E-fulfillment: the strategy and operational requirements

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Keywords

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Abstract

An e-fulfillment system is designed to meet the high order volume and stringent customer service requirements of global business-to-consumer e-commerce. The system converts the traditional warehouse into a multi-channel e-fulfillment center. In the e-commerce environment, some of the toughest decisions must be made on little or no hard information. In this study, the nature of e-business and the typical fulfillment process are discussed. The authors further examine the strategy and operational requirements for e-fulfillment. This article is concluded with the implication of a successful e-fulfillment system, a suggested design of an e-fulfillment center, and the future research focuses.

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Introduction

Most people have become familiar with e-commerce and the Internet by acting as shoppers in a retail store. They look at what is available, place an order, and wait for the merchandise to arrive. What they do not appreciate is the miraculous chain of events they have triggered. The order goes to the fulfillment operation, the distributor, the manufacturer, or a combination of the above. It is then picked, packed, handed to a shipper, and delivered to the customer. Most of this process is accomplished seemingly and expeditiously. The consumer who ordered quickly expects delivery in the same way. As a result, when the merchandise is not there, a customer who will not return or a lost sale has just been created. This phenomenon is placing increased pressure on managing demand and planning up and down the supply chain.

The average consumer today still prefers to place orders over the phone or use traditional shopping methods rather than placing orders online, although he or she may be a regular Internet user and may have found the product on a Web site (Sullivan, 2001; Jorgensen, 1999). Eventually, the Internet is likely to become the primary channel of order placement despite the initial struggle for survival by the Internet retailers. Success of surviving Internet retailers depends upon identifying factors attributed to the demise of many of their own and solving those problems as efficiently as possible. According to Harrington (2000), several factors leading to the failure are identified:

- significant start-up cost combined with slow growth in sales, unprofitable sales and high customer acquisition costs;
- inability to meet or exceed customer expectations in fulfillment, value or service; and
- failure to retain existing customers and attract new customers.

Developing true, end-to-end electronic order processing and fulfillment involves as much planning as does the establishment of classic catalog or mail order operations. True e-commerce capability involves becoming fully automated, with the exception of customer service tasks, from order receipt to picking, packing, shipment, and customer profile updating (Cunningham, 1999).

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An e-fulfillment system is designed to meet the high order volume and stringent customer service requirements of global business-to-consumer e-commerce. The system converts the traditional warehouse into a multi-channel e-fulfillment center. In this dynamic environment, product and information are highly synchronized to achieve unprecedented levels of customer service. Some of the toughest decisions must be made on little or no hard information. For example, what will be the demand for their products via the Web? How much volume should the facility be designed to handle? Making these types of judgments greatly affects the choice of materials handling systems.

Online shopping seems to be heading toward the 20 percent of consumer goods volume that many forecasters predict will be achieved by 2005 (Rasmusson, 1999; Henzler, 2000; Capell and Dawley, 2000). In many respects the final mail-order fulfillment and delivery did not live up to expectations. Many of the hiccups can be corrected with better management, disciplined operations, and appropriate use of technology. However, the final mile has more serious problems than getting the right merchandise delivered on time. The reality of the final mile as it exists today is that it is costly and inefficient. Fulfillment center designs are labor intensive, driving costs up. They share the common attributes of piece picking and packaging. According to St Onge (2000), "the functions of picking, packing, and line replenishment range from 40 to 50 percent of the annual costs of operating fulfillment centers". Significantly reduced labor content is exactly what is needed to rein in fulfillment center costs.

Furthermore, forecasting, planning, and replenishment have been the key to the success of most good companies in the past (Fosnaught, 1999; Jain, 2001; Cooke, 2000; Helms *et al.*, 2000; Reeder and Rowell, 2001). In fact, without an effective planning system in the middle, a company can go out of business quicker than it got into business in the world of e-commerce. A proper synchronization of the front end, back end and middle end is the key for survival and success of an e-commerce company. Reputation of e-commerce companies in both the business-to-customer (B2C) and business-to-business (B2B) worlds are made (or broken) on their ability (or inability) to get it right for the customer the first time (Morrell, 2000).

In this study, the nature of e-business and the typical fulfillment process are discussed. The authors further examine the strategy and operational requirements for e-fulfillment. This article is concluded with the implication of a successful e-fulfillment system, a suggested design of an e-fulfillment center, and the future research focuses.

