will often scan a paper remittance advice into a computer system, where data entry will be performed. Modern remittance advices can include dozens or hundreds of invoice numbers and other vital information. The primary purpose for the remittance advice is to let the supplier know when and how

much was paid and when it will arrive. This helps greatly in the balancing of cash flow from a vendor standpoint.

- MSDS (Material Safety Data Sheet) is sent electronically through transaction set 848. The transaction set can be used to communicate chemical characteristics, hazards, and precautions for the safe handling and use of a material. The transaction set is intended to convey the information required for an MSDS as defined by the Occupational Safety and Health Administration (OSHA). The MSDS provides the receiver with detailed information concerning material identity, emergency response, chemical and physical characteristics, toxicology, and industrial hygiene procedures.
- Price Information Transaction Set is called the 879. The transaction set contains the current price or price changes to the customer for documentation or for their electronic catalog.
- Price/Sales Catalog is sent through transaction set 832. The 832 EDI document type is used to provide a trading partner with a report of vendor product data for ordering purposes while maintaining an established practice in furnishing trading partners with prices of goods or services in a catalog. The 832 Price/Sales Catalog has four major functions: catalog operation, a traditional vendor catalog, item setup and maintenance, and sales price communication. After the 832 Price/Sales Catalog is received, a 997 Functional Acknowledgment is sent back from the transportation provider indicating that the Price/Sales Catalog was successfully received.
- Traditionally Scan Based Trading programs use EDI solutions as the key component to synchronize information on store locations. Here are a few of the transaction sets:

    - Organizational Structure 816—This transaction set can be used to transmit pertinent information about a parent organization, its members, and the relationship of a member to another member and/or to the parent organization. The transaction set contains some of the following information: address, geographical location, contacts, and identity code. The identity code is the D-U-N-S numbers and the supplier company numbers, which may be internal numbers to identify the individual companies, buying units, and suppliers.
    - Items Price/Sales Catalog 832—This transaction set is used to update an electronic catalog or share pricing with the buyer or seller. It has the following components: item

identification, data time reference, restrictions and conditions, product description, item physical details, pricing information, bracket pricing, currency, address information, and geographical information.

- Price Information 879—This transaction set can be used to enable a manufacturer, a supplier, a broker, or an agent to provide a trading partner with pricing information. The transaction set is also used in setting up new items in a store. When a new item is set up, Item Maintenance Transaction Set 888 is needed. The details are similar to those for the Items Price/Sales Catalog 832.
- Item Maintenance Transaction Set 888—This transaction set is used to enable a manufacturer, a supplier, a broker, or an agent to provide detailed finished goods product information to a partner. This transaction set can be used to provide information about new products or changes in existing product specifications.
- Daily Sales Product Activity Data 852—This transaction set gives the supplier or user information about the movement of the product. This transaction set is used when performing VMI or QR quick response with trading partners. It has the following fields: Item on Hand per Location, Item on Order per Location, Item Usage per Location, and Item Backorder per Location.
- Receiving's Receiving Advice 861—The transaction set can be used to provide for customary and established business and industry practice relative to the notification of receipt or formal acceptance of goods and services. It uses the following fields: Currency, Date Time, Purchase Order Reference, Carrier Details, Carrier Routing, Carrier Special Handling, Geographical Information, and F.O.B.-Related Information.
- Organizational Structure 210—The Motor Carrier Freight Invoice transaction gives the location of the delivery, and from this you can determine its approximate delivery time. This is extremely useful in planning for the receiving staff and also for customer notification of product delivery.
- Forecast Planning Schedule 830—This is one of the innovations that sets us apart from the competition. The transaction set tells the supplier what we will be selling on promotions with anticipated volume. The supplier can plan its MRP processes better, and our service levels are greatly enhanced.

Summary of the EDI Transaction Sets

Transaction set 856: Advance Ship Notice
Transaction set 810: Invoice
Transaction Set 210: Motor Carrier Freight Invoice
Transaction set 214: Transportation Carrier Shipment Status
Transaction set 820: Payment Order/Remittance Advice
Transaction set 850: Purchase Order
Transaction set 848: Material Safety Data Sheet
Transaction set 879: Price Information
Transaction set 832: Price/Sales Catalog
Transaction set 997: Functional Acknowledgment
Transaction set 816: Organizational Structure
Transaction set 888: Item Maintenance
Transaction set 852: Daily Sales Product Activity Data
Transaction set 861: Receiving's Receiving Advice
Transaction set 830: Forecast Planning Schedule

Lean and Green Savings Using EDI

This section covers the metrics and savings that can be actualized through the implementation of the Vendor Management Program and electronic data interchange. The use of these tools requires a trusting relationship between the trading partners, but the return for both is significant. When a VMI vendor is added, that vendor needs to be on the same certification program. The VMI productivity increase is composed of three parts:

1. The EDI savings on the Advance Ship Notice, Purchase Order, and Invoice
2. The VMI Reduction of Inventory
3. Productivity Increase in
   a. Sales,
   b. SKU count, and
   c. Increased Service Level for Promotional and Seasonal Items

The following is a list of some of the important EDI automation savings used in VMI.

The Advance Ship Notice (ASN) transaction set 856 offers a view of the contents of the goods arriving on the carrier in advance of the delivery date. Using this document alone has allowed Do it Best Corp. to realize a 15% increase in labor productivity in the Receiving Department and a labor savings of 7 people × .15 = 1.05 person labor hours. At $18 per hour and with additional benefits of 25%, direct labor savings is $46,800 per year. This assumes the need for one less person in receiving.

The ASN can replace the Purchase Order (PO) when the vendor is doing the planning for the customer as in VMI. The ASN shows what is coming in, and this document can be used to pay the invoice. Payment is made through the ASN. The *Supply Management Handbook* says, "It often costs organizations more than $100 in administrative expenses to generate a purchase order" and adds, "In many firms, the cost of managing and generating a purchase order can exceed $200 per transaction." The analysis conducted by Do it Best Corp. found that paper purchase orders can range from a cost of $50 per manual paper purchase order to $1.50 electronically. The solution to their success was to integrate as many transactions with the supplier as possible.

(Note: The tables in Chapter 4, "Transportation Management System (TMS)," are used in the following analysis.)

There were 1,625 × 9 = 14,625 purchase orders per month. The average PO is three pages. This is 14,625 × 3 = 43,875 pages per month or 526,500 pages per year. Normally 500 sheets weigh five pounds, which means that 5,265 pounds of paper were consumed per year. A tree produces roughly 800 pounds of paper. So performing the calculation:

$$\frac{\left(\frac{526,500}{500}\right) X5}{800} ?\, 7$$

shows that the purchase order process consumed seven trees per year (see Table 4-4 in Chapter 4). There are 175,500 pages of invoices per year. The invoice has miscellaneous credit memos and other explanatory pages with and following the invoice statement. In estimation, the number of pages in the invoice process is about the same as in the PO process. Knowing this, we can calculate that seven additional trees are consumed in the invoice process. The total savings is 7 + 7 = 14 trees per year for automating both the PO and the invoice process.

In manufacturing paper, the wood is turned into pulp. The yield is about 50%—about half of the tree is knots, lignin, and other material not used to make paper. Therefore, a pine tree yields about 805 pounds of paper. A ream of photocopier paper weighs about 5 pounds and contains 500 sheets (paper is often seen described as "20-pound stock" or "24-pound stock"—which is the weight of 500 sheets of 17" × 22" paper). Using these measurements, a tree would produce (805 / 5 × 500) = 80,500 sheets of paper (see Table 4-4).

Lean and Green EDI Savings of the Advance Ship Notice, Purchase Order, and Invoice

Using the ASN to replace the purchase order and invoice for the VMI vendor results in Lean Savings:

- The electronic purchase order system saves $525,500 per year compared to the manual purchase order procedure.
- The electronic invoice system saves $1,228,500 per year compared to the manual invoice procedure.
- The ASN allows a 15% increase in labor productivity in the Receiving Department. This is a labor savings of 7 × .15 = 1.05 person labor hours. This means reducing the number of employees needed by one. At $18 per hour and with additional benefits of 25%, direct labor savings is 1 × 1.25 × 40 × 52 × $18 = $46,800 per year.
- The Lean Savings is ($525,500 + $1,228,500 + $46,800) = $1,800,800 per year.
- The Green Savings amounts to 14 trees per year being saved. Using Table 4-7, we can see that 14 trees equates to 910 pounds of CO_2 saved per year.
- Total savings so far is $1,800,800 per year + 14 trees + 910 pounds of CO_2 saved per year.

These savings can be used as productivity metrics for personnel or management. Visual Supply Management increases the productivity of personnel, using better and timelier information from the suppliers. For instance, in the past, it took all day for a purchase agent to review a very large vendor manually for all nine of the Do it Best Corp. warehouses. It can now be reviewed in 5 minutes. The only things to review on the VMI vendors are the turns and service levels for each warehouse. As long as the turns and service levels are increasing, they are increasing profit and sales for the company. This also shows that the supplier is doing a better job of demand forecasting if the turns are going up (more sales for less inventory) and the out of stocks are going down (more revenue with less inventory). The increase in labor efficiency is 400% using the collaborative electronic system. Employees can be deployed to more profitable jobs. Installing a VMI system does not create success by itself. Other processes are needed to enable the technology. These processes include the technologies discussed throughout this book.

Eight people are involved in the purchasing/invoice system. With a 400% increase in productivity, two are currently required. 3,060 kWh × \$0.16 = \$490 dollars were saved in electricity usage by reduction of computer usage for the purchasing group. Similar productivity improvements allow for the creation of a company with 50% fewer personnel than the competition.

VMI collaborative metrics for the supply chain include a 400% increase in staff productivity. There is also a 30% to 50% increase in turns. If there exists a \$300 million inventory, assuming a 35% increase in turns, \$78 million in inventory dollars are freed to be invested elsewhere. Using this method, Do it Best Corp. created a sales increase of 3.5% with no increase in inventory levels, a 25% increase in SKU count with no increase in warehouse space, and customer service levels of 97% or more on promotional and seasonal items, as well as significantly reduced paper-handling costs.

Do it Best Corp. originally had three turns with \$300 million average inventory and \$900 million in sales. At 35% increase in turns, the new number of turns, after VMI, is 4.05. With average sales of \$900 million for the VMI vendors, the new inventory figure would be \$900 million / 4.05 = \$222 million (\$78 million in reduced inventory). There was an increase of 3.5% in sales without an increase in inventory. This was possible only with a long-term partnership with suppliers who are now able to work with the customer on better selling categories, new promotions, and new items. It becomes essential for the supplier that the customer succeeds as well. The trend for DBI took approximately five years to develop. So the learning curve was five years.

The savings to Damaged and Obsolescence is 9.75% of inventory. Do it Best Corp. obtained the savings through VMI. Calculations show a 9.75% of $78 million, or $7.606 million, savings in Damaged and Obsolescence costs.

With the 400% increase in productivity and the 35% increase in turns, the calculations shown in the following section are now possible.

Lean and Green Savings of VMI Reduction of Inventory

- The Lean Savings of VMI Reduction of Inventory:
  - Starting Inventory is $300,000,000.
  - Starting Sales are $900,000,000.
  - Starting Turns are 3.00.
  - A 35% increase in turns, allowing an inventory reduction of $78,000,000.
  - The New Inventory using VMI is $300,000,000 – $78,000,000 = $222,000,000.
  - The new turns are 4.05.
  - Carrying cost of 26.66% savings yields a $20,720,000 reduction.
  - Freed-up cost of capital is .02 × $78,000,000 = $1,560,000.
- Total Lean Savings from VMI Reduction of Inventory is $22,280,000.
- The Green Savings of VMI Reduction of Inventory:
  - $490 saved in electricity usage for the Purchasing area.
  - $7.606 million per year in landfill savings.
- Total Lean and Green Savings for VMI Reduction of Inventory is $29,886,490.

The Green Savings is as shown here:

- A new warehouse (now unnecessary) would cost \$14 million in inventory and \$10 million in the building cost. The VMI initiative would save:
  - \$3.517 million in additional infrastructure cost.
  - An additional 3 to 6.5 million with an average of 4.75 million in furnishing, equipment, racking, and automation equipment will not be needed.
  - This totals to \$14 million in inventory dollars + \$3.517 million + \$4.75 million equals a total cost of \$22,260,000.
- Without the existing improvement in technology, it would be necessary to increase the size of the warehouse by 35%. The increase would represent additional costs of 35% × \$22,260,000 = \$7.791 million.
- The added cost of utilities would be computed as \$0.5717 a square foot annually. This is dependent on the amount of automated equipment in the warehouse. For a 450,000-square-foot warehouse the average is 450,000 × \$0.57170 = \$256,500 spent annually on electricity. Total savings in utility costs is .35 × \$256,500 × 9 = \$807,975.

The last three categories of savings are Green Savings. The savings are a 25% increase in SKU count with no increase in inventory space, a cost savings of \$807,975 saved in electrical usage generation, and finally a sales increase of 3.5% without additional resource expenditures.

- The Lean Savings is the added sales = 1.035 × \$900,000,000 = \$931,000,000. This is a \$31,000,000 increase in sales. With a profit margin of 18%, this represents an increase in profits of \$5,580,000.
- The new turns are 931,000,000 / \$222,000,000 = 4.19 turns.
- The Green Savings erases the need to spend an additional \$7.791 million in added warehouse infrastructure costs to accommodate the 3.5% sales increase and the 25% addition in SKU count. This is considered Green Savings because raw materials for warehouse expansion are unnecessary.

- The added cost of utilities would be computed as \$0.5717 a square foot annually. This is dependent on the amount of automated equipment in the warehouse. For a 450,000-square-foot warehouse, the average is 450,000 × \$0.57170 = \$256,500 spent annually on electricity.

The Total Lean for the three categories is the increased profits from an increase of 3.5% of sales = \$5,580,000; company turns are 4.19, sales are \$931 million, and inventory is \$222 million.

The Total Green for the three categories is the decrease in infrastructure cost = \$7,791,000; the decrease in utilities cost = \$807,975; and the total Green Cost = \$8,598,975.

