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RFID:
RAPIDLY FALLING INDUSTRIAL DEMAND?

APRIL 21, 2004

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EXECUTIVE SUMMARY

Radio Frequency Identification (RFID) has been a very hot topic recently, due in large part to Wal-Mart's initial mandate that all major suppliers adopt the technology by January 2005 and Gillette's reported purchase of 500 million units. The technology has been proclaimed to "lead to an entirely new relationship between people and things."[1] According to one analyst, the world will need about one-half the warehouse space it needs today.[3] In this paper we introduce the technology and its potential implications. Although we find the technology compelling, we believe there are serious near-term challenges. Finally, we take a look at the impact the technology could have on the supply chain, the warehouse and future demand for industrial real estate.

- Radio Frequency Identification (RFID), or Automatic Identification Data Capture (AIDC), or "Smart Tags" are tags that contain identity information about a product (exactly like a bar code). These tags enable businesses to identify and track assets wirelessly.

- While bar codes serve an almost identical purpose, they require a direct line of light, rather than radio waves, and require a specific action to "read" the bar code. The primary advantages over existing bar code technology are that the data are collected continuously, at some distance from the actual product, with no direct line of sight and without labor. This allows for theoretical real-time visibility and tracking of assets and inventory throughout the supply chain.

- Promoters of RFID and related technologies describe a supply chain where all assets are in perfect visibility through production, distribution, retail and consumption.

- Although the technology has been in use for decades, and contrary to what providers of this technology have been touting to the press, there are significant near-term challenges to widespread adoption of the technology. Challenges include lack of standards, cost, data/infrastructure/systems implementation issues, data sharing and security. The largest impediment is the current performance of the technology, which some have pegged at 80% successful read rates.

- Although there are many obstacles, we believe the RFID value proposition is significant and that the technology will gain significant traction in the next three to five years and gain widespread adoption in the next five to ten years.

- The supply chain has become increasingly complex because of: globalization, outsourcing, Stock Keeping Unit (SKU) proliferation and shorter product life cycles. RFID will help companies cope with the ever-increasing complexities of the supply chain by speeding up many of the activities that are relatively inefficient (pick, pack, inventory counts, receiving, etc).

EXECUTIVE SUMMARY

- We anticipate that large-scale implementation of RFID will enable many types of firms to incrementally shift transportation to cheaper and more efficient modes.

- The central function of the warehouse is to store items and retrieve them efficiently.[15] RFID is most likely going to have a profound impact on how warehouses are configured to implement the technology and perform these primary tasks.

- An RFID-enabled warehouse of the future would enjoy much lower error rates; much less time and labor would be spent in quality control and order tracking. Key functions, such as pick and pack, and shipping and receiving, would require significantly less labor and marginally less space. Some of the operations, which are currently geared toward human interaction, can be redesigned and optimized. The RFID warehouse of the future may look totally chaotic, but in reality, there will be much more control, with products and processes moving much more quickly.

- The impact of RFID technology will have implications for facilities design:
  - Cross-docked warehouse facilities will grow to be even more important to many users as movements become increasingly time sensitive and inventory spends less time on shelves. While dock doors will continue to be important, they will become much more productive as trucks will spend significantly less time waiting for shipping and receiving operations.
  - Although clear height will eventually become less important (as goods will be stored for shorter periods and will need to be in easy-retrieval locations), it will allow for storage emergencies and will be deemed important for some time to come.
  - Warehouse finish may become slightly less important as there will be fewer jobs tracking and reconciling shipments and inventory. However, there will be more technology-related jobs as well as a need to store more hardware.
  - Column spacing will be more critical as the RFID warehouse will require multiple, simultaneous movements with more goods moving at a faster pace.
  - Trailer storage and truck parking will remain important. Although trucks will load and unload faster, there will be more frequent shipments and deliveries. Parking and storage will serve as a buffer zone for increased truck movements.

- RFID might enable warehouses to be smaller and located more centrally to population centers.[15] Locations near dense business and consumer hubs will become even more important because of the speed and agility the supply chain will demand. Rapidly moving and lean inventories require fast replenishment; distribution locations at the nexus of demand will be ever more valuable.

- We expect RFID to have a major impact on the costs associated with logistics and warehousing, but not on the cost of the actual facilities. We expect most savings to come from the optimization of time (labor), followed by a reduction in shrink (theft).

EXECUTIVE SUMMARY

- In attempting to understand the impact on demand, we conducted interviews with our tenants, other warehouse users and consultants. None of our interview subjects projected RFID ever having much, if any impact on future demand for space.

- To estimate the impact of RFID technologies on industrial real estate, we undertook an historical approach, analyzing the relationships between GDP, inventories and demand for industrial space. It is impossible to extrapolate any effect RFID might have on occupied stock, as the recent technological advances on which RFID is dependent have not had an historical discernible effect. Simply stated, while technological advances to date have improved inventory management processes, they have not diminished space requirements. As a result, we expect that the effect of broad-based RFID implementation on demand for space will be, on the order of magnitude, a few basis points.

- The quest for efficiency in the warehouse has been a long and fairly successful one, beginning with the advent of the interstate highway system, trucking deregulation and the rise of Internet applications. RFID is another tool which will make existing technology more efficient. It will have a large financial impact on the supply chain and the operations that are carried out in the warehouse. Eventually, the value proposition will make RFID a "must" for firms to remain competitive. While great cost savings, mainly in labor, shrink, accuracy and transportation will be realized across the supply chain, the impact on the macro demand for industrial real estate will be insignificant.