Nature of e-business

Why would fulfilling orders placed over the Internet (e-fulfillment) be different from fulfilling orders placed any other way? Actually, there are quite a few reasons. First of all, since anyone sitting with a computer connected to the Internet is a potential customer, the customer base is huge and so does the unpredictability in demand. Second, fulfilling individual customers" demand (B2C), for example a thousand items sent to different customers, is more time consuming than sending same number of items to a single business (B2B distribution). A single error in information processing or in the e-fulfillment process is enough to jeopardize a timely delivery. Even though the fulfillment process for e-retailers does not differ much from traditional brick-and-mortar retailers since typical warehouse components like conveyors, bar codes, sorting systems, warehouse management systems (WMS), etc. are used in both kinds of businesses, the key is to understand the nature of e-business and respond to the consumer need with a flexible, mostly automatic and efficient fulfillment system combined with a prompt and cost effective delivery system. As the primary source, customer and demand separate an e-business from a brick-and-mortar business. The characteristics of customer and demand and their implications are listed below:

(1) *Customer characteristics:*
- The customer base is broad.
- Previously reluctant customers can now enjoy convenient shopping from home or office.
- Customer expects competitive price, quality products and fastest delivery.
- Highly sensitive customers (due to the availability of multiple vendors offering same products and services at a competitive price). Unlike the

process of choosing an alternate brick-and-mortar retailers, the Web allows the customer just to move to a different Web site with the click of a mouse.

(2) *Demand characteristics:*
- Higher number of order transactions.
- Order sizes tend to be small, one or just a few stock-keeping units (SKUs) per order.
- High probability of significant fluctuation in customer demand.
- Seasonality in customer demand.

(3) *Implication of customer and demand nature:*
- E-retailers need secure Web sites for exchange of sensitive information.
- The broad customer base combined with high probability of demand fluctuation makes seasonality factor in demand forecast more unpredictable.
- The broad customer base makes it harder for e-retailers to ship product quickly.
- Since most e-customers do not see and feel their products before purchasing, the probability that the customer will return a product becomes higher than the traditional purchasing process where the customer could see and feel the product before making his or her purchasing decision.
- Higher number of small size vehicles and/or third party logistic (3PL) partners are required to support delivery of small order sizes to a demographically dispersed customer base.
- E-retailers experience more picks and valleys than traditional businesses.

E-fulfillment process

A series of coordinated steps are required to bridge the gap between a customer browsing an e-commerce site and actually purchasing and receiving an ordered product. The site needs to be user friendly and be able to communicate with the customer which products are available for sale. Customers must be able to shop, select from the offered products and place an order in a secure Web environment. This order is then transmitted to the fulfiller or fulfillers, who assume responsibility for delivering the goods to the customer. Finally, the site and fulfiller jointly handle any post-purchase activity such as returns or exchanges, and perform transaction reconciliation.

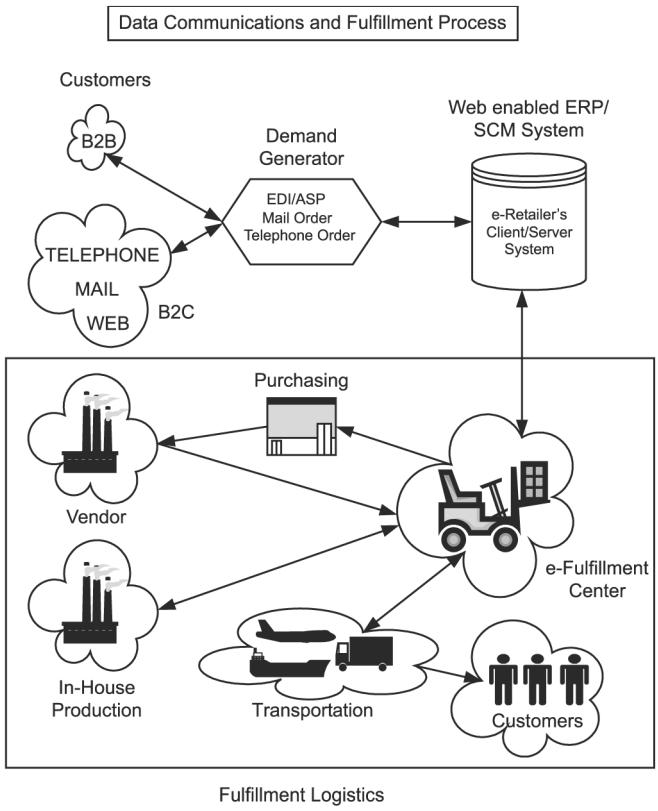
After an order has been captured and transmitted, there is still much work to be done. The fulfillment center undergoes a series of steps to process the order. It allocates inventory for the requested order items. Work orders for picking and packaging are issued, charge to the customer's credit card is made and finally, the products are shipped to the customer's shipping address. If some of the items requested by a customer are not available, the customer's order is placed on hold (backorder), until the fulfiller's inventory is replenished with new stock from its suppliers. During these steps, the buyer must be kept informed as to his or her order status. The buyer should be able to go to the site and bring up the order history and request a real-time order-status query.