The total savings for the entire VMI & EDI program including all the preceding steps is as shown here:

Lean Savings of \$29,660,800 +

Green Savings of \$16,205,465 =

Total Savings of \$45,866,265

Certification Program and Scorecarding

The next area of concern is the vendor or supplier scorecard. This helps keep a dashboard view of the supplier and perhaps also the carrier's performance for eventual continuous improvement, or the Kaizen process. Development of a joint retailer/supplier scorecard is critical to success. Measurements include the following:

- Product profitability
- Inventory turns and service level
- Promotional effectiveness
- New product introduction effectiveness
- Quality/returned goods
- On-time performance

The operational issues of certification programs include these:

- Product frequency of arrival with receiving cost in mind
- Product delivery timing during the day
- Vendor minimum

- Item minimums
- Pallets
- Pallet layer stacking
- Frequency of arrivals
- Pallet or container type
- Label type to use
- Label placement
- RF collaboration with current system to make a more efficient information flow between the supplier and the distributor

Certification programs cut Do it Best Corp. lead times down by approximately one day. That one-day savings included a reduction in manufacturing lead time as well as receiving and stocking the product. Do it Best Corp. found that the certification program equates to an additional 2.2% reduction of inventory for each day saved in lead time. Therefore, the savings for the certification program is 2.2% × \$222 million in inventory. This is approximately \$5 million in inventory reduction, making the new inventory level \$217 million.

Do it Best Corp. also mandated the use of specific labels, pallet sizes, and label placement to maximize productivity. Logistics labels are increasingly used to track containers and other logistics units through the supply chain, as recording and monitoring the movement of goods is an essential part of supply chain management. This allows the employees to scan each container or large box and know how many items are inside. These are the most successful mandates:

SCC-14 (Shipping Container Code) is a 14-digit number assigned to fixed-content shipping containers. Using the SCC-14, it is assumed that like items are in each box. When the box is scanned, the count is given without opening the container for counts. For example, the UPC number tells the system that the box holds 12 units.

SCC-18 (the Serial Shipping Container Code) is a unique serial number that is used to identify each individual pallet, assuming that various assorted products are on a pallet. Scanning the pallet gives the items contained on it. The pallet can be moved to the stocking location without the shrink-wrap being broken at this time. Employees can scan more products per hour and move products from receiving to stocking at a much faster rate.

Another part of the certification program is the use of the "funnel" program. Do it Best Corp. asked the supplier to stock like items on each pallet. This means that a pallet may have multiple purchase order numbers from multiple orders for the same item. Using the old system, manufacturers filled their orders by purchase order and any back orders were filled and palletized by PO. Having like items spread across multiple pallets hurts productivity. Do it Best Corp. also requires suppliers to have bin location numbers on their files. The suppliers place stock merchandise in the pallets with the same inventory location.

The largest part of receiving is the breakdown and sorting of product. This accounts for as much as 80% of the time spent in receiving. The bottleneck is eliminated by having the pallets go directly to the stocking location without any breakdown or sorting.

Certification Program Savings

- The Lean Savings of the Certification Program
  - Carrying cost savings \$5,000,000 inventory × 26.6% = \$1,330,000
  - Freed-up cost of capital is .02 × \$5,000,000 inventory savings = \$100,000.
- The Green Savings of the Certification Program
  - 9.75% for Damage and Obsolescence × \$5,000,000 = \$487,500 per year in landfill savings.
- Total Lean and Green Savings so far is \$1,917,500.

To this point, after the Certification Program:

- Company turns are 4.25.
- Sales are \$922 million.
- Inventory now is \$217 million.

References

(1) http://www.urenio.org/tools/en/supply_chain_management.pdf.

2

Warehouse Management System (WMS)

Warehouse management is part of Supply Chain Management and Demand Management. Supply Chain Management (SCM) is composed of two parts: Supply Chain Planning (SCP) and Supply Chain Execution (SCE). The Warehouse Management System, or WMS, is part of the SCE strategy. The execution portion of the supply chain is definitely action-oriented. Even production management is, to a great extent, dependent on warehouse management. Efficient warehouse management gives a cutting edge to a retailer or distributor. Warehouse management does not start with receipt of material. It starts with the initial planning of the container design made for a product. Warehouse design and process design within the warehouse are also part of warehouse management. Warehouse management is part of logistics and SCM.

A WMS is a key part of the supply chain and primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, stocking, and picking. The systems can also optimize the stocking process. The optimization routine is based on real-time information of bin locations in the warehouse and the products to be put away. The system knows the cube of the product and exactly where the closest empty bin will be to place the merchandise.

The optimization programs attempt to minimize the time it takes the workers to stock the product. The system is also cognizant of the picking operations. Because it is more efficient for the picker to place the item in a particular warehouse bin in close proximity, the system navigates through the alternative locations to find the optimum bin location. The system also balances both the stocking and the picking operations by choosing product placement to minimize the time for the overall warehouse operation.

The WMS provides a computerized schedule to guide employees through their daily tasks by setting up the procedures and times for each operation performance. The system can be automated to notify suppliers electronically if product is being returned and get the authorization number e-mailed back for proper identification. It can perform the initial dialog with the Transportation Management System (TMS) to set up communication with the carriers. It won't perform the logistic functions but can notify carriers when the product will be ready to be picked up. This enhances efficiency through collaboration of both the WMS and the TMS systems. The WMS should be integrated with other systems as discussed in the next section.

System Integration with the WMS

The WMS can capture data for the ERP system. It can track employee performance, allowing managers to plan which operations the worker performs best, enabling assignments by performance ratings. This is invaluable when using an incentive system and capturing the times below the goal.

The WMS system should be linked to the Inventory Management System so that product movement is immediately visible to the ordering system. The closer the operation is to real time, the lower the inventory. Any percentage reduction of lead time has an equal reduction in average inventory. This helps in demand planning through balancing demand with real-time inventory availability. The WMS is also connected throughout the ERP system to the Accounting and Controls area of the company, allowing for a more accurate evaluation of the warehouse assets. The WMS system should be set up to communicate to the IT system with a seamless approach, synchronizing files from the WMS system to the ERP or legacy file structure.

The Functionality of the WMS

When selecting a WMS computer system, find a solution that will address as many of the following areas as possible.

Order Fulfillment—This is the process of completing the entire order transaction, including the order query, the quote, the purchase order generation, the delivery notification, and the receipt and invoicing of the purchase order. The WMS speeds up the process of receipts and picking the merchandise for the order fulfillment function.

Inventory Management—The WMS system can aid in cycle counting regardless of the type of inventory system. The faster the inventory input, the lower the receiving time. As lead times decrease, the need for extra safety stocks decreases and the more accurate the inventory count is.

Web-Based Platform—The system should have the option of a web-based program for connectivity anywhere in the company. This makes the new paradigm accessible anywhere and anytime.

Warehouse Productivity—How efficient are employee schedules? What is the best schedule to use to minimize the distance traveled by the worker? What is the optimum location needed for the system to minimize the cost of receiving and picking? This is the ABC location analysis, in which the merchandise needed the most is placed in the middle of the bin for faster picking or receiving.

Shelf Life Monitoring—The WMS can track shelf life. This is important in the stock rotation and filling orders in a FIFO (first in, first out) environment by minimizing spoilage of perishable products.

Transportation Performance—The WMS must communicate with the Transportation Management System. If the schedule is expedited, the transportation process can be enhanced. The WMS measures what TMS issues are affecting warehouse performance.

Scalability and Configurability—The system should be scaled so that it can grow easily with any future enhancement. This assumes that the system will work well in a plug-and-play environment with other software.

Receive Stock and Returns/Reverse Logistics—The system should maximize the process of receiving by creating the best schedule for labor to match incoming freight. It can match worker times and efficiency to the different types of vendors. The WMS system can facilitate a reverse logistics function. If done correctly, it will minimize the cost of the least productive part of the warehouse system. Companies can see a 10% annual savings in logistics: 20% through labor cost savings and 80% in lowered freight costs and reduced pipeline inventory.[1]

Manage Storage Facilities—The WMS can model the warehouse into multiple locations based on the best use of cube and worker productivity. This is the process of designing the warehouse and partitioning it into multiple areas such as slow pick, fast pick, heavy bulk, over stock, zone picking and receiving, mezzanine levels, and so on. The system can allow for random storage or manual storage.

Manage Stock—A simulation package can be used to minimize time and maximize employee performance by placing the goods in better locations so that they can be picked at a faster pace. Placing faster moving items in the middle of the bins or at the front of each racking location minimizes the worker's horizontal or vertical travel.

Provide Connectivity to the Enterprise—With the advent of ERP systems, the WMS system can give notification of delivery to all the departments. For instance, customer service departments need to know when an item is received. The WMS will notify customer service immediately upon receipt of the ASN. The customer support staff then notifies the customer and schedules receipt or delivery.

The WMS allows the following warehouse productivity techniques to be computerized:

Cross Docking—Cross docking is a practice in logistics of unloading materials from an incoming semitrailer truck or rail car and loading these materials directly into outbound trucks, trailers, or rail cars, with little or no storage in between. This practice can reduce overall cost of pick-to-stock and pick-to-order by 15% to 21% by eliminating unnecessary movement from receiving to stock and then back to the shipping door.

Postponement—A postponement strategy aims at delaying some supply chain activities until customer demand is revealed in order to maintain both low systemwide cost and fast response. The driving force of postponement is waiting on manufacturing, packaging, or labeling until product is needed by the customer. This is a great definition of the pull system in Lean terminology. Don't stock it until it is needed. Inventory cost is reduced and the variety of end products to the customer is increased. This process also helps to increase service levels because the interchangeable parts are stocked with a higher level of safety stock. From these parts comes the final product. Postponement cuts the total cost to delivery to the customer by 5%.[2]

Work Planning—This process organizes and coordinates the activities of an enterprise in accordance with certain policies and in achievement of clearly defined objectives. The system will plan the incoming shipments against standardized worker times to generate a schedule that uses the fewest resources. Management will be included in the decision making of production schedules, along with machines, materials, and cost.

Order Processing—This is the ability to process the order from the customer accurately and in a timely manner.

Tracking Material Flow—This involves setting metrics to analyze labor hour's efficiencies and standards. *Logistics → Logistics Execution → Information System → Warehouse → Standard Analyses → Material Flow*. By tracking material flow in the warehouse, labor costs can be cut by 20% to 40%. Management can spot the bottleneck and act immediately.

Metrics Used in a WMS

The WMS system uses several metrics to improve the order fulfillment. These are critical because the customer sees these metrics and evaluates performance based on these figures.

- Order Fill Rate—This is the average fill rate per order.
- Line Fill Rate—This is the average of all the items shipped to the items ordered. This is the average service level the customer receives and is the best indication of how quickly the customer receives the order. The service level has the normal standard distribution. The line fill rate is the center of the probability distribution of line fill rate. The normal complaints are at the left end of the curve. For instance, 50% of the customers have a service level of 97% if this is the normal line fill rate. Table 2-1 illustrates the spread of service levels when all is going well. For instance, when the service level is 97%, then 5.57% of the membership is at a service level between 90 and 97%. To be exact .76% of customers are at a 90% service level. This is why companies cannot afford to turn a blind eye on customer complaints

about service. The last example shows that .76% of the customers will have a service level of 80% or 20% out of stocks. The table assumes that the cumulative probability distribution set at .5, with a mean of .97, and the standard deviation of .5.

Table 2-1 Percentage of Customers at Specified Service Levels

Service Level	Cumulative	The Exact Service Level
96% to 97%	.8%	0.80%
95% to 97%	1.6%	0.80%
94% to 97%	2.39%	0.80%
93% to 97%	3.19%	0.79%
92% to 97%	3.98%	0.79%
91% to 97%	4.78%	0.79%
90% to 97%	5.57%	0.79%
89% to 97%	6.36%	0.79%
88% to 97%	7.14%	0.79%
87% to 97%	7.93%	0.78%
86% to 97%	8.71%	0.78%
85% to 97%	9.48%	0.78%
84% to 97%	10.26%	0.77%
83% to 97%	11.03%	0.77%
82% to 97%	11.79%	0.77%
81% to 97%	12.55%	0.76%
80% to 97%	13.31%	0.76%

- Dollar Fill Rate—This is the average of the entire dollars shipped to the dollars ordered. The indicator shows how much revenue is lost. This figure is usually lower than the line fill rate.
- Order Accuracy—This is the accuracy with which the picker picks the order to be delivered to the customer. Did the warehouse employee fill the wrong order? This is where the RF process and the WMS work well together. This combination makes it much harder to make mistakes.
- Line Accuracy—This is the accuracy of the specific SKUs in the order. Are all lines filled? Is the right product being filled?
- Orders Cycle Time—This is the time between orders. This is scheduled by the WMS to maximize the productivity of the employees.

- Number of Back Orders—This is a great metric of how well a vendor is doing in filling the order, which can cause higher outs. One of the metrics can measure the time it takes to fill an entire order, including all back orders.
- Calculated Vendor Lead Time—This is where the computer calculates the vendor lead times based on all back orders and their respective times. For example, let's say the vendor had three back orders. The first order was shipped in 15 days and was 60% complete. The second back order was shipped in 20 days and shipped 30% of the order. The last back order was shipped in 30 days and shipped the remaining 10% of the order. The new calculated vendor lead time for that distribution center is:

$$\frac{1X15\ .\ .30X20\ .\ .10X10}{1\ .\ .3\ .\ .1} = 17.14286 \text{ days}$$

  The first order weight value is 1, and it is assumed that this would be the proper lead time to use if there were no back orders. This increased lead time can be input into the system to allow for greater stock or more safety stock.
- Back Order Time to Completion—This is the total time of completion. In the preceding illustration the time would be 30 days.
- On-Time Delivery—This is usually the metric that is used to show the number of times per year the vendor shipped on time. It can also show the spread of the variance around the designated ship date.
- Vendor Lead Time—This is the normal standardized time for the vendor. The vendor lead time is calculated as Total Lead Time – Receiving to Stock Time – Transit Time.
- Individual Item Lead Time—This is the calculated average item lead time. This may not be near the vendor lead time or calculated vendor lead time of the product. In vendor negotiations, it is essential to run a vendor report and show which items have an item lead time significantly greater than the vendor lead time.