WHAT IS RFID?

INTRODUCTION

RFID has been a very hot topic recently, due in large part to Wal-Mart's initial mandate that all major suppliers adopt the technology by January 2005 and Gillette's reported purchase of 500 million units. The technology has been proclaimed to "lead to an entirely new relationship between people and things."[1] Others have said "we think it will be bigger than the Internet. All the Web did was connect computers to computers. That's not as big as connecting things to computers."[2] Promoters describe a supply chain, where all assets are in perfect visibility through production, distribution, retail and consumption. According to one analyst, the world will need about one-half the warehouse space it needs today.[3]

In this paper we introduce the technology and its potential implications. Although we find the technology compelling, we believe there are serious near-term challenges. Finally, we look at the impact the technology could have on the supply chain, the warehouse and future demand for industrial real estate.

WHAT IS RFID?

RFID, or Automatic Identification Data Capture (AIDC), or "Smart Tags" are tags that contain identity information about a product (similar to a bar code). These tags enable businesses to identify and track assets wirelessly. RFID tags typically consist of a very small silicon chip that is encoded with numbers known as an Electronic Product Code (EPC), that uniquely identify the product and potentially even the individual item (two boxes of identical soap could in fact have unique identification codes). This chip is also attached to a small antenna and the combination can be attached to a product, much like a small label. Radio frequency readers read the tag and identify the product. Bar codes serve an almost identical purpose; however, they require a direct line of light, rather than radio waves, and require a specific action to "read" the bar code. The primary advantages over existing bar code technology are that the data are collected continuously, at some distance from the actual product, with no direct line of sight and without labor. This allows for theoretical real-time visibility and tracking of assets and inventory throughout the supply chain. Tags come in various levels of "smartness" (data storage capabilities) and readers can locate tags from various distances. Low-frequency passive tags can be read from 1-2 feet away while higher-frequency passive tags, which cost about $0.30, can be read from about ten feet. Active tags contain batteries, allowing them to transmit their data over hundreds of feet. However, these tags are quite costly, ranging from a few dollars to several hundred dollars apiece in complex applications.

Railroads and automobile manufacturers experimented with bar codes in the 1960s and 1970s, in the identification of rail cars throughout the network and in automotive production. Both found bar codes were inadequate due to the obscuring of the labels from dirt and automotive production processes. The railroads switched to the use of RFID in the 1970s, tagging virtually every railcar in America. Readers were strategically positioned throughout the nation to track rail movements and provide the data for route planning of trains and cargo. General Motors first implemented RFID in its production process in 1984, and today, GM and most other automobile manufacturers depend on RFID for tracking automobiles and parts through production.

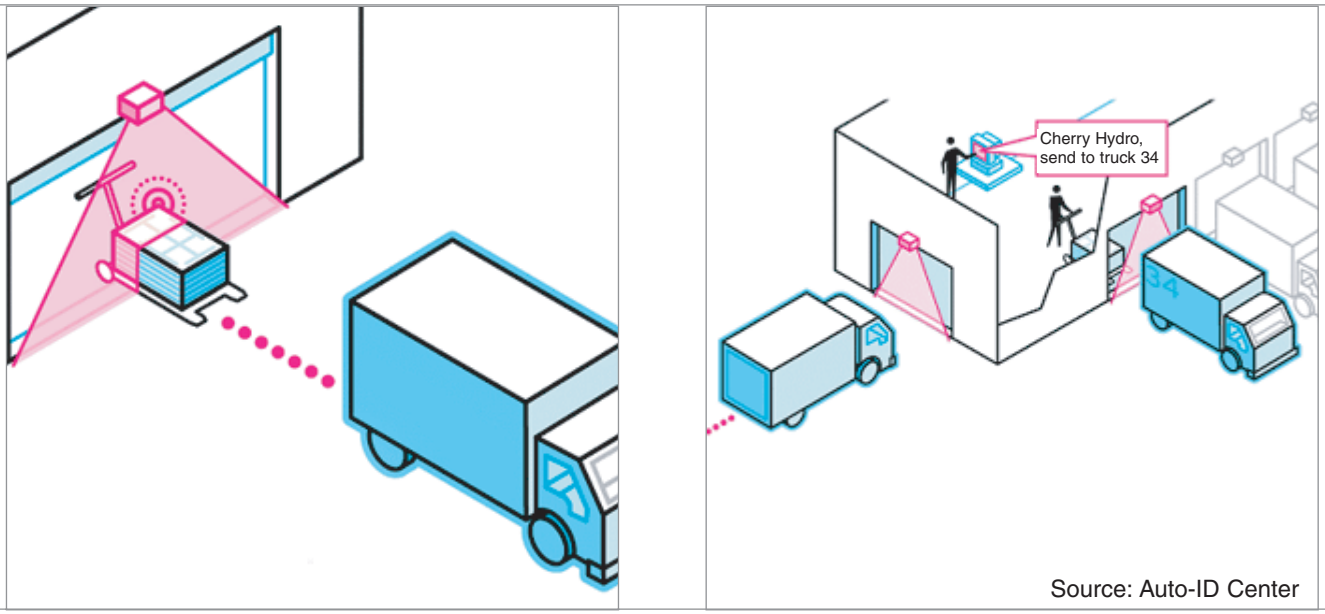
Current examples of RFID applications include toll systems like "EZ Pass" on the East Coast and "FasTrak" in the San Francisco Bay Area. Commercial versions include Sensormatic theft deterrent devices, attached to most items

THE VISION

in many retail stores and Exxon's "Speed Pass" concept introduced in the early 1990s. Most car keys today contain an RFID chip to prevent theft and many employees use a "SmartCard" to gain access to the office each day.