As previously mentioned, the physical components of an e-fulfillment process are similar to a traditional fulfillment process. However, latest technology needs to be adopted in picking, packing and shipment along with sound operational and information systems procedures to support the unique nature of e-business because there is a big difference between providing boxes of goods to its retail stores and fulfilling individual order online (Krueger, 2000). The business process and data communication leading to fulfillment logistics in Figure 1 illustrates the importance of real-time communication among customers, suppliers, 3PL partners for transportation and e-retailers.

E-fulfillment strategy

The precondition for an effective strategy formulation is a through understanding of the problems or challenges. First and foremost we need to understand that the traditional distribution systems established for retailers are not designed to accommodate the needs of individual customers with variety of small orders. The order fulfillment from a distribution center is where the limits of the physical world meet the promise of the virtual world. Successful strategies are multi-layered and full of many decision points. Principles that drive e-commerce success are: high velocity; flexible systems and procedures; extremely high service levels; and full

Figure 1 Data communications among e-business partners



electronic connections to the trading community (Forger, 2000; Draenos, 2000; Feare, 2002). According to Feare (2002), five points must be addressed in order to develop the right strategy. They are the viability of outsourcing order fulfillment, the applicability of the catalog fulfillment experience, the value of real-time information systems, the role of planning, and the reverse logistics issue. In addition, learning from competitors, planning for demand and not shying away from the returns issue will be the key to success (Ba *et al.*, 1999; Thompson, 2001; DeTienne and Jackson, 2001).

Accordingly, the major challenges in prompt delivery, supply chain, demand nature, reverse logistics, and accuracy are identified. We then proceed with possible strategy formulation that can be taken to overcome these challenges.

Prompt delivery

Challenge

The first major challenge faced by e-retailers was high expectations for prompt delivery of Web orders by customers (Krueger, 2000).

In the beginning, it was all about the Web site. How did it look? Was it easy to navigate? Could customers buy things easily? And expectations were high. If a customer placed an order at 8.00 a.m., he or she fully expected it to be filled within minutes. That was the first major disconnection between some e-commerce companies and their customers. People actually thought that life in the warehouse was on the same speed setting as the Web site they visited. It was too late for some e-commerce companies before they realized that too much emphasis had been put on marketing Web sites along with promoting Web shopping and not enough emphasis on establishing required backend operations. Receiving orders is easy, compared to satisfying customers with on time delivery of right products. As Krueger (2000) points out: "What good is a well-designed Web site if it can't deliver the goods?".

But exactly how any of the companies" products are distributed varies almost as much as the companies themselves. A single distribution model does not suit all, nor is the model that a company starts with necessarily the same one it will have next year or the year after that. The Web is young enough that there are no real rules, and the trends that do exist are constantly evolving. In order to fulfill customer orders, some e-commerce companies rely on 3PL providers to fill the orders collected at the Web site. For some companies, this is only a temporary arrangement and they fully expect to run their own warehouses in time. Others plan to make this a permanent arrangement. Regardless of whether they purchase automated solutions or turn to a third party, companies can expect that, at least for the next few years, their focus will be on tightening up their fulfillment systems.

Strategy

One of several delivery options such as, express (next day), priority (three to four days) and regular (five to ten days) may be selected and paid for by the customer while ordering the product. One or several reliable 3PL partners may be chosen to handle product delivery to customers. Even for some products it may be economical to have supplier directly ship the product to the customer via chosen shipping method. However, without reliable 3PL partners e-commerce companies get into bigger problems. They outsource the work but keep the responsibilities (Frieswick, 2000). A Web-/telephone-based tracking system should allow

customers real-time tracking of their ordered products.