Improve Inventory Management

Improve Inventory Management is one of the greatest advances in the WMS. Service levels and turns significantly improve shortly after the WMS is introduced.

- Inventory Accuracy—This is needed when computing the perpetual inventory cycle counting system. The WMS increases accuracy in quarterly sample checks of inventory and in complete inventory counts.
- Days on Hand—This can be calculated using the WMS.
- Storage Utilization—The WMS calculates the spatial efficiency by cube in the warehouse.
- Dock to Stock Time—This is the time it takes to enter the item into inventory after receipt.
- Inventory Visibility—This can be accommodated by a real-time dashboard that shows warehouse movement and congestion. The product placement and inventory dollars can be illustrated on a CAD/CAM diagram of the warehouse.
- Simulations for Decision Making—The WMS can visually show the results of changes in the procedure and recommend a future course of action.
- Inventory Turns by Warehouse—This is an excellent metric in which to gauge the warehouse productivity. The productivity could be within the Distribution Center or it could be a function of the routing issues into the warehouse.
- Inventory Turns by Warehouse Section—The metric shows the difference in stocking levels for different sections or departments.

The Improved Warehouse Worker Productivity

The Improved Warehouse Worker Productivity can be measured with these key performance indicators:

- Orders picked per hour per worker
- Order stocked per hour per worker

- Lines picked per hour per worker
- Lines stocked per hour per worker
- Comparison of warehouse location costs
- Cost per order
- Demurrage cost by carrier
- Productivity improvement
- Comparison to standard for incentive pay by worker
- Cost as percentage of sales

Improved Transportation Performance

The WMS can also help to show the Improved Transportation Performance. This is an important metric because the transportation process is one of the more expensive segments of the supply chain. The WMS will show all the TMS key performance indicators as related to the distribution center.

- On-time deliveries
- Demurrage cost percentage
- Damage
- Missed appointments percentage
- Freight bill accuracy
- Cost per order
- Delivery date accuracy

In Management by Walking Around, problems with employee performance are discovered and potential solutions are discussed with the staff. A typical order picker can walk six miles a day through the warehouse. Order picking constitutes the highest operations cost and time, so increasing productivity through stronger talent-management techniques is a great place to start. Here is a breakdown of costs by percentage in the manufacturing sector:

- Shipping: 20%
- Receiving: 10%
- Storage: 15%
- Order picking: 55%

Order picking can be the most labor-intensive activity in the warehouse, with as much as 75% of time spent in activities related to picking. If the functions of order picking are examined with a process map using value stream mapping, the following will result:

- 10%: searching (which is non-value-added)
- 5%: writing (which is non-value-added)
- 25%: picking (which is value-added)
- 60%: walking (which is non-value-added)

When Value Stream Mapping (VSM) is used, the yield equals a 25% value-added for the picking process. Picking is a large problem for most warehouses. A dynamic scheduling program will help to optimize the efficiencies of the order pickers. A good example of making changes to the productivity of the process is to use the Pareto process.

The largest producer of non-value-added in the picking process is walking. Decreasing walking time by 30% increases efficiency from 25% to 31.25%: 25 / (10 + 5 + 25 + 40) = 31.25%. This represents a 25% increase in the total picking process, which translates to a 25% decrease in labor needs. Existing workers can be reassigned to more productive tasks.

A typical example of a worker receiving orders from the WMS is explained in this paragraph. The WMS offers the employee routing information or the warehouse location and quantity of the next pick. It offers the employee routing information or the warehouse location and quantity of the next pick. The screen can also be used in the receiving process. It tells the worker which trailers are the most important in the overall service-level needs of the company. If the receipt is being cross-docked, it will tell the employee upon receipt of the goods which items need to go to stocking and which items need to go to shipping.

Table 5-1 in Chapter 5, "Savings of B2B E-commerce," shows that the highest warehouse costs are labor and space. This can be addressed by the WMS. Use of the WMS can produce the following benefits:

- Warehouse labor hours decreased by 40% to 50%, but 50% to 60% with RF. The computer tracks the worker efficiency and flow, matching the worker to the job. The system also picks the shortest distance to travel per worker. Recall that a typical warehouse worker will walk six miles a day in filling orders. Minimizing this will significantly add to labor efficiency.

- Inventory write-off dropped by 5%. This is caused by better real-time tracking of inventory so that merchandise is not lost in the system. The system also monitors shelf life and reduces mis-ships.
- Total inventory dropped by 2.7%. The system allows better and faster tracking of inbound receipts to the stocking area. All overstock locations are minimized, so it does not take as long to split orders into stocking and overstock.
- Shipping errors dropped by 80%, caused by the double-checking of the system with the RF system (discussed in the section later in this chapter, "Radio Frequency (RF) as a Warehouse Management System—An Introduction into RF Systems Used in the Distribution Centers").
- Space utilization improved by 20% to 30%. WMS is designed to minimize the distance traveled, simulating a smaller distribution center.
- Scrap reduced by 13% to 30%. This is attributed to better real-time visibility of the inventory and process.
- Picking productivity increased by 16% to 25%. This would not be possible without the use of a fully computerized and real-time system measuring against the needed metrics. Also available:
  - Optimized picking routes
  - Labor standards to match the laborer to the task
  - Labor standards to show the need for staffing
- Customer returns reduced by 11% to 25% due to fewer picking errors.
- Cross docking saved 21% in labor cost by minimizing the distance the worker has to travel to fill orders.

WMS Savings:

- The Lean Savings
  - Warehouse labor hours dropped by 40%. A warehouse with 600,000 square feet of space would need about 200 workers.

Using 125 people with a savings of $18 per hour and benefits of 25%, the total cost is $22.50 per hour. Total savings is 250 days per year × 8 hours × $22.50 × 75 people = $3,375,000 in labor savings per year.

- Inventory reduction of 2.7% of $217 million is $6 million.
- Carrying cost savings of 26.6% × $6 million = $1.60 million.
- Freed-up cost of capital is .02 × $6 million with inventory savings = $120,000.
- Total Lean Savings is $5,095,000.

- The Green Savings
  - Improved space utilization of 25% means a warehouse designed with 25% fewer square feet. This is a savings of 600,000 square feet × 25% = 150,000 square feet.
  - Value for electric utility bill is .5717 per square foot × 150,000 square feet saved = $85,755 in utilities per year.
- Total savings so far is $5,180,755.
  - Company turns are 4.41.
  - Sales are $931 million.
  - Inventory now is $211 million.

Radio Frequency (RF) as a Warehouse Management System—An Introduction into RF Systems Used in the Distribution Centers

The RF system is used for receiving, storage, and physically counting inventory. As an extension of the WMS, it enhances the physical counting process by entering the counts in the system by the terminal, making the process of warehouse management paperless. Rather than weekly or monthly physical counts, the RF system works on a perpetual inventory cycle. Productivity is increased because inventory tracking does not require warehouse downtime due to physical count requirements. The RF makes the process of entering a number a seamless event and extends the WMS capabilities by enabling and improving the times and error rates for the following functions in distribution:

1. **Unloading and staging merchandise** on the receiving floor. This is the process of receiving and checking delivery contents against POs. Using an RF hand-held gun works extremely well in this environment. After the product is staged on the receiving floor, it can be moved to the stocking area.
2. **Sorting** the product occurs after it has been staged. It is sorted out by warehouse location number. This process takes the longest in the receiving process. Employees use the RF device to scan the item and then separate pallets by RF locations. Each pallet will go to a different location in the warehouse based on the WMS instruction. After the pallet is placed in the stocking area, the items will all be stocked in close proximity. They can be license-plated with a bar code telling the computer that the product is on the pallet. Many Warehouse Management Systems mandate the use of the RF process.
3. The RF process also helps facilitate **creating the carrier identification file.** This file keeps track of all inbound or outbound shipments by carrier.

   Track the shipments by scanning the inbound and outbound specifics:

   - Get the date of the shipment and store it.
   - Record the time of delivery. This allows management to see whether the suppliers are shipping on schedule and abiding by the shipping agreement.
   - Track the employee loading or unloading time for performance levels.
4. **Reducing paper** documentation and permission needed to perform certain tasks. The paper savings can be a great source for minimizing paperwork. Tasks can be accomplished faster without an accompanying paper trail. All the adjust inventory slips and exception **slips can be eliminated.**

5. **Minimizing errors** because less time is spent writing the adjustments on a form. The forms could also be scanned and input in the system by the RF or RFID system.
6. **Receiving multiple POs** at the same time. Depending on the WMS software, the PO and vendor number can be scanned, as well as individual boxes for receipts. In working with certified vendors, the PO, vendor number, and contents are scanned and the PO is taken off the on-order file and added to the item file simultaneously. This assumes that the product is stocked before billing starts.
7. **Improving inventory levels**. The return on investment can be anywhere from one to three years, after which the warehouse is working with improved technology and lower overhead.
8. **Improving time on return goods** or reverse logistics. Looking up the item's bin number or location is no longer required because after it's scanned the printer at the station can print the location tag to be placed on the item. If an item is damaged, a tag can be printed to throw away or repair. If the item needs to be sent to auction, the appropriate tag is printed.
9. **Cross docking** notifies the warehouse of out-of-stock merchandise. The item can be received and placed on the customer's outgoing order from receiving, eliminating the out of stock and the double trips from receiving-to-stock and stock-to-shipping.

The standardized bill of lading is used to ensure that each supplier gives the information in the same sequence. When bills of lading have fields in different positions on the form, it becomes easier to make mistakes. The standardized bill of lading will speed up the receiving process because every form looks the same. The same efficiencies will follow the product through the supply chain, from supplier to carrier to distributor to customer.

The form shown in Figure 2-1 is an illustration of the standardized bill of lading. The form was established by the Voluntary Interindustry Commerce Solutions Association.[3]

Date: **BILL OF LADING**	**Page** ______
SHIP FROM	
Name:	**Bill of Lading Number:** ____________________
Address:	
City/State/Zip:	**BAR CODE SPACE**
SID#: FOB: ☐	
SHIP TO	**CARRIER NAME:** ____________________________
Name: Location #: __________	Trailer number:
Address:	Seal number(s):
City/State/Zip:	**SCAC:**
CID#: FOB: ☐	**Pro number:**
THIRD-PARTY FREIGHT CHARGES BILL TO:	
Name:	**BAR CODE SPACE**
Address:	
City/State/Zip:	**Freight Charge Terms:** ***(freight charges are prepaid unless marked otherwise)***
SPECIAL INSTRUCTIONS:	**Prepaid** ______ **Collect** _____ **3rd Party** _____
	☐ Master Bill of Lading: with attached

Figure 2-1A The standardized bill of lading (page one)

	(check box) underlying Bills of Lading

CUSTOMER ORDER INFORMATION					
CUSTOMER ORDER NUMBER	**# PKGS**	**WEIGHT**	**PALLET/SLIP** (CIRCLE ONE)		**ADDITIONAL SHIPPER INFO**
			Y	**N**	
			Y	**N**	
			Y	**N**	
			Y	**N**	
			Y	**N**	
GRAND TOTAL					

CARRIER INFORMATION								
HANDLING UNIT		**PACKAGE**				**COMMODITY DESCRIPTION**	**LTL ONLY**	
QTY	**TYPE**	**QTY**	**TYPE**	**WEIGHT**	**H.M.** (X)	Commodities requiring special or additional care or attention in handling or stowing must be so marked and packaged as to ensure safe transportation with ordinary care. ***See Section 2(e) of NMFC Item 360***	**NMFC #**	**CLASS**
						RECEIVING		
						STAMP SPACE		

Figure 2-1B The standardized bill of lading (page two)

						GRAND TOTAL		

Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property as follows: ñThe agreed or declared value of the property is specifically stated by the shipper to be not exceeding _________________ per __________________.ò	**COD Amount: $** ____________________ **Fee Terms: Collect: ☐ Prepaid: ☐** **Customer check acceptable: ☐**

NOTE Liability Limitation for loss or damage in this shipment may be applicable. See 49 U.S.C. 14706(c)(1)(A) and (B).

RECEIVED, subject to individually determined rates or contracts that have been agreed upon in writing between the carrier and shipper, if applicable, otherwise to the rates, classifications and rules that have been established by the carrier and are available to the shipper, on request, and to all applicable state and federal regulations.	The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges. ____________________________________**Shipper Signature**

SHIPPER SIGNATURE / DATE	Trailer Loaded:	Freight Counted:	**CARRIER SIGNATURE / PICKUP DATE**
This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. DOT.	☐ By Shipper ☐ By Driver	☐ By Shipper ☐ By Driver/pallets said to contain ☐ By Driver/Pieces	Carrier acknowledges receipt of packages and required placards. Carrier certifies emergency response information was made available and/or carrier has the U.S. DOT emergency response guidebook or equivalent documentation in the vehicle. ***Property described above is received in good order, except as noted.***

Figure 2-1C The standardized bill of lading (page three)

The Importance of the Voluntary Interindustry Commerce Solutions Association to the Industry

VICS, the Voluntary Interindustry Commerce Solutions Association, has worked to improve the efficiency and effectiveness of the entire supply chain. VICS pioneered the implementation of a cross-industry standard, Quick Response (QR), that simplified the flow of product and information in the retail industry for retailers and suppliers alike.(3)

A 1996 study by Kurt Salmon Associates showed that companies that implemented VICS's business replenishment processes had dramatic results: increased sales, faster turns, improved inventory control, and cost savings. Although the results were impressive, VICS continued to develop a new collaborative dimension to supply chain processes: Collaborative Planning, Forecasting, and Replenishment (CPFR®).(3)

By 2001, an AMR research study demonstrated that retailers and suppliers jointly achieved higher sales with double-digit inventory decreases and improved stock at wholesale and on the retail shelf at a lower overall logistics cost. At the same time, Kurt Salmon Associates estimated that "the benefits of CPFR for just the apparel industry alone could conservatively total $8.3 billion annually."(3) VICS's committees continue to build their legacy of supply chain excellence through continuous improvement of existing supply chain processes, development of new collaborative commerce business processes, and effective implementation of e-commerce standards.(3)

VICS is composed of the following committees:

- Collaborative Planning Committee
- CPFR Collaborative Planning Forecasting and Replenishment Committee
- Floor Ready Merchandise Committee
- Logistics Committees
    - Collaborative Transportation Management (CTM)
    - DC Bypass
    - Global Logistics Management (GLM)
- Product Image Committee

The Applied RF Analysis: Receiving, Directed Putaway, Stocking, and Order Filling

In receiving, the radio frequency (RF) process starts when merchandise arrives at the distribution center. The merchandise is unloaded and a piece-count is verified. Full pallets of merchandise are labeled with a bar-coded license plate for tracking. The scanner provides the status code for warehouse employees who are putting the merchandise into the stocking locations. The workers will have real-time information on their forklift display as to relevancy and need of the stocking items.