THE VISION

The vision is that tags and readers will become so inexpensive that nearly every product and subcomponent of products will be tagged throughout the entire supply chain. Imagine a can of soda leaving the factory on a pallet to a wholesaler or retailer as it comes off the production line. As the pallet leaves the factory, an RFID reader verifies that the truck is correctly loaded and software automatically generates an Advance Ship Notice (ASN), which is communicated to the customer.

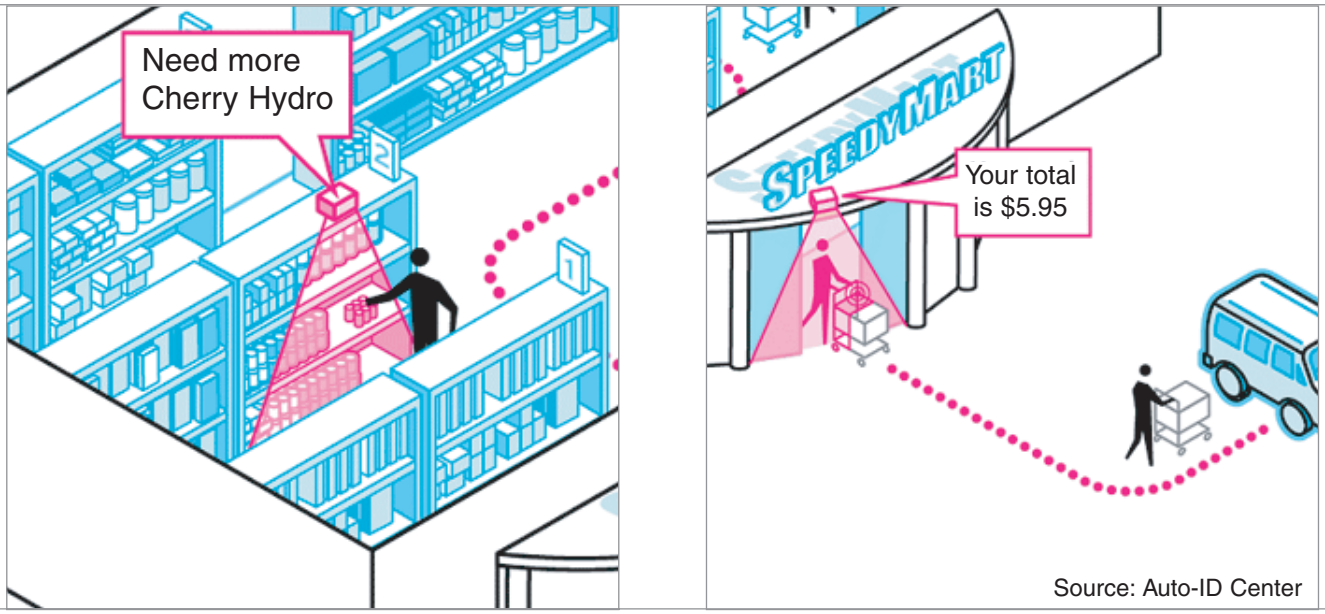


Source: Auto-ID Center

The truck is tracked en route with Global Positioning System (GPS) technology, providing live updates of location and delivery status to the customer. Upon arrival at the customer's distribution center (DC), the customer unloads the truck and the order is automatically verified and a receipt is sent to the manufacturer. Software then routes individual cases on the pallets to storage shelves and to trucks heading to individual stores. Each store's shipment is verified and recorded as it enters the truck, and again upon arrival at the store. The product is then routed to the stockroom and store shelves.

Readers inside the store notify personnel when product is running low on the shelves, or if product is sitting on the wrong shelf (phantom inventory).

THE REALITY (CHALLENGES)



The consumer, carrying a store smart card, enters the store, selects items for purchase and leaves. The consumer's credit card is automatically debited and a receipt is generated. The manufacturer and retailer share all of this information, which goes into plans for production and future deliveries. After consumption of the soda, the recycling plant identifies the soda can, and routes it to the appropriate location.

While sounding futuristic, some of what was just described is already in place at companies today, without the use of RFID. Collaborative Planning Forecasting and Replenishment (CPFR), Enterprise Resource Planning (ERP), Warehouse Management Systems (WMS) and Transportation Management Systems (TMS) currently allow companies to optimize forecasts, production, warehouse operations and transportation. What RFID will deliver is more frequent and less costly data reads into these existing systems, significantly enhancing their usefulness and productivity.

The goal of supply chain management is to have the right product at the right price in the right place at the right time.[4] Inventory is only necessary because of poor information.[18] RFID would provide faster, better and more accurate information into the system, allowing companies to further optimize resources.

THE REALITY (CHALLENGES)

Although the technology has been in use for decades, and contrary to what providers of this technology have been touting to the press, there are significant near-term challenges to widespread adoption of the technology.