Supply chain

Challenge

Ensuring supply of required amount of raw materials and products at the right time for the right price as well as proper slotting and picking methods are as important as having a customer centric Web site.

From L.L. Bean to Victoria's Secret, companies have pioneered paths to successful distribution direct to consumers. The only front-end difference is in electronic order receipt rather than in taking orders by phone, mail or fax. In e-commerce, suppliers must be able to provide quality products and materials at all time. Inbound goods will be staged and cross-docked in the fulfillment center as much as possible. Incoming SKUs will be slotted into areas for the most efficient picking methods. Moreover, picking will have to be automatic and paperless as much as possible. A warehouse management system (WMS) compatible to be a part of the SCM will be necessary to oversee these activities and others such as order sorting, packing, and final bar coding for shipment. Some WMS suppliers already tailor their systems so they are pre-configured for e-commerce.

Strategy

E-retailers need to team up with reliable supply-chain partners with the support of a back end supply-chain management systems. Proper slotting and picking methods based on the size, weight and demand nature must be devised to receive, slot, pick and pack properly.

Demand nature

Challenge

Uncertain demand nature of products sold on the Web added another dimension to the challenges we already discussed.

Successful e-retailing enterprises will have to create the agility and scalability so that they can ramp up to meet unpredictable demand. A news-worthy event can create a huge demand for a product overnight. Seasonality factor also contributes to the unpredictability of the demand nature. Online book that finally got fat off a major book launch when the number of pre-ordered copies of *Harry Potter and the Goblet of Fire* dwarfed all previous records. Nearly 400,000 orders have been placed at Amazon, the largest number of books pre-ordered in the site's history. BarnesandNoble.com also set a site record with more than 80,000 consumers pre-ordering the book (Hein, 2000).

Strategy

Popular featured items and specials may need to be pre-packed or otherwise prepared in advance for high demand to avoid processing delays. For example, a best selling book might come from the publishing house already wrapped for shipment. Then batch picking and automated sorting bring all the ordered copies of the book to shipping, where a bar code label is applied to each customer order. Proper use of seasonality factors in forecasting models may contribute to better demand forecasting for highly unpredictable items.

Reverse logistics

Challenge

In any retail business, some products are returned from the point of consumption. Therefore, the challenge is setting up infrastructure and procedures for reverse logistics.

Reverse logistics is a process in which a producer, supplier or retailer systematically accepts previously shipped products or parts from the point of consumption for possible resale, recycling, remanufacturing or disposal (Dowlatshahi, 2000). The process is not only inevitable but also gaining importance as a viable, sustainable and profitable business strategy (Dowlatshahi, 2000). Procedures need to be established for returning orders. Drop-off points must also be set up. A customer wanting to return merchandise should be encouraged to have authorization to do so through the Web site. This step should then advise the returns operation to expect the incoming item and plan for its restocking and resale. Existing retailers have a big edge with their stores, which can serve as drop-offs. In Japan, e-retailers without their own retail outlets use local convenience stores for this purpose.

Strategy

Need to have an understandable product return policy on the Web. A copy of the same policy may also be included in the shipped package. A customer must identify the reason for returning the item. Based on the reason, one of several actions such as, restock, recycle, remanufacture, send back to the supplier may

be taken. A flexible sorting or packaging line in the warehouse may be used to handle returned items when needed. Retailers without sufficient retail outlets may follow Japanese model and use convenience and or other stores as drop-off points.

Accuracy

Challenge

Accuracy is the backbone of repeat business, which is put at the core of any e-fulfillment strategies.

A motto in e-commerce today is "meeting customer expectations". Reputations of e-commerce companies are made on their ability to get it right for the customer at the first time. All it takes is one error between receiving, storage, picking, and shipping to blemish perfection. You go for 100 percent and hope that you get 99.9 percent. Fortunately, the tools exist to give e-commerce companies a running start.