If this is a new item, the scanner scans the bar code from the UPC number. The new SKU number is found and entered into the scanner. This process updates the company's table for associating UPC numbers with internal numbers. The RF scanner provides a status code that will show the following results:

- Out of Stock—The forklift display shows the workers which purchase orders have the highest percentage of line outs. This can be traced to incoming shipments that have the items marked with their corresponding ASNs. The shipments can be directed to allow the most important shipments to be received first. The worker is empowered with this knowledge first and does not need to seek direction from purchasing for stocking decisions. Many times the forklift driver, rather than purchasing, knows what needs to be stocked to minimize out-of-stocks.
- On Sale—The software tells employees when each sale starts and stops. The purchase orders are rated by the timeline of receipt. If an order is being received just before the sale ends, it is given a higher priority index, which means to restock immediately.
- Central Stock to Send to Other Centers—If an item is received and the system determines that there is too much merchandise in stock, it will scan other warehouses to see whether the item is needed elsewhere. If the merchandise is needed in another warehouse, the system directs the cartons or pallet to be transshipped from the existing center to the new center. This saves the shipment from being stored and then repulled. If the item is received and is at the wrong location, the system sends a notification error indicating that it is in the incorrect distribution center. This saves any errors in receiving and stocking.
- Discontinued Items—If discontinued items are received from the manufacturer, they are redirected to the exception area. Purchasing decides whether to stock the merchandise or return it to the supplier. The message is sent to the buyer as an exception e-mail on the system software instead of a phone call from distribution, saving time for both the distribution and the purchasing centers.
- Replenishment Inventory—Material is expedited to stocking locations based on the status code provided. The license plate is scanned per pallet so that employees know what product is on a pallet and the location of each pallet. Each item, carton, or bag is labeled with the appropriate bin location number.

The second area for the WMS and RF system is the directed putaway. Material is expedited to stocking locations based on the status code. The license plate is scanned per pallet so that employees know what product is on what pallet and the location of each pallet. Each item, carton, or bag is labeled with the appropriate bin location number.

- The RF system tracks all locations within the warehouse.
- The system recognizes all empty overstock locations.
- The RF system searches for a location based on the size and weight of the pallet.
- The scanner displays the exact location of the merchandise.
- When merchandise is received, the RF system will search the warehouse for an empty location.

The third area the WMS and RF system is used is order stocking.

- The item is scanned to check the location number.
- The location is scanned to double-check the location.
- The operator places the material in the location.
- The operator verifies the quantities and keys it into the scanner.
- The receipt file is updated.
- The operator returns to the dock for the next pallet.
- The scanner will determine the sequence of stocking to reduce travel time and distance.

The fourth and final part of the WMS and RF system is the order filling.

- The scanner sequences the locations to be pulled in order by priority and for the shortest distance and time.
- The forklift operator is directed to the location from which overstock is to be pulled via display screen on the scanner.
- Member orders are filled from overstock locations.
- The RF system searches locations to do the following:
  - Avoid the need to pick a large quantity from the pick location.
  - Combine bin replenishment and order filling with one move.
  - Avoid returning partial pallets to overstock.
  - Fill orders requiring a full pallet of merchandise.

- Remove partial pallets from overstock, opening locations for the storage of full pallets.
- Sequence the locations to be pulled in the order by priority and for the shortest distance and time using the scanner.
- Direct the driver to the correct shipping door using the scanner.

The Applied RF Metrics Used in the Distribution Centers

The following represents the process improvements with the implementation of RF:

- A 28% increase in units handled per man-hour worked, showing performance and accuracy in order picking
- A 50% increase in efficiency in receiving
- An 18% reduction in cost per unit handled
- Location of each product known
- Picking accuracy of 99.95%
- Improved customer service

The Lean Savings of RF:

- The enhancements of the certification programs and the RF scanning techniques.
- The initial Lean inventory reduction is 2.4% × \$211 million inventory = \$5 million reduction in inventory.
- The new inventory: \$206 million.
- Frees up the cost of capital which is 2% × \$5 million, resulting in an inventory savings = \$100,000.
- The Lean reduction of carrying cost due to the reduction in inventory. The reduced carrying cost is .266% × \$5 million = \$1,330,000 in additional savings.

The Green Savings of RF:

- Damaged inventory represents .75% × $5 million inventory = $37,500.
- Obsolete inventory cost reduction is 9% × inventory reduction = $450,000.
- Combined savings of $487,500 on potentially wasted merchandise.
- Inventory transfer cost of .5% to 1% in wasted movement in the system. It is moving product from one warehouse to another. The Green Savings of moving product from one warehouse to another with an average of 450 miles between the warehouses and the cost per mile for the semi truck is the variable cost of 6 miles per gallon plus wear and tear on the truck: variable cost is $3.12 per gallon × 450 / 6 = $234. The fixed cost (wear and tear) is $0.65 per mile (450 × .65 = $292). One trip has a total cost of $234 + $292 = $526.
- If a company has nine warehouses, at a pace of one trip a month for each truck to each warehouse, the total cost per year is 12 × 9 × $526 = $56,808. This does not include any round-trip costs or the wear and tear on the existing highway infrastructure.
- Total savings for RF is $1,974,308.

The savings after the RF program includes company turns at 4.52, sales at $931 million, and inventory at $206 million. The savings for the RF with a WMS program are Lean Savings of $1,430,000; Green Savings of $544,308; and a total savings of $1,974,308.

References

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(2) http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1087&context=pacis2001&sei-redir=1#search="Postponement+metrics".

(3) "P11 VICS Voluntary Guide Lines for the Bill of Lading," February 2005, http://www.vics.org.

3

The Use of Radio Frequency Identity Tags in Industry

Radio Frequency Identity Tags (RFID) can greatly enhance a company's performance, but there must exist a definite need for this solution because it is not for all companies. RFID is an additional expense that makes sense only when the gain is greater than the cost of the technology. The expense is found in the purchase of the tags used on each item or each bin location, as well as the infrastructure expense of RFID readers and antennas at each point of read. An additional expense is the required integration of the data recorded by the readers communicating to the main computer through middleware. The cost of the installation depends on the size and complexity of the job. The larger the job, the more readers, tags, and Wi-Fi connectivity points are necessary. Issues to consider include scalability, security, inseparability, integration, administration, and managing.

Here is a generalized idea of the cost of a 900 MHz RFID implementation. Other frequencies are available but not included in this cost analysis:

- 125 to 134 kHz is classified as Low Frequency for scanning items close at hand and is used for access control, livestock, and race times, such as triathlon or marathon times for the participants.
- 13.56 MHz is classified as High Frequency. This offers more distance than the low-frequency tags and is generally used as smart tags for loyalty cards, books, and smart shelves.
- 860 to 960 MHz is classified as Ultra High Frequency. This is used in the supply chain for all the tasks discussed in this chapter.

- 2.45 GHz and 5.8 GHz are also classified as Ultra High Frequency, and 2.4 GHz is mainly used for the toll road I-Pass.

The components of an RFID system are broken down into five categories. The costs are an accumulation or a summary of the quantities used in the following groupings: RFID Tags, RFID reader, RFID printer, RFID antennas and cabling, and RFID middleware:

- RFID Tags—The passive tag is used for a license plate on a pallet, a bin location, a container load, or item-level tags. The item-level tags are relatively cheap based on volume. They can be one to five cents. The tabs for the license plate and bin tags can range from 10 cents to $1. Depending on the complexity required, environmentally protected tags are available for around $1 to $5 or more.
- RFID Reader—The reader can cost from $1,200 to $3,000 or more depending on the vendor and type used. If the reader is a hand-held it will be more expensive.
- RFID Printer—These are the devices that print a label with readable data and also have an RFID tag on them. The cost can range from $1,500 to $4,000 or more.
- RFID Antennas and Cabling—These cost $125 to $300 per antenna combination plus $50 for cabling.
- RFID Middleware—These may cost $6,000 to $300,000 or more. The cost depends on the complexity and number of jobs required by the system. This requires a talented IT staff or an external company specializing in RFID implementation.

RFID does not require line of sight as does the UPC. The RFID can read through boxes assuming that there is no metal or liquid inside. When metal or liquid is present, one layer is read, but not the entire case. This is why it is prudent to place the tag on the top of the product, so the readers can read down on the container and count the number of items, boxes, or packages inside. The container label can be read with a UPC reader, and then the RFID reader reads the carton count. The UPC tells the computer this is a box of 24 bottles, for example. The RFID read confirms that the container truly has 24 bottles. Productivity increases because no personnel are required to complete the process.

This process can also be used in the certification of suppliers. The retailer knows that the vendor accuracy is around 100%. When the items are received, they do not have to be counted. Instead, they are immediately stocked. This saves greatly in labor and in receiving-to-stock times. Lean Savings is enhanced due to greater efficiency of the operation. The Green Savings is found in fewer inventories, less spoilage, and less wasted merchandise.

The other advantage to RFID is that the tag is not a UPC but an EPC, or Electronic Product Code. The electronic product code has four fields for a 96-bit tag. The first part is the 8-bit header, indicating whether the tag is an item tag, a location tag, an asset tag, and so on. The second field is the EPC Manager with 28 bits, and it names which supplier the tag belongs to. The third field is the object class with 24 bits, and it is the item SKU or the UPC. The last field is the serial number with 36 bits, making each item unique. With 24 bottles of Dasani water, for example, each UPC will be the same but the serial numbers will be different. Having the same UPC with different serial numbers makes each bottle unique.

Every time an RFID tag is read, the time and date are recorded, which allows for tracking items throughout the supply chain. This option generates quantifiable data that can be used in the Business Intelligence system. The data from the RFID tag can be used as explored in Table 3-1.

Table 3-1 The Five Categories of Real-Time Information Used by an RFID System

Sense and Response is the name given when the system acts as an autonomous system and alerts the managers of any abnormalities when it senses them. A networked supply chain system can be built to show any abnormalities in the system, alert the appropriate personnel, and offer recommendations.
Pedigree Tracking is the term used to show that this is the right item for the delivery. As its name denotes, the item has the correct pedigree for the customer requirements.
Track and Trace makes it possible to have the Visual Supply Chain track the item through the entire supply chain. The product is traced, which allows for accurate delivery-time notification.
Chain of Custody shows who has owned the product or has had possession of it all through the supply chain. If there are damages or theft along the way, the owner knows where to look for answers.
Real-Time Location Systems are used in yard management and WMS. These systems act as an asset tracking system in either a yard or a warehouse. It gives real-time information about product, quantity, and location.

RFID technology is growing exponentially. More than 2.35 billion tags were sold globally in the year 2009: 200 million were used in the apparel industry, 105 million were used in the tagging of animals, 1.7 billion were used in factories, warehouses, hospitals, and other companies, and finally 350 million RFID tags used as tickets in transportation.(1) The RFID industry is expected to exceed $8.25 billion by the year 2014. This represents a 14% compound annual rate of growth for the 5 years 2009 to 2014.(2) The greatest growth will come from the Real Time Location Systems (RTLS) segment of the industry, representing baggage handling, animal ID, and item-level tagging in fashion apparel, library systems, consumer packaged goods supply chain, and retail systems. This segment of RTLS is forecasted to grow by 19% in the next few years.(3) When planning an RFID initiative, it is helpful to see how it has improved supply chain sustainability and competitiveness. The following paragraphs illustrate the advantage of RFID in several different industries.

The Apparel Industry—The apparel industry is expected to grow by 14% in the next few years.(4) Apparel and laundry companies globally used 200 million RFID labels in the year 2009.(4) The following is a list of the process improvements initiatives and metrics for the apparel industry:(4)

- The companies that use RFID in the apparel industry have experienced a 14% increase in sales. The biggest reason for the sales increase was the quick availability of the stock. With so many items in a retail store, a sale can be lost because the needed item is either in a different location or in the receiving room and the sales clerk cannot find it, or the customer just assumes the product is unavailable.(5)
- Their labor cost has been reduced by 30%. Fewer people are needed in the retail location because of increased accuracy and speed of the process.(1)
- Their inventory accuracy has increased by 27%.(5) This is brought about through the removal of human error. The people stocking and receiving are at the mercy of the accuracy of the tags that label the product. This is where the error can occur. Even this can be automated to a great degree.
- Inventory accuracy has increased to 98%-plus.(6)

- The system also delivers a 99% visibility to the supply chain.[1] This visibility is very important to the service level and performance of the company as described in Chapter 15, "The Visual and Visible Supply Chain."
- Visibility has also allowed the inventory to decrease by 15%. The enhanced visibility allows for faster receiving and better planning in cross-docking the received product.[1]
- On the average of all the industries sampled, the return on investments was three to four months.[1]
- Process improvement is measured by a number of metrics, as explained here:[1]

    - The system tracks every item from the time it is received until point-of-sale.
    - It facilitates stock replenishment within minutes of a sale, thereby improving inventory accuracy and maintaining available stock on the selling floor.
    - Because the RFID tags do not require line-of-sight, they can be used for cycle counting. Livingston American Apparel reported that what used to take 120 hours now takes only 15 hours.
    - Bloomingdale also confirmed this by stating that with item-level RFID scanning, the inventory counts time decreased by 96%. Item-level scanning of 100,000 items used to take 53 hours and now it is done in 2 hours. On average, 209 items could be counted in an hour with the bar coding UPC process. With the RFID process, 4,767 items are counted in one hour. Bloomingdale can count the inventory 26 times over with RFID in the time it takes to count the inventory once with the UPC system.
    - There is a definite reduction in man-hours required for restocking. This results in increased man-hours available for customer interaction.[6] The increase in efficiencies is because RFID has allowed for an increased in-stock position and shelf-level accuracy, more efficient backroom replenishment, a 50% improvement in response time to identify and resolve in-transit problems, a 20% reduction in excess product/safety stock inventory, a 20% reduction in container fleet, up to 90% improvement in reliability of delivery time windows, elimination/early detection of product theft, and

elimination of the historical 10% to 15% human error rate associated with manual work processes to capture and enter data.(6)

The Animal Industry—The tagging of animals (such as pigs and sheep) is growing strongly as it becomes a legal requirement, with 105 million tags being used for this sector in 2009.(7) RFID tags will facilitate the collection of performance information following slaughter or death, a function that was far too labor-intensive and prone to error using the previous visual tags.(8) The industry as a whole will benefit from an increase in the capacity to trace sheep and lambs through the market chain and facilitate the collection of better data on characteristics such as carcass quality, superior rams, and increases in productivity.