There are currently no globally agreed-upon standards and there are literally dozens of manufacturers of tags and readers, utilizing multiple frequencies and specifications. Most readers are compatible with only a single manufacturer's tag; however, multifrequency or "agile" readers are beginning to emerge. It is difficult for most

THE REALITY (CHALLENGES)

companies to commit the significant resources required if they do not know if their suppliers and customers will be using a compatible technology. Another issue is in the global radio spectrum. Wal-Mart's initiative requires the use of a frequency that is restricted in power in much of Europe and prohibited from RFID use in Japan.[6] However, the Japanese government recently announced its intention to open a portion of the ultra-high-frequency spectrum for RFID use.[30] In addition, the FAA has only approved a few tags for use in air cargo, fearing interference with airplane operations; however, they are actively evaluating others. As learned from the implementation of bar codes and WIFI, standards and compatibility are crucial to widespread adoption and use. Although bar code standards encountered ten years of conflict before standardization agreement, we think RFID standards will happen much faster. The EPC Group formed from the Auto-ID center (4 universities and 90 member companies) and the Uniform Code Council (UCC) are making great progress in this endeavor today; however, there are still conflicts with other organizations, including the International Standards Organization (ISO) and the European version of the UCC, EAN International.[6]

The costs of the tags at $0.20-0.30 are still prohibitively high for use in most item-level applications. Some argue they might even be too high for many case-level applications. The cost of a $0.20 tag is trivial on a $500 pallet or a $20 case of goods; however, the cost of shipping a case is typically $0.30-$1.00, excluding transportation. RFID then adds 20-67% to the cost of distribution. It is unclear if it will take an equivalent amount out of distribution and shipping costs in an environment where logistics contracts are won on the basis of a penny.[7] However the cost of the tags and readers are expected to decrease dramatically in coming years. Gillette's purchase of 500 million tags is estimated at $0.10 per tag. Still, the cost will probably not be economically viable to most companies for two to four years.

Another question arises in the implementation of the tags and readers. Ideally, the tags are attached as early in the supply chain as possible. Tags come in several types including read-only, write-once-read-many and read-write. The lowest-cost tags are manufactured with their code embedded, or can be written to once. There is a logistical issue in ensuring that the tag is correctly applied to the right item at the right time. Tags that can have data written to them multiple times cost significantly more and still require the "programming" step somewhere in the supply chain. Readers now cost about $1,000, though the price is expected to halve over the coming years. In an environment of perfect visibility, readers would have to be ubiquitous throughout the supply chain. In reality, they will probably be located at dock doors and other strategic decision points and on forklifts, providing less than "perfect visibility" at all times. This limitation would be due to the cost of the readers and the massive amount of data that would be generated.

In addition to the cost and implementation of the actual RFID readers and tags, the most overlooked and possibly significant hindrance to the technology are other costs. Significant infrastructure investment is often needed in software and systems integration. To illustrate, a moderately sized distribution center could have 10,000 pallets and a million cases of products on hand. The installed readers interrogate and identify the RFID tags thousands of times each second. In a busy warehouse with case-level tagging and many readers installed, many billions of reads are generated each hour. In fact, in the perfect visibility scenario where all cases are identified in real time, there

THE REALITY (CHALLENGES)

could be 4 trillion reads an hour.[8] While software removes duplicate reads of product that has not changed location, the data generated at the case and pallet level alone is incredible. All of this RFID-generated information is useless without integration into the previously mentioned Enterprise Resource Planning Systems (ERP), Warehouse Management Systems (WMS) and Transportation Management Systems (TMS). In reality, it is these systems that utilize the RFID-generated data to make the warehouse more efficient. It is estimated that of the over 600,000 warehouses in the U.S., only 20,000 utilize a WMS.[9] This limits the opportunity to a subsection of the entire supply chain; however, it may also increase the demand for these important but costly systems. In addition, those companies that do have systems in place are currently heavily invested in bar code technology. AMR Research claims that the "lowly" bar code already keeps inventory accuracy at 98.5% and improving accuracy slightly does not justify cost.[10] The bar code and RFID will coexist for quite some time, before bar code technology is ultimately replaced.

The largest current obstacle is that the technology today in the lower-cost tags does not perform at a satisfactory level. Pilot programs have shown that errors such as misread and no-read occur too often. In pilot programs by sponsors of the Auto-ID Center, tags only had an 80% success rate in being identified.[11] In addition, the technology suffers from radio interference. In fact, the frequency mandated by Wal-Mart is the same one used by most cordless phones. Also, most chips have a range of four feet or less; those mandated by Wal-Mart have a maximum range of about ten feet, as Wal-Mart has 10-foot dock doors at most of its distribution centers.[11] Other shortcomings of the technology are evident in collision issues that occur and in the fact that the radio waves are absorbed by liquids (many consumer products) and reflected by metals. However, at least one vendor has made important strides in improving the accuracy of reads in products surrounded by liquids.

Another potential obstacle would be growth in the consumer backlash that RFID has encountered. Vocal privacy groups have emerged, demanding an end to the invasive technology (www.stoprfid.com). Numerous articles have also addressed privacy issues raising consumer awareness. Consumer protest prompted Benetton to cancel plans for implementing RFID tags on clothing labels. There is a risk that the backlash could accelerate; however, it is really an issue of educating the consumer. The tags can only be read from a few feet away from readers, so consumers cannot be tracked all over the world. In addition, most customers are already supplying retailers with their buying habits through affinity programs or simply with purchases by a credit card, which the retailers use for a "reverse lookup" with the credit card companies. The California legislature is currently holding hearings on RFID privacy concerns.