Strategy

To achieve high levels of accuracy means the firm has to make a significant investment in materials handling hardware and information systems. What is considered the right equipment to increase accuracy will vary with the company, the nature of its operation, and the level of adjustment that managers are willing to make to minimize human errors. Just as automation alone cannot promise a completely error-free operation, none of the steps described above can ensure 100 percent accuracy and customer satisfaction once and for all. But if companies gather and analyze warehouse performance statistics regularly, invest in automated data collection and verification systems and equipment to the extent possible, create efficient picking procedures, and train all employees thoroughly, they are virtually guaranteed to improve accuracy and streamline the fulfillment process, no matter what the product is or how exotic the locations to which it is shipped (Huduck, 1998).

At any time, an e-commerce company has to look at its total channel costs, not just the cost of picking that order or cost of the order. For a company setting up a balanced scorecard, a critical factor is choosing the right metrics that reflect competitive factors affecting the business. The key performance indicators (KPIs) should measure how much the company is able to reduce operating expenses, e.g. warehousing and distribution expenses and how well the customer is being served by the organization. Order fulfillment rate, accuracy of order fulfillment and cost per order fulfillment are among important indicators need to be evaluated routinely.

Operational requirements for e-fulfillment

The materials handling tools available to any Web house are the same ones used in warehouses that fill orders outside the e-commerce world such as lift trucks, storage, picking, containers, conveyors, sortation, packaging, docks, data capture and WMS software. Due to the fact that B2C e-fulfillment is mostly about each individual item, e-fulfillment operations have their own needs. As a result, materials handling equipment, automatic data capture hardware, and supply chain software get a different work out. Speed and accuracy are the key factors in e-fulfillment in order to attract and retain so called e-customers. Ways to achieve efficiency are by applying automation, increasing process integration and providing appropriate training. However, companies look toward automation for not only to increase the delivery speed to the customer but also to reduce distribution cost in the long run. For the benefit of automation in the context of fulfillment process, Richardson (2001) states: "Automation is reducing direct labor content, reducing errors, increasing production and fulfillment rates, and helping distribution/fulfillment centers become an efficient process adding to the overall profitability of the company".

According to the nature of e-business, three key operational areas are identified for e-fulfillment:

(1) fulfillment center;
(2) infostructure; and
(3) handling returns (reverse logistics).

It is important to note that the fulfillment center and infostructure must be supported by a robust WMS. A more comprehensive system consisting of WMS, enterprise resource planning (ERP) and supply chain management (SCM) system along with the ability to track shipped product on 3PL partners" systems would provide real-time information to all parties involved. In this article, this comprehensive system is referred

as the infostructure of an e-retailer. The requirements of the three operational areas for an efficient e-fulfillment center are assessed as follows.

Fulfillment center

An e-fulfillment operation including e-fulfillment processes and their components consists of slotting (storage), picking, sorting, packaging and delivery processes.

Storage

Storage and staging equipment requirements for an e-commerce firm will be dictated partly by the physical characteristics such as the dimensions and weight of items warehoused. Some storage for e-commerce is in unit loads in pallet rack, particularly on the inbound side of distribution. But far fewer outbound items leave as unit loads compared to traditional distribution to retail stores. Some greater degree of storage of smaller items and cases in static shelving and carton flow rack are necessary.

An effective slotting mechanism is pre-requisite to an efficient picking process. Slotting goods properly into warehouse locations in the staging equipment selected need to be done so that not only can fast movers be picked quickly, but also the process will improve throughput, labor and space utilization. With piece picking predominating, certainly so in direct-to-consumer e-fulfillment operations, there are opportunities to invest in systems that not only store small items but make the associated order filling process far easier. Saenz (2001) proposes 80/20 rule in developing storage strategy in which "the most active items (the top 20 percent of products, representing 80 percent of the throughput) are placed at the middle picking level to improve picker productivity and reduce the risk of injury". As shown in Figure 2, three zones for fast, medium and slow moving items can be created and different slotting/picking strategy and physical systems suitable for these groups of items can be used. With swift deliveries to customers a high priority, e-commerce companies will want to stress staging of inbound palletized loads as much as possible, rather than storage. Paring stocking levels to the bare minimum may work in more traditional warehousing. But with all the demand uncertainties of Internet order volumes and seasonal peaks, erring on the side of having more supply may be the wisest course.