Viewing RFID tags as an investment in tools and not strictly a cost is a key to success.(8) RFID systems can facilitate savings in labor costs by making various management chores more efficient. Improvements in flock health and productivity are made possible by applying RFID systems and flock management software. This, in turn, provides the capability to analyze production information gathered and stored electronically from individual animals.(8)

Over one-third of the calories in an ordinary American's diet come from honey bee–pollinated food—including a wide variety of fruits, vegetables, nuts, and berries.(9) RFID tags are used to monitor the beehives. By applying RFID to their processes, beekeepers, industrial buyers, and producers can get real-time visibility into the complete production chain.(9) A solution from Apitrack, for example, includes RFID tags, hand-held RFID readers, and software that allow users to collect production data from extraction rooms, fractioning rooms, and warehouses. The result is real-time data that can be used for the traceability and safety of honey, wax, and pollen.(9) Another benefit of RFID tags is tracking for diseases such as mad cow disease. When the rancher learns through the tracking system which herd the disease came from, he will not have to destroy the entire herd. The productivity of cow milk production has also been increased by the use of RFID tags. In one estimate, users claimed that their productivity was three times the national average.(10)

The Auto Industry—Misplaced or lost containers is a major problem in the automotive industry. When a container with critical parts is lost, it results in a loss of time and cost for reordering. It is estimated that the loss of parts in the auto industry costs $750,000,000 per year. To fix this problem, location, content, MSDS, and other data need to be stored. UPC does not offer this solution but RFID does. The industry might eventually phase out the UPC solution in favor of the total RFID solution for container and parts marking. The North American transmission plant, Balluff, saved $2 million per year from their automatic RFID tool management system.[11]

The Healthcare and Pharmaceutical Industry—The necessity for immediate care and medication for patients prompted the need for RFID in the healthcare and pharmaceutical industry. With RFID in the supply chain, these speedy transactions could bring a potential cost savings of $2.6 billion a year. Another benefit is the capability to keep the supply chain visible and used in a collaborative way to share demand information. This demand and supply information can be focused on medications that are critical to the activity of the clinic, pharmacy, or hospital.[12] One of the greatest benefits in the healthcare industry is the use of RFID to have better security through the Track and Trace techniques. Here are a few examples of enhanced functionalities from different perspectives:

- *Event Driven*—This is the true visible supply chain scenario in which an item may be getting close to an expiration date and still fill the shelves. The product may begin to increase or decrease in sales in the desired supply chain. These events and others will signal the supply chain operator that the questionable or bad event is about to happen. This is referred to as Opportunity Management due to the opportunity to correctly manage the supply chain.
- *Pedigree Tracking*—It is now possible to track the logistics of the supply chain to decide whether the correct item is delivered. In the pharmaceutical industry, this is very critical because it aids pharmacists in ensuring prescription accuracy.
- *Trace and Track*—This term really applies to the visible logistics network. The information here is mostly used to see where in the supply chain the product is. This improves delivery timing

accuracy and ensures that receiving departments are properly staffed.

- *Chain of Custody*—This tracks ownership and location of each product. Each person who has received the product will be identified. If there was any tampering or theft of the product, each point of ownership will be identified.

The Logistics Industry—The advantages of RFID in the logistics industry is greatly enhanced through the use of sensor technology. Sensors are used to measure the following:

- Temperature within the shipping period can be measured. If the temperature has gone outside the limits set for the item, the amount of time spent outside the acceptable range is recorded. This can minimize spoilage of perishable goods.
- The humidity can be measured for items like plants that need or don't need to be in a humid environment.
- Light can be measured on the product. In certain cases, as with bacteria or film, the product will need to be in a dark environment.
- Vibration can be measured to account for certain product defects.

Warehouse Management Systems—Warehouse management systems can be greatly enhanced in the use of RFID. Not only can employees learn what is in the bins at a faster rate, but they are also notified in real time of what is in inventory. To truly automate the warehouse, RFID tags can be placed in the concrete of certain areas of the warehouse. As the forklift travels over the designated points and unloads the pallets in the location with an RFID tag on the floor, the activity is recorded. The forklift's onboard computer also knows what products are being stored or loaded at each location. Automatically assigning item, quantity, and location to all pieces in a warehouse cuts down on loss and allows for date-stamping for goods that are perishable. This aids in the creation of a true first in, first out environment.

Supply Chain Management—The supply chain and the movement of supplies can represent 50% to 80% of the cost of the procedures in the healthcare industry. Supplies are the second-leading cost to hospitals after labor in providing patient care. Managing supply chains in healthcare has been a neglected area in efforts to improve efficiency and save costs. The purchase of goods and services can account for 50% to 80% of a company's expenditure. Purchase and supply chain management has to play an important role in cost-reduction programs. This role, however, should not be restricted to obtaining price reductions from suppliers but should also be extended to more constructive areas in which the participation and involvement of purchase and supply chain management is of immense importance. This involvement of RFID extends to the technology solutions of the supply chain using VMI, CPFR, and the rest of the technologies.

The Bullwhip Effect—The level of uncertainty between demand from the retailer to the distributor to the manufacturer and to the raw material producers increases, beginning with the retailer. This also means that the level of safety stock at each stage must increase. RFID, through item level, helps minimize this effect. The bullwhip effect is significantly reduced by sharing information and collaborating with the suppliers.

Replenishment Policies—This is the decision-making policy of the company in determining the frequency of arrivals and the size of the orders. The size of the orders is also determined by the EOQ policy or the minimum inventory policies of the supplier or the distributor. RFID will improve the inventory performance by making the item-level detail more visible to the trading partners.

Asset Life Cycle Management—Asset Life Cycle Management tracks maintenance, quality issues, safety records, and the lifetime before replacement. Airbus is using RFID to track thousands of key components from the time of purchase until they are placed on the plane. The entire life cycle is tracked, including repair and maintenance records. This gives an excellent database of which vendors and which parts have the best quality records. If certified with the suppliers, this information will show them how they are doing on their partnership agreement and whether or not they are meeting the key metrics.

RFID Used in Manufacturing—The greatest success stories come from the process of labor movement in manufacturing. A good example of the RFID improvements is the system installed in Johnson Controls. It synchronized the assembly of seats with the RFID tag under each seat. The computer knows which seat is coming to each cell of operation. The operator does not have to move because, even though each seat may be unique, the computer knows exactly when the seat will hit the cell, and the appropriate material for the worker will have been previously delivered. This is true just-in-time production. The amount of time saved by Johnson controls is significant. They can produce multiple models of car and truck seats on the same line without having to worry about grouping or staging until it gets to the final ship designation. This allows them to produce on one line what would have taken multiple lines. If no modifications are required at the station, the conveyor simply passes the operator without stopping.

The Gaming Industry—RFID is being used in the form of the Progressive Table Link in Las Vegas casinos for enhancing the efficiencies of the gambling operations. The information gathered does the following:(13)

- Gives the average bet per table and per user
- Shows the high and low wagers
- Gives the casino manager an idea of the bet spreads
- Alerts the manager of a run by a customer (the customer may be counting the cards)
- Ensures that the casino will not have to invest in numerous pit clerks because the customer realizes the casino is aware of the betting strategy

The Jewelry Management Industry—The best part of the technology in this industry is the labor and asset savings of expensive inventory. Employees can use an RFID hand-held gun to scan the cases for inventory. Each piece of jewelry has an RFID tag. Inventory counting can be enhanced by 90% to 96%. The next step is to use an RFID shelf. The RFID shelf has readers in the shelf, and the employee or manager can always see the inventory count. The final design for the RFID inventory of jewelry is to have a large antenna underneath a flat surface. Each time the jewelry is placed against the flat surface, the system will read the tag. As many as 250 small pieces of jewelry can be picked up by the reader. Multiple antennas can be placed so that each time a piece of jewelry is taken from the shelf, it is recorded. The system can be hooked up to alarm or security cameras.(14)

With the integration of Business Intelligence, it is time to begin the process of Autonomic Supply Chain Management. For competitive reasons, company names are not used in the following sections. Following are some examples of process improvement efforts.

An apparel company in Mexico was taking inventory and had experienced yearly losses in the inventory count. The inventory inaccuracies were not because of theft. They had the correct procedures in place to adhere to good practices. The problem existed because the ordinary worker did not want to do extra duties to make the count perfectly accurate. The last count showed a shortage of $400,000. They were interested in an RFID system that would use apparel tags to identify the products. The system upgrade would cost $100,000 with a return on investment of three months. The system not only saves in labor, but also prevents having to mark down old merchandise because employees could not find the product quickly enough to satisfy the customer.

Another system would allow the manufacturer to track 60-pound drums of paint from the manufacturers. The product needed to be painted as it rolled off the production line. Any shortage in the paint product could stall or stop the manufacturing process. This could cost over a million dollars an hour for a production stoppage. The RFID system would track the shipment and loading of the paint drums from the supplier, creating a visible supply chain where the manufacturer can plan production on existing or all new products received. The product accuracy is practically 100%. The product can be delivered with 90% accuracy to the hour. The fact that management can plan for a contingency observed in freight is a real advantage. The cost of the system would be no more than $300,000, and this would include all the appropriate software and hardware to run the entire operation. To date, a shutdown on the line happens approximately once every 18 months. Assuming a one-hour downtime, the yearly cost would be approximately $660,000. The break-even timeframe is six months.

In the correctional system, prisoners are identified with wrist badges. When they are traveling through the court system, approximately once or twice a year a prisoner will exchange wrist badges and leave earlier than allowed. These mistakes cost the legal system about $125,000 to correct. The system necessary to avoid this in the future costs about $150,000. Considering a once- or twice-a-year incidence, the ROI would be less than a year. The system proposed would have a wristband with an RFID tag on the prisoner's wrist. This would be coupled with a 2-D biometric facial recognition system. The system is specially designed for RFID tags and to work in concert with the technology. If the prisoner takes off or swaps the wristband, it will not work through the system's scanner and will signal that something is wrong. If the tag were to be enabled on another person, the scanner would tell the guard that the prisoner has the wrong ID. This is definitely a Lean and Green Savings.

Case Studies of Two Industries: The Medical Environment and the Distribution Industry

These are case studies that talk about the benefits of using RFID in the hospital environment and a distribution environment. The names of the companies have not been disclosed for privacy considerations. The name of the consulting firm was mentioned with the permission of the owner, John Baker. The case studies were chosen because of the connection to the Lean and Green theme of using and wasting fewer resources.

Case Study: Medical Environment

This section is about a case study of the hospital system. In 2007, SIMS was created to address the problem of the inefficient use and control of costly surgical equipment. During research, it was discovered that risky surgical operations were often interrupted by the absence of the right equipment necessary to complete the procedure. It was further discovered that the reason for the absence was not due to the lack of preparation, but was instead a direct result of an antiquated inventory management system. In addition to lost time and in order to compensate for the inaccurate system, hospitals are forced to house an inflated inventory of equipment. There are even times when equipment is simply confused with loaned items and must be tracked down or replaced.

It was therefore decided that SIMS should use RFID technology to produce and implement a surgical-instrument inventory management system in order to help the healthcare industry focus more time and money on patient care. Through the use of SIMS products and services, a healthcare facility will be able to provide surgical services more efficiently and at lower costs. Currently, the use of RFID technology in the healthcare industry is limited to a few examples. If implemented properly and with the right commitment, the use of this kind of technology can provide unmatched differentiation from competitors. The ideas presented in this proposal are just the beginning of many RFID programs that can save hundreds of thousands in inventory and lost productivity cost.

It is estimated that as much as three times the necessary amount of surgical equipment is purchased and housed in a hospital in order to compensate for the lack of asset-tracking efficiency. This leads to inflated annual capital expenditures and higher monthly carrying and maintenance costs. With an average of one million dollars in inventory, this problem costs hospitals hundreds of thousands of dollars in underutilized equipment alone. Additionally, thousands are wasted each month through carrying and maintenance costs.

A much more critical problem is the unexpected delay in the operating room. It is true that surgeons are highly trained professionals who are very thorough and avoid rushing. It is also true, however, that extended delays due to unexpected equipment problems add to the risk of the procedure. This risk can manifest itself in various ways. Surgeons are human and can become distracted in these situations, which may lead to mistakes. Additionally, more medications, like anesthesia, are needed to keep patients stable, which may lead to side effects.

Operating rooms are technologically complicated environments that employ highly trained and compensated professionals. At a cost of hundreds of dollars per hour and with an estimated 1,500 operations per year in lost minutes per procedure, this can add up to tens of thousands of dollars per year.