Finally, the sharing of data and security are potential obstacles. The RFID vision is dependent upon complete sharing of data across the supply chain. Very few companies are willing to do this today and that is unlikely to change. Security is also an issue, as companies will worry about their competitors' ability to monitor what they are producing and shipping.

IMPACT ON THE SUPPLY CHAIN

For many of these reasons, most companies using RFID at this point are doing so in pilot programs, attempting to prove a business case. The RFID readers and tags for most pilot programs currently cost between $1 million and $18 million.[9] Very few companies have been able to identify a sustainable value proposition in implementing the technology. Consider the June Wal-Mart mandate that required Wal-Mart's top 130 vendors to attach tags to all pallets and cases by January 2005: By October 2003, the mandate was effectively converted into a pilot program, requiring pallet-only tagging for product shipped to three distribution centers in Texas. At this time the plan still calls for full implementation by January 2006 (extended one year). Additionally, Wal-Mart's top 30 pharmaceutical suppliers need to be RFID compliant at the container level by March 2004. Tesco, the United Kingdom's largest retailer, is currently using the technology in many of their warehouses and has mandated that their suppliers tag cases and pallets by the fourth quarter of this year. In December, the Department of Defense scaled its mandate back to require its top 100 suppliers to be RFID-compliant, and expects all suppliers to comply by January 2006. The Department of Defense's mandate may actually occur faster and more smoothly than Wal-Mart's, as the Department of Defense has agreed to pay suppliers for including the technology, while Wal-Mart is expecting its suppliers to bear the entire burden as a cost of doing business with the company. It is estimated that this will cost Wal-Mart's top 125 vendors $500 million.[30] In February, as expected, Target mandated that all its suppliers too would need to be compliant, although Target's 2007 deadline is somewhat more conservative than Wal-Mart's.

IMPACT ON THE SUPPLY CHAIN

Although there are many obstacles, we believe the RFID value proposition is large and the technology will gain significant traction in the next three to five years and gain widespread use in the next five to ten years. Implementation will begin with consumer product companies and suppliers to Wal-Mart and the Department of Defense. Major retailers will adopt in unison. Smaller and regional retailers will come somewhat later, along with many manufacturers and third-party logistics (3PL) companies. Venture Development Corporation (VDC) estimates the 2002 market for readers and tags was $965 million, and estimates a 22.6% compound annual growth rate over the next five years ($2.7 billion by 2007).[12] Others estimate the market to be $15-30 billion by 2010.[13] The bottom line is the technology is coming, but we expect widespread adoption to take somewhat longer than many others are anticipating.

The supply chain has become increasingly complex because of:

- Globalization – more products and components of products are sourced from more countries than ever before, making the supply chain longer and more fragmented.

- Outsourcing – of an increasing number of components of the supply chain. From production to transportation to logistics, more entities than ever support the links between the sources of production and the sources of consumption.

- Stock Keeping Unit (SKU) Proliferation – innovations in the supply chain have not previously reduced the need for industrial space, as they have been more than offset by increases in new products and configurations. For example, the Mercedes E class can be ordered in 3.9 trillion unique configurations, each representing a unique SKU.[14]

IMPACT ON THE SUPPLY CHAIN

> Shorter Product Lifecycles – leading to less historical data on supply and demand and faster changes in product offer.[15]

RFID is now being implemented into the supply chain through the Smart and Secure Tradelanes initiative. This initiative is the largest cargo security program in operation, helping global shippers to automatically track the location and status of containers while creating a system to detect and report container tampering. RFID-enabled "smart and secure" containers are critically important to this initiative and have proven very successful in pilot tests. The initiative now involves implementation at 11 major ocean tradelanes worldwide and has grown to include 35 partners handling 70 percent of world trade. Given the success of the pilots, every sea container will someday be made "smart" with the help of RFID technology.

RFID will help companies cope with the ever-increasing complexities of the supply chain by accelerating many relatively inefficient activities (pick, pack, inventory counts, receiving, etc). AMR Research estimates early implementations have shown potential supply chain cost reductions of 3-5% and sales increases of 2-7%. They also point out the technology will not be economically viable for most companies until 2006.[16]

In retail, the savings will be most apparent, helping reduce shrink, out-of-stock losses and phantom inventory, while increasing inventory turns. Deloitte Consulting estimates that out-of-stock items alone cost supermarkets $6 billion in 2002.[17] Another estimate puts the out-of-stock loss for all retailers at 4% of sales each year.[15]

We anticipate that large-scale implementation of RFID will enable many types of firms to incrementally shift transportation to cheaper and more effective modes. RFID will enable earlier detection of problems in the supply chain and will lead to some modal shift.[15] Suppose in the production process that, for a variety of reasons, a good is running critically short. Without earlier detection, these goods might have been sent by air cargo; however, with earlier detection, time-definite trucking might suffice. However, this is not a new phenomenon; advances in the supply chain (e.g., TMS) have been facilitating a shift from domestic air cargo to trucking for many years.[19] We expect this trend will continue with better planning facilitated by RFID; however, we expect there will be virtually no effect on international air cargo as there is no viable transportation substitute. In fact, in an RFID-enabled supply chain, goods will need to move faster and will be much more time sensitive (a missed shipment could potentially shut down the entire system). This will result in increases in international air cargo, as the sea cargo alternative takes 30 to 60 times longer. Modal shift may also occur between trucking segments. RFID-enabled warehouses would be better equipped to consolidate shipments, leading to some modal shift from "less-than-truckload" (LTL) to "truck load" (TL).[15] By knowing more precisely what is arriving and departing, picking can be optimized for consolidation. This should occur on the fringe, as TMS's perform this service now. However, increased adoption of TMS's associated with widespread RFID use would lead to further modal shift.