Picking

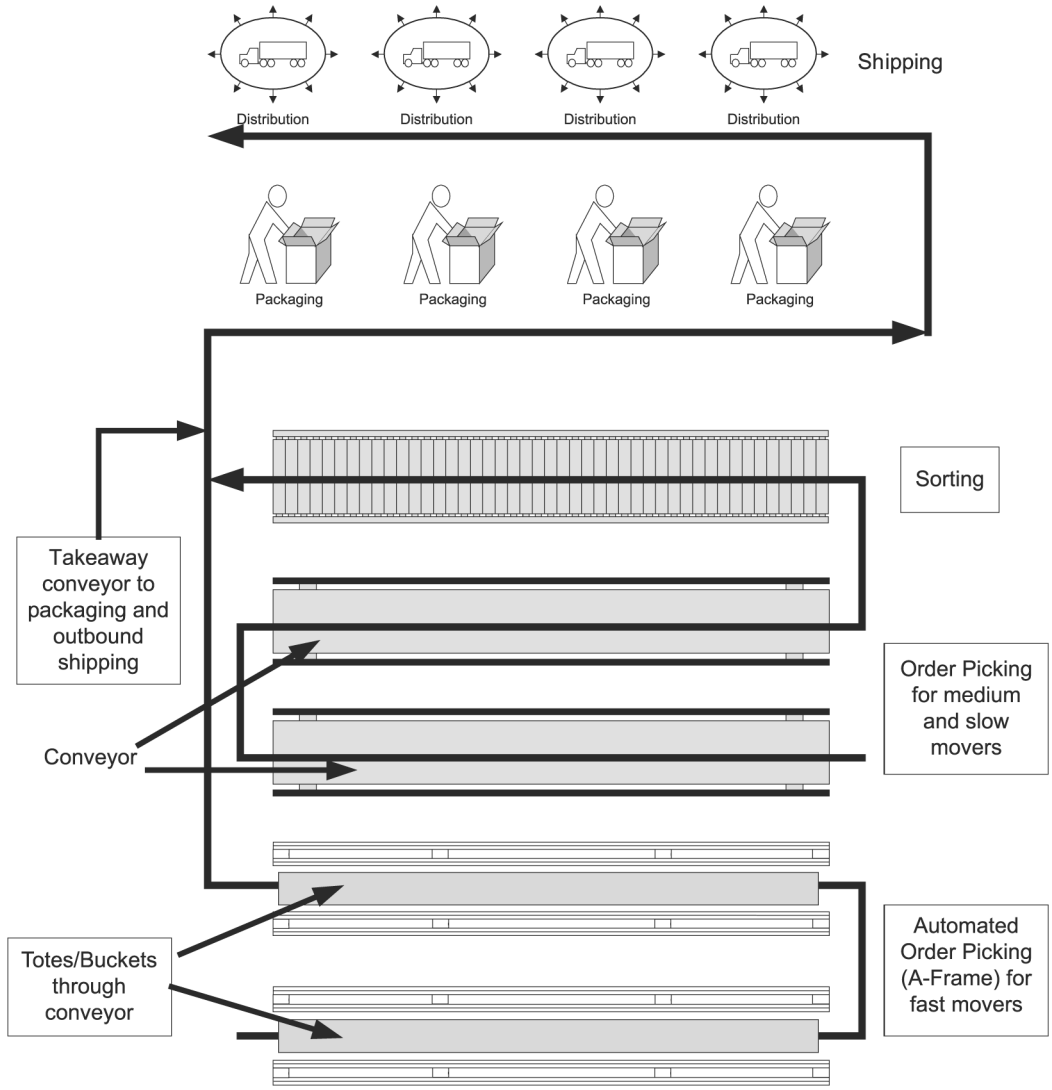
Picking systems are where e-business shines or fails miserably. For all the fascination with e-commerce Web sites, the real business gets done during order picking. Consumers demand an extremely high level of service. The order shipped had better have the right items 100 percent of the time, or very nearly so. Mistakes are costly. They are expensive to fix and probably far more damaging in lost business for the future. Speed in filling and shipping orders is also vital. There are various picking methods such as discrete, zone, batch and cluster used in the industry. Readers can see Saenz (2000) for a comprehensive list and description of these methods.

A good WMS integrated with effective picking technologies will together lower the rate of mistakes. RFT (radio-frequency terminals), wireless speech recognition, pick/put-to-light and pick-to-display systems are the key examples of these paperless methods. They help the order picker pull the right items and the right quantities the first time as instructed to do so by the WMS. In Figure 2, the A-frame structure with a product channel arranged on both sides of an A-frame, which straddles a central conveyor, can be very effective in processing high volume of less-than-case orders. The items can be dispensed directly into cartons, totes or even delivery packages instead of a belt conveyor and then moving them to totes or cartons later. In general, A-frame systems are suitable for smaller items such as compact disks, VHS cassettes, books, health and beauty products, contact lenses, pharmaceuticals and small auto parts. Automated, high throughput A-frame systems capable of handling fast, medium and slow moving items are available in the market. Examples of typical A-frame systems can be found at www.sihs.com.