Surgical equipment is very costly. A simple pack of drill bits may cost more than $20,000 to replace. Lost or misplaced equipment can cost a hospital hundreds of thousands in replacement capital. Even if the lost equipment is found, the time and money expended for retrieval add thousands to the bottom line.

Savings Estimation

Based on the inventory reduction assumption, the initial saving is $150,000 excess inventory × 50% reduction = $75,000. The 50% inventory replacement assumption brings $22,500 savings from the $45,000 cost for instrument replacement × 50%.

According to conversations with the hospital, employee time savings could approximate 300 hours or $12,000 per year. Surgery time saved during operating procedure is $16,875 from the 5 minutes per surgery × 1,500 surgeries per year × $2.25 per minute. The savings in sterilization is an approximate number based on the following logic in calculations.

The sterilization machine is usually filled in with four sets of instruments or 100 instruments before it is operated (per the hospital estimation). The research team assumed conservatively that currently (without RFID technology) each surgery would consume two standard sets of instruments on average. Thus, two surgeries would be necessary to fill in the sterilization machine. Hence, there are approximately 750 sterilization cycles per year from the 1,500 surgeries per year / 2. The research team assumed that RFID project implementation would reduce instrument waste per surgery by 50%. Therefore, one set of instruments instead of two would be consumed in each OR procedure. This brings down the sterilization cycles per year to 375. Based on the $50 assumption in sterilization savings, the total number is $18,750 from 75 runs per year × $50. Total savings per year is estimated to be $70,125.

ROI

During the first year of the project, total costs would be higher because of the initial investment needed. The total cost would be $208,200. This would be somewhat offset by a higher savings amount during the first year of $145,125 from the $75,000 initial savings + $70,125 yearly savings. A negative cash flow of $63,075 is expected during the initial year of the project.

After the first year there is a constant cost flow of $25,500 and a savings flow of $70,125 per year. The final result for the ROI estimate based on the assumptions in this project is 2.4 years.

Case Study: Distribution Industry

EXECUTIVE SUMMARY

The distribution company has a long history of delivering quality products to their customers. Even though the location falls within company standards, the desire is to seek a way to create more efficient movements in order to save money. Areas where this might be possible include broken, damaged, and lost inventory (BD&L), inventory knowledge, and warehouse organization.

After these possibilities were investigated, solutions were found that would reduce labor costs, carrying costs, and BD&L. The first solution is using RFID at the pallet level. This would allow a quicker and more accurate counting of the inventory on hand. The second solution would be to have RFID at the case level, which would further enhance quickness and accuracy. The third solution would be for back-stock gravity-fed shelving. This would not only help with the FIFO rotation of stock but also make everything more accessible.

The recommendation at this time is that distributor institute a pallet-level RFID solution. Other solutions could be implemented at a later date when the RFID has proven itself.

CURRENT SITUATION

Statement of Problem

Managing efficiencies within an organization is an ongoing process. Being more efficient will lead to cost savings and, in return, increased profit. Within all organizations lie certain inefficiencies that leave room for constant improvement. These inefficiencies cost companies millions of dollars each year. By implementing some relatively inexpensive processes, in relation to the current overall losses, companies can vastly improve their bottom line. In the case of the distributor, there are three such areas in which improvements can be made that could result in significant cost savings, leading to higher profits for the company as a whole:

- Broken, damaged, and lost inventory (BD&L)
- Inventory knowledge
- Warehouse organization

The first area that needs to be addressed is that of broken, damaged, and lost inventory (BD&L). Last year the distributor lost $189,400 due to BD&L.

As shown in Figure 3-1, nearly half of that loss was due to outdated products. Another 45% of total BD&L was due to reworkable or damaged inventory. The remaining 6% is due to lack of demand for a new product and inventory that has been lost.

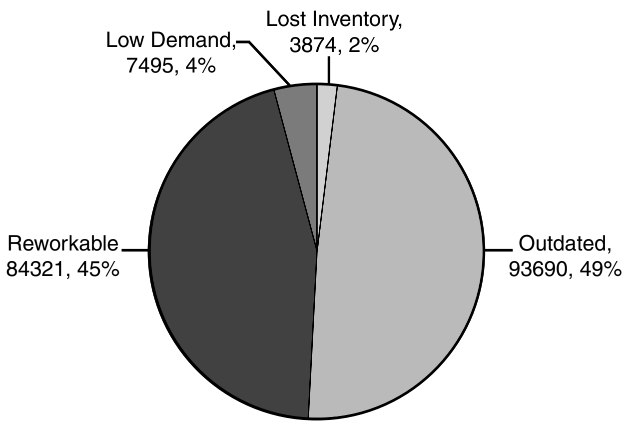

Figure 3-1 Cost associated with BD&L

The second major area in which inefficiencies exist is in the area of inventory knowledge. Currently, a daily inventory of all products in the warehouse must be taken in order to ensure that inventory is being properly tracked. If this knowledge could be gained instantly, not only would the company save on labor expenses, but also efficiency could be gained in restocking products.

The third area where efficiencies could be improved is warehouse organization. Because products are date sensitive, the company operates on a first in, first out inventory control method. (See Figures 3-2 and 3-3 for warehouse setup and product flow.)

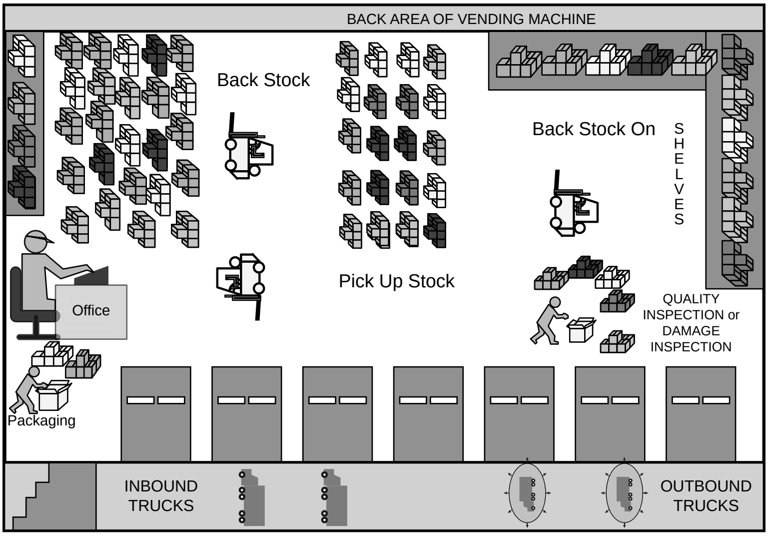

Figure 3-2 Current floor plan of the distributor

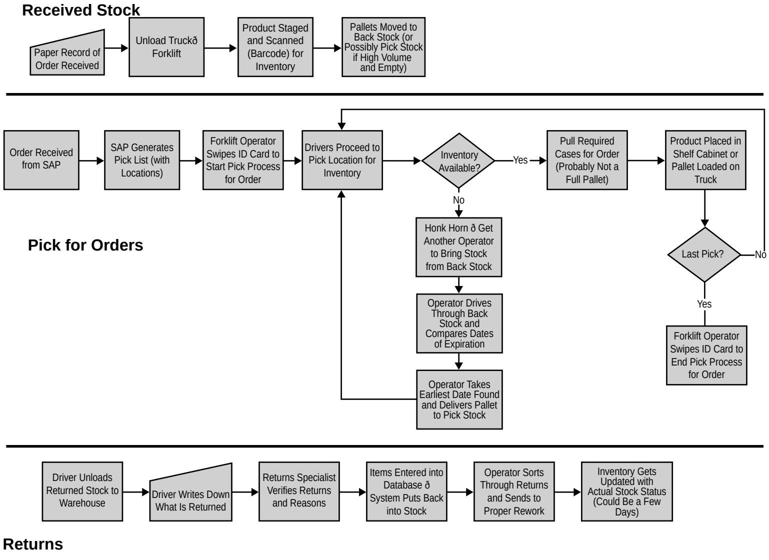

Figure 3-3 Current process map of the distributor

Currently, orders are fulfilled from the picking area in the central location of the warehouse. When the inventory in this area becomes low, a horn honk from the picking forklift operator signals to another forklift operator that more inventory is needed. The forklift operator must then go to the picking area to find out what is needed to be stocked. That driver then searches the back-stock area for the needed product with the oldest expiration date and then proceeds to refill the pick area. This is where efficiency can be created. Because none of the back stock is in a specific order, the oldest products are not always sent out first. If these older products are not used by their expiration date, they must be disposed of, resulting in BD&L.

Scope of Analysis

After the processes at the enterprise warehouse have been collected and examined, options have been compiled that could create efficiencies resulting in cost savings. One option involves implementing an RFID inventory control system on the pallet level, and another option exists in moving one step forward with RFID on the case level. In regard to warehouse organization, a complete reorganization of the warehouse to a gravity-fed inventory control system will offer one more option for increasing warehouse efficiency. These processes set forth individually or in combination will offer cost savings to the company now and into the future.

Goals

- Reduce labor-related costs by 10% by May 2010.
- Reduce the costs associated with BD&L by 25% within a one-year period.
- Reduce inventory 20% through better inventory control methods.

These goals would result in bringing the warehouse above company standards and make it the model for the enterprise across the nation. Implementing RFID would help to achieve these goals.

RFID

With properly planned cost analysis research and implementation of an RFID application system, items may be tracked automatically and without human intervention. This will minimize time involved in identification processes, and with high integrity of data capture. In today's enterprise supply chain management, this could tremendously improve the efficiency of inventory tracking and management, while reducing the cost of inventory management and property of ownership.

RFID on the pallet level offers many benefits such as its easy implementation and low-cost way to do basic inventory tracking while making it possible to send out the oldest products in the back stock first, reducing BD&L. Another benefit this solution offers is that it makes employees' tasks within the warehouse much more streamlined. Instead of having to manually receive the orders for picking, they can receive this information instantaneously from a monitor on their forklift.

The major drawback of RFID on the pallet level is rectified with the major benefit of RFID at the case level. It is a common practice to split up pallets in order to fill uneven orders. Because of this, some inventory will still have to be entered manually when RFID is done on the pallet level. If the distributor would decide to move forward with RFID in the future on the case level, the manual inventory tracking step could be eliminated. However, this step would be much more costly to implement due to the fact that the tags would have to be integrated into that packaging by the manufacture. Another drawback of this RFID solution is that when a tag is in extremely close proximity to a metal or liquid, it could possibly malfunction, causing an inaccurate inventory reading.

Gravity Flow Roller System

If the gravity flow system were implemented, it would offer several benefits. The major benefit is that this system, in combination with RFID, would streamline the distributor's FIFO inventory-control method. By guaranteeing that the oldest products are constantly being pushed to a central location near the picking area, the center could once again decrease BD&L. This option also offers added benefits to workers. Because the bulk of the inventory is on rolling racks, it can be moved with ease. This also makes the work environment much safer by reducing the probability that a pallet could be dropped by a forklift. The drawbacks of such a system include implementation costs and the need for a large amount of space. However, even with these drawbacks, this system offers the company an easy way to become more efficient.

RECOMMENDATION

RFID Implementation

The corporation could improve its operations in several ways. An RFID system needs to be implemented in the plant. Further, the company will need to install an RFID printer to print the tags it chooses to use. The distribution center will also need to supply employees with RFID hand-held readers and mobile applications so that products can be tracked instantaneously.

The company will also need to rework the current forklift process in the facility. The company currently has five forklifts that will need RFID readers installed on them. There are three single-forked units and two double-forked units; the double-forked units will need external antennas installed on them so that they can read both pallets at one time. Finally, all forklifts will need floor-facing antennas installed. It is also recommended to install two single-facing, ruggedized enclosures and four double-facing ruggedized enclosures on each dock door. Figure 3-4 shows the proposed setup of the RFID portals. Venture Research, Inc., proposed five RFID portals at the loading docks. The ruggedized enclosures will be placed at the five dock doors per the drawing in Figure 3-5. The current warehouse setup will remain the same.

The corporation will need to instruct employees about how to handle RFID tags and how to implement the process. Therefore, they should provide 1,000 floor tags and instructions for personnel. It's also recommended to provide 100 shelf tags for installation and install extra on an as-needed basis. The distributor will need to have a running server at the location, and a SAP interface will need to be written and mapped out so that the RFID software will work with the current software.

Product-flow efficiency will improve after RFID implementation. Tags will be placed on each pallet as it arrives in the warehouse. These tags will be scanned and pallets will be placed in back stock or pick locations as needed. The RFID scanner on the forklift will provide the product location with expiration date information. The forklift drivers will save a significant amount of time by not searching for product. The forklift driver will locate the product with the closest expiration date and place it in the pick line. The more efficient rotation of stock should result in a 50% reduction in outdated products cost. Labor efficiency will be improved for both the forklift operator and the person waiting for product to be restocked on the line. Figure 3-5 shows the new process map after RFID is implemented. It also gives a better indication of the flow of the process.

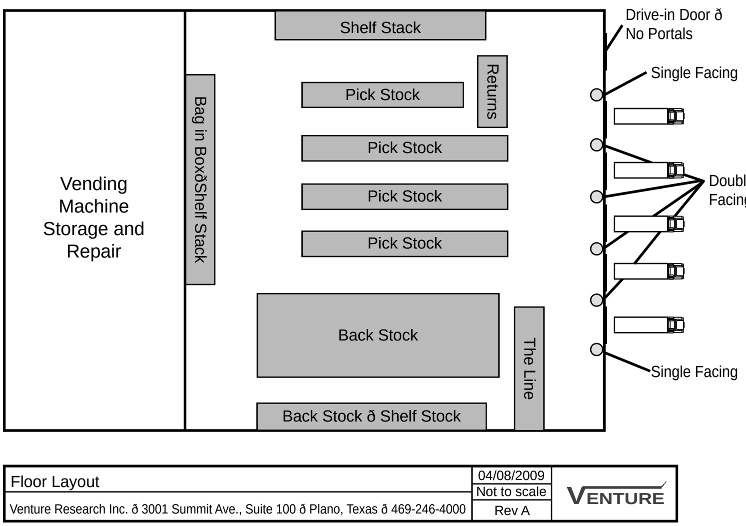

Figure 3-4 Floor layout map after RFID implementation

Information provided courtesy of Venture Research, Inc. Copyright 2003–2011

Cost Structure of RFID Implementation

Table 3-2, provided by Venture Research, Inc., is a summary report of the cost of the RFID system implementation in the warehouse. According to this table, the total cost of implementation would be about $151,909.83. This calculation is based on provided information and assumptions from 2009. The pricing is for educational purposes only and is not representative of current industry pricing. This cost includes system design, installation, equipment, software support expenses, training, RFID tags, and shipping.