The increasing complexities and speed required in an RFID-enabled supply chain will lead even more companies to contract out their logistics requirements. 3PL's business has grown by 15% per year over the last eight years and we expect it will continue to grow at a double-digit pace for the foreseeable future.[5]

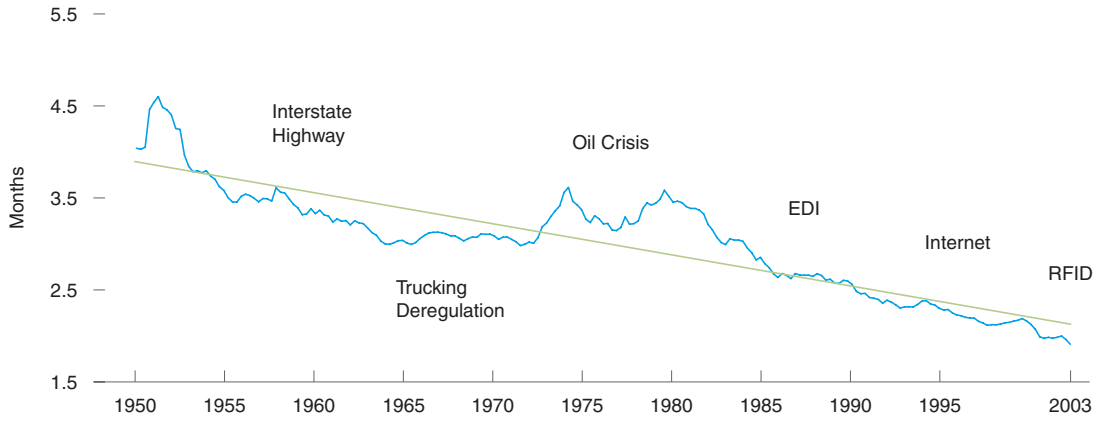
IMPACT ON THE WAREHOUSE

Widespread adoption of RFID will be integrated with further investment in Global Positioning Systems (GPS) combined with cellular technology. GPS transponders are relatively expensive at several hundred dollars apiece; however, they provide accurate positioning anywhere in the world. The value proposition will be even more meaningful when RFID is in use at the case or pallet level. While many trucks utilize this technology now, adoption will accelerate in line with RFID. Finally, widespread successful adoption of RFID will go hand in hand with further investment in the supporting systems, mainly WMS, TMS and/or ERP.

IMPACT ON THE WAREHOUSE

As indicated in the graphic below, inventories relative to sales have been contracting for 50 years, a trend that will continue as technology, such as RFID, allows companies to better utilize their resources. However, on an absolute basis, inventory continues to grow as our economy grows and becomes more complex. In fact between 1996 and today, inventories have grown by almost 20%, and in the 19 years leading up to 2002, total business inventories grew by 109%.[20]

PRIVATE INVENTORY TO FINAL SALES



The central function of the warehouse is to store items and retrieve them efficiently. RFID is most likely going to have a profound impact on how warehouses are configured to implement the technology and perform these primary tasks. For example, some of the key hindrances to productivity that occur in the warehouse are:

- Shipping – late orders, emergency shipments, transportation capacity, misplaced or mis-picked items.
- Transportation – delays, misrouted items, wrong drop-off or pick-up, pilferage and spoilage.
- Receiving – item shortages, wrong item, wrong quantities, wrong location or door, wrong put-away or data entry.

IMPACT ON THE WAREHOUSE

Shipping the perfect order is the goal of every DC. In reality, deliveries that are on time, free of damage, and that contain the correct quantities, products and documentation arrive to customers only 40-60% of the time.[21] It is apparent that the control and visibility offered by RFID implementation would significantly aid in alleviating many of the key hindrances outlined above, leading to higher-quality shipments and lower costs.

An RFID-enabled warehouse of the future would enjoy much lower error rates and much less time and labor would be spent in quality control and order tracking. Key functions, such as pick, pack, shipping and receiving, would require significantly less labor and marginally less space. Some of the operations, which are currently geared toward human interaction, can be redesigned and optimized. The RFID warehouse of the future will look totally chaotic, but in reality, there will be much more control, with everything moving much more quickly.[15]

One of the biggest savings will be in labor. IBM Business Consulting Services estimates that 50-80% of the cost for most DC operations is in labor. The bulk of this labor is devoted to picking (40-50%), receiving (20-30%) and shipping (15-25%). These three areas alone typically require 90% of a DC's human resources and all three of these areas would be greatly impacted by RFID. None of these items are going away; in fact, in an RFID-enabled warehouse, they become more important, more efficient, and occur more frequently. The push toward smaller, more frequent deliveries means picking is more important than ever. Full-pallet shipments are dwindling. IBM estimates that full-pallet shipments are 40-60% of total shipments for consumer-packaged goods and <5% for retailers. Case-level picking is fast becoming the method of necessity. RFID could direct the pickers to the appropriate location and verify items picked for accuracy. Then instead of moving the items to the staging area for verification, the items would be loaded directly on to a truck and verified once more. The result is far fewer errors at a much faster rate, with the virtual elimination of staging and verification. Another major use of labor is in inventory counts, which could be almost eliminated. IBM estimates labor savings of 10% for most RFID-enabled distribution centers; however, as labor is the largest expense, this represents 60-80% of the total savings RFID might offer.[21]

Another important area of savings will be in the reduction of theft or shrink, which cost retailers a record $31.3 billion last year. Only a third was the result of shoplifting. Nearly half was employee theft, about 5% was vendor theft and 15% was paperwork errors.[31] An RFID-enabled supply chain will dramatically reduce all these types of shrinkage and will benefit sectors other than retail as well.

We also expect that an RFID-enabled supply chain will allow companies to reduce and optimize the locations of safety stock, increasing capacity and turns.

Regarding warehouse characteristics, cross-docked facilities will grow to be even more important to many users as movements become more time sensitive and inventory spends less time on shelves. While dock doors will continue to be important, they will become much more productive as trucks will spend significantly less time waiting for shipping and receiving operations. Although clear height will eventually become less important (as goods will be

IMPACT ON THE WAREHOUSE

stored for shorter periods and will need to be in easy-retrieval locations), it will allow for storage emergencies and will be deemed important for some time to come. Finish might become slightly less important as there will be fewer desk jobs tracking and reconciling shipments and inventory. However, there will be more technology-related jobs as well as a need to store more hardware. Column spacing will be more critical as the RFID warehouse will appear highly chaotic with more goods moving at a faster pace. Trailer storage and truck parking will remain important. Although trucks will load and unload faster, there will be more frequent shipments and deliveries. Parking and storage will serve as a buffer zone for increased truck movements.

It has been surmised that RFID might enable warehouses to be smaller and more centrally located to population centers.[15] Locations near dense business and consumer hubs will become even more important because of the speed and agility the supply chain will demand. Fast and lean inventory requires fast replenishment, and locations nearer the center of demand will be ever more valuable.

IMPACT ON DEMAND

In the mid-eighties when bar code technology and Just In Time (JIT) delivery were introduced, much like today, the end of the warehouse was proclaimed. Since 1980, occupied industrial space has increased by 45%.[22] Inventory facilitates the matching of supply and demand. No matter how fast the supply chain operates, there will always be mismatches and disruptions, and safety stock will need to be maintained somewhere in the supply chain. Furthermore, the optimal location of this safety stock changes as networks (customers and suppliers) and business models change. Also, if production is optimized to enjoy economies of scale, it is unlikely to match demand at that point in time, leading to inventory. In fact, supply chain professionals calculate an "economic order quantity," to calculate the lowest total cost reorder quantity.[23]

Typically larger orders have lower unit costs, so it is the quantity-to-order where savings offset the added cost of carry. This "best-buy quantity" is calculated because it is oftentimes cheaper to store products than not. Firms hold inventory for two main reasons: to improve customer service and to reduce costs.[24]

For most businesses, demand is a random variable implying that all forecasts are essentially wrong, leading to the need for buffer inventories and/or speed and agility.[15] RFID will increase the speed and agility of the warehouse.

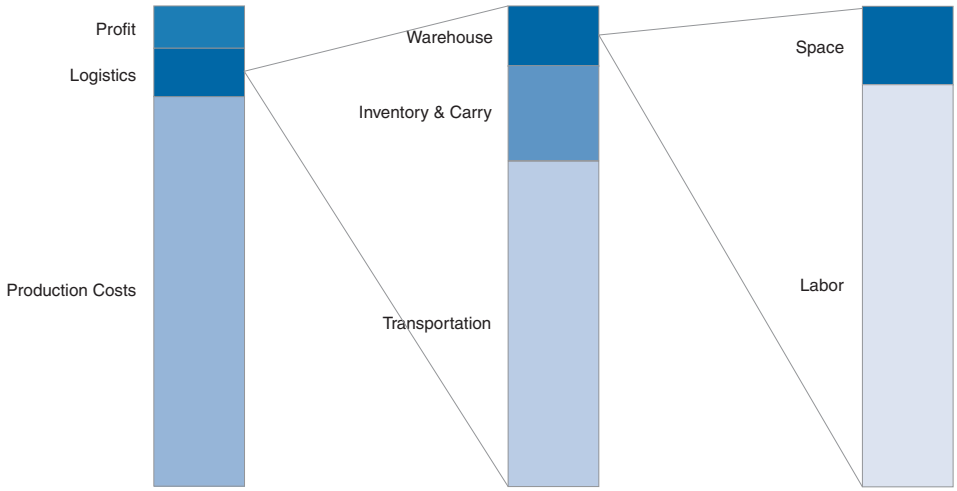
The operations to be performed at the warehouse are steadily increasing, while the product turnaround time experiences a big fall.[25] "Companies are now storing fewer products of each type but have more types of products to store. They require faster warehouses that can perform more operations. All this, together with the resulting expansion and complexity of the offer; means that storage becomes a bigger problem than ever."[26]

In the IBM study referenced earlier, case-level RFID tagging led to large reductions in labor costs and also a 20% reduction in inventory cost-of-carry.[21] However, reduced cost of carrying inventory does not translate directly into reduced demand for space. The cost-of-carry is the percent cost of maintaining $1 of inventory for one year, so as inventory moves faster (more turns), the cost-of-carry goes down. It can be calculated in a variety of ways, but oftentimes includes labor, rent and utilities, insurance and taxes, inventory counting, shrinkage and obsolescence, and the opportunity cost of the inventory investment.