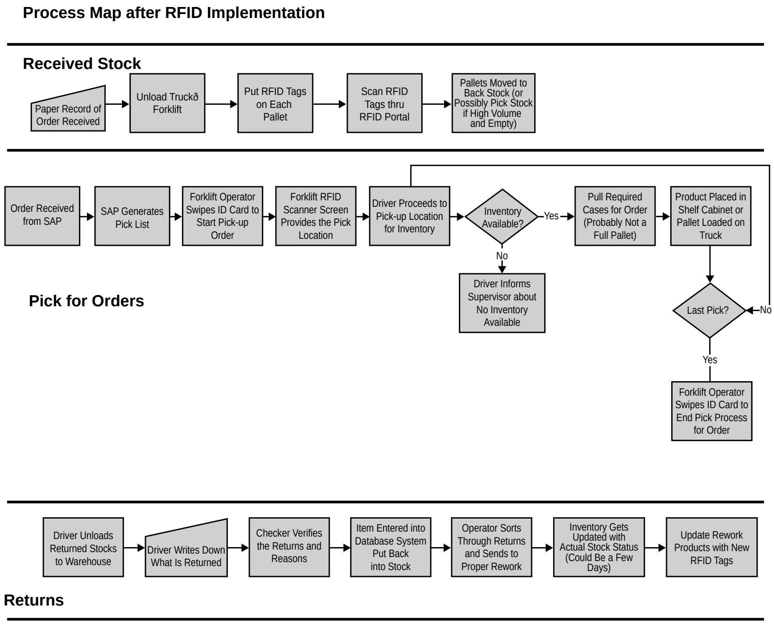

Figure 3-5 Process map after RFID implementation

Table 3-2 Cost of System Design and Installation

Post 1-Year Warranty & License Fees	Ext. Cost Nonrecurring	Unit	Qty.	Description
$0.00	$7,200.00			Design and Review
$359.40	$11,970.00			Back Stock/ Receiving
$0.00	$8,425.00			Pick Stock
$1,227.00	$35,270.00			Dock Doors
$2,166.00	$22,940.00			Forklift/Material Movement (RFID)
$4,057.88	$33,399.00			Computer/Hard-ware/Server/License
$0.00	$3,400.00			Integration/Ship-ping/Staging
$0.00	$10,800.00			On-Site installation/ Training/Support

Post 1-Year Warranty & License Fees	Ext. Cost Nonrecurring	Unit	Qty.	Description
$7,810.28	$133,404.00			
	$11,005.83	0.0825		Management/ Logistics Support
	$7,500.00	0.15	50,000	RFID Labels-4X2, Roll Stock
$7,810.28	**$151,909.83**			**Total Project**

Information provided courtesy of Venture Research, Inc. Copyright 2003-2011.

Return on Investment

The return on investment of the RFID system is based on the following assumptions:

- Outdated product loss will decrease at least 50%.
- Labor efficiency will be increased by 10% minimally.
- Inventory will reduce by 20% minimally.

Table 3-3 illustrates the savings listed in this paragraph. The warehouse had $93,690 in outdated product last year. The system would tell employees exactly which pallets to pick. In doing so, inventory rotation would be managed in a more efficient manner. This improved process for inventory rotation could result in a 50% reduction of outdated products. This reduction leads to an overall decrease of 25% of total BD&L, which would be a savings of $46,845.00 per year. The system also represents a Green Savings of $46,845 due to less waste to dump bins or salvage yards.

Table 3-3 BD&L Inventory Savings Every Year (Based on Last Year Data)

List of BD&L	Last Year Cost	Percentage Reduced Cost After RFID Implementation	Savings After RFID Implementation
Outdated	$93,690.00	50%	$46,845.00
Reworkable	$84,321.00	0%	$0.00
Low-Demand Products	$7,495.00	0%	$0.00

List of BD&L	Last Year Cost	Percentage Reduced Cost After RFID Implementation	Savings After RFID Implementation
Lost Inventory	$3,874.00	0%	$0.00
Total BD&L Cost	$189,380.00		
Total BD&L Cost Saving			**$46,845.00**

RFID, by its nature, would require less handling of the inventory. Everything would be scanned when it arrives, and the floor tags would be scanned when the product is placed in the warehouse. This would lead to a reduction of labor and less time needed to fill the orders. The daily manual inventory would also be reduced. Implementing RFID should allow for a reduction in workforce of at least one person and, at minimum, eliminate at least 50% of overtime costs. Using an average rate for warehouse salaries of $36,000 per year, labor could be reduced by $50,040 per year. This does not take into consideration the savings in employer taxes and employee benefits. This would result in a 10% reduction of labor costs within the first year after implementation. Table 3-4 shows the per-week and per-year comparisons.

Table 3-4 Labor Cost

Labor Cost Structure	Per Week	Yearly
Labor Cost/Week	$9,000.00	$468,000.00
Per Employee Labor Cost (Total 13 Floor Employee)	$692.31	$36,000.00
Overtime Charges (6% of Total Labor Cost)	$540.00	$28,080.00
Labor Cost Saving After RFID Implementation (1 Less Worker Requirement)	$692.31	$36,000.00
Overtime Labor Savings (50%)	$270.00	$14,040.00
Total Labor Savings (Lean Savings)	**$962.31**	**$50,040.00**

Savings

Industry standard for inventory carrying costs is 20% or more of total inventory. RFID could provide the opportunity to reduce inventory by at least 20%. The reasoning behind this reduction is due to increased inventory knowledge. At any given time, the system can show exactly what products are in stock. This will lead to more efficient ordering processes from the warehouse to the supplier. The warehouse typically carries a baseline inventory of one million dollars. A 20% reduction of inventory results in an inventory balance of $800,000. The $200,000 inventory no longer carried will result in a $40,000 savings in inventory handling costs using a conservative 20% savings. Table 3-5 shows the reduction in inventory after RFID, and Table 3-6 gives the total savings of RFID.

Table 3-5 Inventory Handling Cost Saving

Inventory Cost Structure	**Current Inventory**	**Reduced Inventory after RFID (20%)**	**Inventory after RFID**
Baseline Inventory Daily	$1,000,000.00	$200,000.00	$800,000.00
Inventory Handling Cost	$200,000.00		$160,000.00
Inventory Handling Cost Savings		**$40,000.00**	

Table 3-6 Total Return on Investment (ROI) from Direct Savings

Steps of Savings	**Amount**
Total BD&L Cost Savings	$46,845.00
Total Labor Savings	$50,040.00
Inventory Handling Cost Savings	$40,000.00
Total Return on Investment	**$136,885.00**

If all the savings in year one are added together, the result is a cost savings of $136,885. The total cost to implement RFID would be $151,910. The chart in Figure 3-6 shows that the timeline for the ROI would be just over one year.

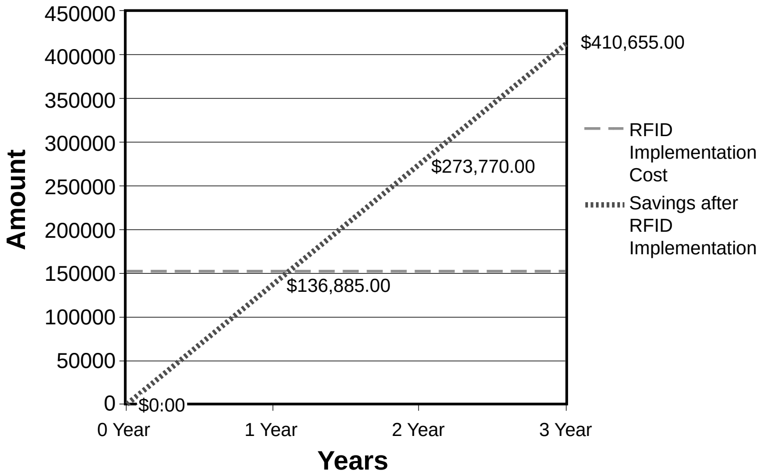

Figure 3-6 ROI chart

Indirect Cost Savings

Implementation of technology results in both direct (hard) and indirect (soft) cost savings. The RFID equipment will reduce the amount of time the office staff commits to daily inventory. It should also assist in reducing the amount of redundant paperwork that is in the system.

Future Recommendations

While the distributor should take the preceding recommendations currently, there are also steps they should look to in the future to help further improve their efficiency and product locating. First, the company should look at installing a rolling rack system. The gravity flow pallet rack is a storage system driven by gravity. The system will work particularly well with the FIFO system that the company employs. It will allow pallets to move through the warehouse on industrial shelves, which will give employees easier, faster access to products. There is an integrated braking system that slows the pallets to a stop so that they don't hit each other and ruin products.

The other recommendation is to implement RFID at the case level instead of the pallet level. This will allow the company to better track products, as pallets are often mixed with different products that the company offers. Currently, there is no way to actually tell which product is going out or coming in, but RFID at the pallet level is a great start.

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4

Transportation Management System (TMS)

TMS is a category of the Supply Chain Management (SCM) software. The TMS system responsibility is the routing of goods into and out of the enterprise. SCM is broken into two categories, Supply Chain Planning (SCP) and Supply Chain Execution (SCE). The TMS software is part of the SCE category. The execution portion of the supply chain requires action. This is appropriate for the TMS because its job is to move the product through the supply chain. TMS solutions can be bought as a solution within the ERP program or can be bought separately from a "Best of Breed" solution from an Independent Service Provider Vendor (ISV). The TMS approach represents the "Best of Breed" technique in which a company buys from the best-of-class software provider in the field. Real-time exchange of information or event management is essential in creating the world-class company and keeping that company ahead of the competition.

There are many ways to license the software. Some vendors offer the choice of various combinations of the licensing agreements. The four most common options are given here:

1. There's traditional purchase of the software and all modules. This works well when a company is in need of many different components of the software and requires payment for all the modules.
2. With the limited traditional model, payment is required for only the installed modules.
3. In the application service provider approach, the program is downloaded from the Internet or the vendor, which allows use as outlined in the traditional licensing agreement. The

difference here is that the software provider will take care of all maintenance and installation of software on their end. This works well when access to IT resources is limited.

4. The next form is the cloud. This is similar to software on-demand. In this format, no installation is necessary because the software is housed at the vendor's site. This format is the easiest and fastest way to implement the software solution with the least amount of IT involvement. The buyer is required to pay only for what is used and is permitted to download only a few modules from the application service provider.

Here is a partial list of some of the best-of-breed TMS vendors on the market today:

- UPS Logistics Roadnet
- Descartes Roadshow
- JDA Software Fleet Management (Manugistics)
- Supply Chain Intelligence's iSaaS and iSaaS GPS
- Red Prairie TMS
- Transworks in Fort Wayne, Indiana
- HighJump
- Oracle TMS Solution
- Microsoft Transportation Management
- HK Systems: TMS Software
- IBM Cognos software for Transportation
- SAP Transportation Management Solution

TMS usually "sits" between an ERP or legacy order processing and a warehouse/distribution module. A typical solution would include both inbound (procurement) and outbound (shipping) orders to be evaluated by the TMS for various routing solutions. After the best provider is selected, the solution can generate electronic load tendering and track/trace. This also allows for the capability of supporting freight audit and payment processes.

TMS has the potential for the greatest Green value since logistics are a large expense (sometimes the greatest) in distribution firms. TMS functions with metrics include the following:

- Order consolidation—freight cost is lower when shipments are larger and represent a savings of 2% to 6%.
- Increased utilization of fleet—fewer trucks traveling less, representing a savings of 8% to 30%.
- Most economical routing by order size (parcel, LTL, FTL, or pool)—lowers freight cost for a savings of 5% to 20%.
- Routing for multiple stops—mileage savings of 5% to 20%.
- Trend analysis—to capture changing events.
- Communication options—EDI, Web, or satellite.
- Carrier performance metrics—for carrier certification.
- Rate shopping—savings of 2% to 10%.

In-transit, visibility is one part of TMS that has a large impact on service levels and inventory with a KPI reporting function that will do the following:

- Increase service levels by .4%.
- Reduce inventory by 5% to 7%. Allocation of orders can be managed more efficiently, minimizing the bullwhip effect and allowing less variation in demand forecast.
- Reduce receiving time by 20%, allowing scheduling personnel for receipt.
- Utilize EDI 214 transaction from carriers to track to receipts, allowing accurate time to the hour of 90%.
- Prioritize each shipment by out-of-stocks, promotional goods, seasonal goods, and danger-level items.
- The effects of the TMS in inbound freight include the initial Lean inventory reduction of 5% × $206 million inventory = $10.3 million reduction. New inventory is at $196 million.

The benefits of TMS are as listed here:

- Freed-up cost of capital is .02 × $10.3 million inventory savings = $206,000.
- New turns are $931 million / $196 million = 4.78 turns.
- Lean reduction of carrying cost by 26.6% × $10.3 million for an additional $2.739 million savings.
- Average freight per ton is 12.0%.

- There are 538 routes per week with an average load of 33,000.
- Freight rate is 12%, but with a 4% discount in lieu of the TMS consolidation the new rate is 12 × 96% = 11.5% freight rate for LTL.
- Freight rate is 11.5% in lieu of consolidation, but rate shopping makes the new discount 6%.
- New freight rate is 11.5% × .94 = 10.8%.
- Yearly savings (51 weeks per year) is \$0.005 × 538 routes / week × 33,000 lbs. × 51 = \$4,527,270 savings in freight rate for consolidation.
- Yearly savings is \$0.007 × 538 × 33,000 × 51 = \$6,338,178.