IMPACT ON DEMAND

Just as warehouses are buffers for demand, they must retain some excess capacity for emergencies and new products or growth in lines of businesses. In fact, it is estimated that the space component (lighting, heating, rent or amortization, etc.) contributes only 1-3% to the overall cost of inventory, which translates to approximately 6% of the total cost-of-carry.[27] So a 20% reduction in cost-of-carry implies a straight-line deduction of 1.2% in the cost of space. However, this straight-line calculation is not appropriate and the impact on the demand of industrial space will be less.

MANUFACTURER/DISTRIBUTOR TYPICAL COST STRUCTURE



IBM estimates that space costs are 18% of the total costs associated with a DC. However DC costs are typically a fraction of a firm's overall logistics costs. In fact, logistics costs are 10-12% of the U.S. economy; however, costs associated with actual facilities are a fraction of this, about 2%.[29] Transportation is the largest component of logistics costs (80%) and as RFID enables more frequent trucking, the relative cost of the warehouse might decrease even further. Furthermore, as transportation is such a large component of the cost structure, savings in consolidation of shipments might actually require increases in inventory. Therefore, we expect RFID to have a major impact on the costs associated with logistics and warehousing, but not on the cost of the actual facilities. We expect most savings from the optimization of time. Space is fixed relative to time.

IMPACT ON DEMAND

Other obstacles RFID has in impacting industrial demand is that one-third of warehouse space is owner occupied; as assets become further amortized, the cost of holding excess space is only the opportunity cost of the capital. Additionally, the decision to lease space is done with a long-term business perspective and excess space is often inventoried for future growth and changing business needs. For example, one study recognizes the fact that RFID might lead to the elimination of staging and some product buffer zones. The study measures the benefit as a six-foot extension of shelf space across the entire front side of the warehouse.[15] The actual cost to relocate is large relative to rent on a small differential of space.

In its recent paper, Property & Portfolio Research (PPR) attempts to quantify the impact of RFID on the demand for industrial real estate.[28] Its analysis is based upon the fact that real GDP and occupied warehouse space have been highly correlated until about 1997, when occupied space began to trail GDP growth. In speaking with the authors, they explained that the disconnect was caused because fewer storage items are now produced in the U.S., the widespread use of super-regional distribution markets (hubs) and JIT inventories. These factors lead to the need for less storage. Extrapolating from this trend, the authors estimate that RFID could potentially lead to a reduction of up to 5% in demand. The authors admit this estimate is most likely far too high. Also, when analyzing a new technology, it is risky to extrapolate the long-term effects using short-term trends. Furthermore, we could not replicate with other data sources the reported disconnect in occupied space and GDP from which they were extrapolated. In fact the period of reportedly disconnected demand from GDP actually showed higher correlation than average for occupied industrial and warehouse space over the identified period (1997-2000). This seems more consistent with our experience of record levels of industrial demand during the late nineties, a period of high economic growth.

The qualitative portion of our research included numerous interviews with our tenants, other warehouse users and consultants. No interview subject projected RFID ever having much, if any, impact on future demand for space.

We also undertook an historical approach, analyzing the relationships between GDP, inventories and demand for industrial space. Interestingly, occupied space was found to have a causal effect on inventories. This makes intuitive sense, because if you plan to significantly increase inventory, you need someplace to put it, and will lease/acquire space before acquiring inventory. This is also good news for the industrial real estate business as inventories now stand at record low levels relative to GDP, and sales and inventories entered their cyclical rebuilding phase in recent months, absorbing underutilized space. The next decision will be to occupy more space, as inventories continue to build.

In our analysis, we attempted to isolate and explain deviations of inventory to GDP and to occupied stock. Over the last 19 years of quarterly data, deviations were small and trends reverted to the mean. Occupied stock has actually grown faster than real inventories, as some stock probably was considered obsolete. It is impossible to extrapolate any effect RFID might have on occupied stock, as the recent technological advances on which RFID is dependent have not had an historical discernible effect. Therefore, we surmise that the effect will be on the order

IMPACT ON DEMAND

of magnitude of basis points. However, during peak adoption years, when additional planning/management systems are brought on line, that effect might spike higher, though likely less than 100 bps. Obviously, changes in the supply chain will affect different locations and buildings differently. It will likely accelerate the obsolescence of buildings designed for long-term storage and increase the demand for locations that strategically fit the "need for speed."[18]

CONCLUSION

Inventories will continue to grow, fueled by globalization (world trade is growing two times world GDP), mass customization, SKU proliferation, packaging, label and product postponement, outsourcing, shorter product lifecycles and increased complexities of the supply chain and the world economy. The quest for efficiency in the warehouse has been a long and fairly successful one, and RFID is another tool to make existing technology more efficient. RFID will have a large financial impact on the supply chain and the operations that are carried out in the warehouse. Eventually the value proposition will make RFID a must for firms to remain competitive. While great cost savings, mainly in labor, shrink, accuracy and transportation will be realized across the supply chain, the impact on the macro demand for industrial real estate will be insignificant. However, the impact will be larger on functionally or locationally obsolete buildings, which will become even less valuable in the supply chain.

Is RFID the next "killer app"? The answer is yes. In a short time we will be connecting many of the world's objects electronically. In the spirit of recent hyped headlines, we leave you with one of our own: "RFID: Uniting the three dimensions of space with the fourth dimension of time."

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