The most economical routing will save in mileage and gasoline in the outbound fleet. There's a savings of 8.0% for inbound transportation:

- The fleet runs at 3.4 million gallons per year.
- The cost is approximately \$3.12 per gallon.
- Yearly savings is \$3.12 × 3.4 million gallons × .08 = \$848,640.

The Green Savings of the TMS includes the following:

- Damaged inventory cost represents .75% of \$10 million inventory = \$75,000.
- Obsolete inventory cost reduction is 9% of inventory reduction = \$900,000. This represents \$975,000 that would have been thrown away or put into a landfill.
- Transportation savings is 8% to 12% savings per year in miles driven for outbound transportation using the route optimization techniques. Note that 3.4 million gallons × .08 = 272,000 gallons of diesel reduction per year. I used the 8% to be conservative.

One of the primary determinants of carbon dioxide (CO_2) emission from mobile sources is the amount of carbon in the fuel. Carbon content varies, but typically average carbon content values are used to estimate CO_2 emissions.[1] Diesel carbon content per gallon is 2,778 grams. For all oil and oil products, the oxidation factor used is 0.99 (99% of the carbon in the fuel is eventually oxidized, while 1% remains unoxidized). To calculate the CO_2 emissions from a gallon of fuel, the carbon emissions are multiplied by the ratio of the molecular weight of CO_2 (m.w. 44) to the molecular weight of carbon (m.w.12): 44 / 12.

Finally, CO_2 emissions from a gallon of diesel are 2,778 grams × 0.99 × (44 / 12) = 10,084 grams = 10.1 kg/gallon = 22.2 pounds/gallon. The weight in pounds of gasoline to kg is 2.2 lbs. per kg. The fleet uses 3.4 million gallons per year. This equates to 22.2 pounds × 3.4 million gallons per year = 75.48 million pounds of CO_2 extracted into the atmosphere each year. This total of 37,740 tons of CO_2 was extracted into the air for the entire fleet per year. The route optimization techniques save 3,019 tons of CO_2 from being released into the atmosphere.(1)

Another Green Savings is wear and tear of the existing highway system. Assume that one five-axle tractor semitrailer has about the same effect on concrete pavement as 9,600 passenger cars (3.83 / .0004) = 9,600.(2) Pavement is designed for a 20-year life span but there can be severe degradations to the infrastructure with an increase in semi-truck traffic. Do it Best Corp. had 258 trucks on the road and they cut their mileage by 8%, saving the use of 19 trucks. Therefore, the Green Savings was 19 trucks × 9,600 cars × 5 days × 51 weeks = 46,512,000 reduction of cars on the road per year.(3)

The average car mileage per year in 2008 was 226 billion miles.(3) The average lifetime of the highway before resurfacing was 20 years.(3) The average mileage per year driven by a passenger car is 12,000.(4) The total reduction by the TMS is 12,000 miles per year × 46,512,000 reduced cars = 558,144,000,000 miles per year. The total number of miles driven on U.S. highways in 2008 was 2,973,509,000,000.(5) The reduction of total miles driven by the TMS program is 558,144,000,000 / 2,973,509,000,000. The TMS improvements program from a large distributor can reduce the total mileage on the highways by .09%.

This may not sound like a lot, but when added to the infrastructure cost it saves .09% of the wear and tear. Federal spending on infrastructure is dominated by transportation. Although capital spending on transportation infrastructure already exceeds $100 billion annually, studies from the Federal Highway Administration and the Federal Aviation Administration suggest that it would cost roughly $20 billion more per year to keep transportation services at current levels.(4)

The TMS savings in dollars to the infrastructure per year starts with the annual highway infrastructure cost of \$20,000,000,000.[4] The cost of auto traffic on new pavement is 38.5%[6] and the TMS alleviates this load by .09%. To be conservative, the weather—with changes in temperature, ice storms with de-icing, snow plowing, and heavy rains with flooding—would account for a large part of the infrastructure cost that is not included. This is a rough estimate but represents a view of the Green Savings of .09% × \$20,000,000,000 × 38.5% = \$6,930,000.

These numbers might not sound very large, but if all the merchants in the United States applied these changes, the benefits would definitely be green.

Most food in the United States travels an average of 1,500 miles from its point of origin to its point of consumption. It is typically transported in trucks that can each cause the same amount of roadway damage as 9,600 cars, according to American Association of State Highway and Transit Officials.[2] Pavement is designed for a 20-year life span but there can be severe degradation to the infrastructure with an increase in semi-truck traffic.[2] In 1994, U.S. residential vehicles and light trucks traveled 1,793 billion miles, as referenced in Figure 4-1.[7]

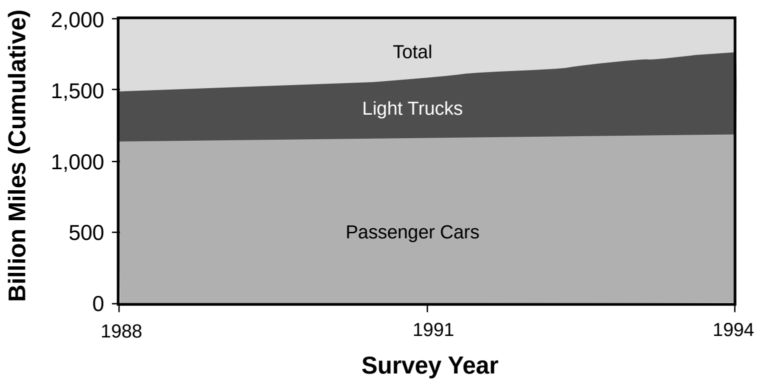

Figure 4-1 Residential vehicle miles traveled by type of vehicle

In January 2008, Americans drove a total of 226 billion miles.[3]

The graph in Figure 4-2 yields an average of 235,000 million miles per month = 2,820,000,000,000 miles per year. Figure 4-2 shows the average miles driven per month from 1970 to 2008.(8)

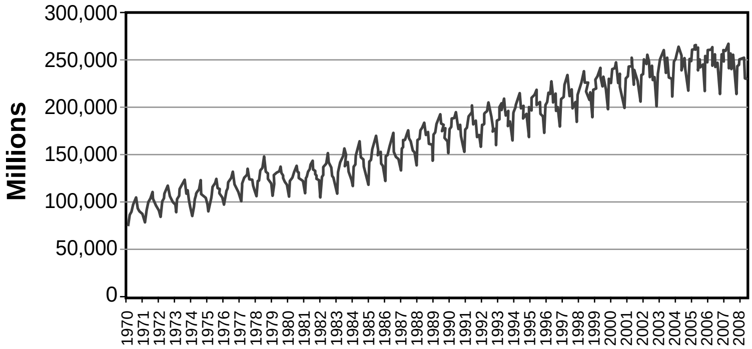

Figure 4-2 Historic monthly vehicle mileage driven per month

The number of miles driven per year is assumed to be 12,000 miles for every passenger vehicle.(9) Calculations from EPA's MOBILE6 model show an average annual mileage of roughly 10,500 miles per year for passenger cars and over 12,400 miles per year for light trucks across all vehicles in the fleet. However, these numbers include the oldest vehicles in the fleet (vehicles 25 years of age and older), which are likely not used as primary vehicles and are driven substantially less than newer vehicles. Since this calculation is for a typical vehicle including the oldest vehicles, it might not be appropriate. For all vehicles up to 10 years old, MOBILE6 shows an annual average mileage of close to 12,000 miles per year for passenger cars, and over 15,000 miles per year for light trucks.

FHWA's National Highway Statistics contains values of 11,766 miles for passenger cars and 11,140 miles for light trucks across the fleet. However, as with the MOBILE6 fleetwide estimates, these numbers include the oldest vehicles in the fleet. EPA's Commuter Model uses 1997 data from Oak Ridge Laboratories for the number of cars nationally and number of miles driven, which produces a value of just over 12,000 miles per year. Due to the wide range of estimates, 12,000 miles per vehicle is used as a rough estimate for calculating the greenhouse gas emissions from a typical passenger vehicle.(9)

Table 4-1 Miles from 1960 to 1999

	1960–1991							
	1960	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1991**
Air carrier, large certificated, domestic, all services	858	1,134	2,068	(R) 1,638	(R) 2,276	(R) 3,026	(R) 3,963	(R) 3,854
General aviation	1,769	2,562	3,207	4,238	5,204	4,673	4,548	4,400
Highway, total	718,763	887,811	1,109,724	1,327,664	1,527,295	1,774,827	2,144,362	2,172,050
Passenger car	587,012	722,696	916,700	1,033,950	1,111,596	1,246,798	1,408,266	1,358,185
Motorcycle	U	U	2,979	5,629	10,214	9,086	9,557	9,178
Other 2-axle 4-tire vehicle	U	U	123,286	200,700	290,935	390,961	574,571	649,394
Truck, single-unit 2-axle 6-tire or more	98,551	128,769	27,081	34,606	39,813	45,441	51,901	52,898
Truck, combination	28,854	31,665	35,134	46,724	68,678	78,063	94,341	96,645
Bus	4,346	4,681	4,544	6,055	6,059	4,478	5,726	5,750
Transit, total	2,143	2,008	1,883	2,176	2,287	2,791	3,242	3,306
Motor bus	1,576	1,528	1,409	1,526	1,677	1,863	2,130	2,167
Light rail	75	42	34	24	18	17	24	28
Heavy rail	391	395	407	423	385	451	537	527
Trolley bus	101	43	33	15	13	16	14	14
Commuter rail	N	N	N	173	179	183	213	215
Demand responsive	N	N	N	N	N	247	306	335

	1960–1991							
	1960	**1965**	**1970**	**1975**	**1980**	**1985**	**1990**	**1991**
Ferry boat	N	N	N	N	U	U	2	2
Other	N	N	N	15	15	15	16	19
Class I freight, train-miles	404	421	427	403	428	347	380	375
Class I freight, car-miles	28,170	29,336	29,890	27,656	29,277	24,920	26,159	25,628
Intercity/Amtrak, train-miles	209	172	93	30	30	30	33	34
Intercity/Amtrak, car-miles	2,208	1,775	690	253	235	251	301	313
Total train-miles	613	593	520	433	458	377	413	409
	1992–1999							
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Air carrier, large certificated, domestic, all services	(R) 3,995	(R) 4,156	(R) 4,378	(R) 4,628	(R) 4,807	(R) 4,907	(R) 5,030	(R) 5,326
General aviation	3,465	3,253	3,358	3,795	3,524	3,877	N	N
Highway, total	2,247,151	2,296,378	2,357,588	2,422,696	2,485,848	2,561,695	2,631,522	2,691,056
Passenger car	1,371,569	1,374,709	1,406,089	1,438,294	1,469,854	1,502,556	1,549,577	1,569,100
Motorcycle	9,557	9,906	10,240	9,797	9,920	10,081	10,283	10,584
Other 2-axle 4-tire vehicle	706,863	745,750	764,634	790,029	816,540	850,739	868,275	901,022
Truck, single-unit 2-axle 6-tire or more	53,874	56,772	61,284	62,705	64,072	66,893	68,021	70,304

Table 4-1 Miles from 1960 to 1999 (continued)

	1992–1999							
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Truck, combination	99,510	103,116	108,932	115,451	118,899	124,584	128,359	132,384
Bus	5,778	6,125	6,409	6,420	6,563	6,842	7,007	7,662
Transit, total	3,355	3,435	3,467	3,551	3,082	3,201	3,347	3,500
Motor bus	2,178	2,210	2,162	2,184	1,813	1,849	1,904	1,985
Light rail	29	28	34	35	37	41	43	48
Heavy rail	525	522	532	537	543	558	566	578
Trolley bus	14	13	14	14	14	14	14	14
Commuter rail	219	224	231	238	242	251	259	266
Demand responsive	364	406	464	507	363	410	469	494
Ferry boat	2	3	2	3	2	2	2	3
Other	24	30	29	34	68	77	90	112
Class I freight, train-miles	390	405	441	458	469	475	475	490
Class I freight, car-miles	26,128	26,883	28,485	30,383	31,715	31,660	32,657	33,851
Intercity/Amtrak, train-miles	34	35	34	32	30	32	33	34
Intercity/Amtrak, car-miles	307	303	304	292	276	288	312	342
Total train-miles	424	440	475	490	499	507	508	524

Table 4-2 Miles from 2000 to 2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Air carrier, large certificated, domestic, all services	(R) 5,662	(R) 5,545	(R) 5,615	(R) 6,106	(R) 6,602	(R) 6,716	(R) 6,605	(R) 6,733	6,446
General aviation	N	N	N	N	N	N	N	N	N
Highway, total	2,746,925	2,797,287	2,855,508	2,890,450	2,964,788	2,989,430	(R) 3,014,371	(R) 3,032,399	2,973,509
Passenger car	1,600,287	1,628,332	1,658,474	1,672,079	1,699,890	1,708,421	(R) 1,690,534	(R) 1,672,467	1,615,850
Motorcycle	10,469	9,639	9,552	9,577	10,122	10,454	(R) 12,049	(R) 13,621	14,484
Other 2-axle 4-tire vehicle	923,059	943,207	966,034	984,094	1,027,164	1,041,051	(R) 1,082,490	(R) 1,112,271	1,108,603
Truck, single-unit 2-axle 6-tire or more	70,500	72,448	75,866	77,757	78,441	78,496	(R) 80,344	(R) 82,014	83,951
Truck, combination	135,020	136,584	138,737	140,160	142,370	144,028	(R) 142,169	(R) 145,046	143,507
Bus	7,590	7,077	6,845	6,783	6,801	6,980	(R) 6,783	(R) 6,980	7,114
Transit, total	3,605	3,735	3,855	3,915	3,972	4,054	4,127	4,238	4,375
Motor bus	2,041	2,104	2,156	2,177	2,169	2,192	2,214	2,241	2,272
Light rail	52	54	61	64	67	69	74	84	88
Heavy rail	595	608	621	630	642	646	652	657	674
Trolley bus	15	13	14	14	13	13	12	11	12