Totes/containers

While they possess a simple square design, containers are the basic tool of distribution. Few warehouses could survive without these versatile cubes. E-commerce distribution is no exception. Containers in e-commerce DCs hold in-process work and gather customer orders. They provide strength and durability, as well as a consistent size for the storage area, which makes handling easier and maximizes

Figure 2 E-fulfillment center



density. Containers are also used for various types of e-commerce picking. Smaller containers hold open stock in flow racks and shelving in pick modules. Consistency is important here, as it provides a cleaner picking area in which product can be found easily. Some facilities use different colored containers to signify various SKUs or pick frequency, such as fast-moving SKUs.

A few unique e-firms are actually sending their products to end-users in returnable containers. A grocery dot com uses three types of containers for its deliveries. One holds frozen foods, another handles refrigerated items, and the third contains dry goods. The containers are designed to keep foods fresh until they reach a customer's home.

Conveyors

Conveyors are the backbone of e-fulfillment, providing the speed necessary to keep up with today's high e-demands. Dot com DCs handle smaller cartons that typically contain only a few items. Conveyors in these facilities tend to be much faster and designed for lighter weights than their case-and-pallet conveyor cousins used in retail distribution operations. What e-retailers lack in individual order size and weight, they more than make up for with order quantities, which is why speed is so necessary. Conveyors function in a variety of applications in these facilities, including putaway and order fulfillment. They are designed for high-speed conveying of product with a light-to-medium weight.

Additionally, conveyor flexibility is a must in e-commerce operations. Some e-retailers that may be in the book business today may find themselves distributing bar bells tomorrow. Modular conveyors allow e-firms to build in flexibility. They are designed as self-contained and powered sections that can be easily reconfigured, as needs change. This

emerging breed of conveyors can be re-routed over a weekend, combining flexibility with long-term investment.

Sortation

In many ways it is fair to say that e-commerce distribution could not be possible without effective sortation. Orders in most e-facilities are typically small and contain only a few items, there has to be a way to easily and rapidly pick and accumulate these items so that they are ready to be packed for individual shipment. One of the advantages of profiling items as fast, medium and slow movers is that slotting, picking, sorting, packaging and leveling of fast moving items can be automated thereby reducing direct labor and improving accuracy and throughput (see Figure 2 for the order processing that consists of fast moving items). For medium and slow movers, modern sorters are also available (see Figure 2). Batch picking is one approach. Items needed to fill many orders are all picked at the same time. Full pallets and individual cartons are pulled from pallet storage or picking areas and sent to a sorter that divides the batch into the individual orders that meet each customer's needs.

High-throughput facilities that process orders with batch picking require large, high-volume sorters capable of functioning at fast speeds. Tilt tray, sliding shoe, and cross belt sortation systems are commonly used. Most of these sorters accept the entire batch, then send product down individual chutes where items are packed for outbound shipments. Batches may vary according to size, product offerings, or destination.

Small-to-medium-size companies may also utilize pop-up wheel, pop-up belt, right-angle transfers, push diverters, and sliding shoe sorters. These are often placed in picking zones where limited sortation takes place to fill orders. Normally these sorters process smaller batches that may be accumulated onto conveyor spurs. Containers with full of picks are sent down these spurs by the various sortation systems. From there, they may be sorted by hand into individual orders.

Since e-firms send out a much larger number of packages than retail distribution centers, good sorting of outbound parcels is a must. The majority of cartons are shipped by commercial parcel carriers, such as Fed-Ex, RPS and UPS. Sorters are used to divert cartons to desired carrier lanes or dock doors. Sliding shoe and push diverters are most commonly used in shipping areas, while tilt trays are sometimes used for high-volume shipping docks. This type of good sorting also helps the bottom line. The ability to rate shop and then sort to the specific carriers that offer the best rates or delivery parameters can save big money. Good sorting also eliminates much of the physical handling in facilities, which can save labor and the risk of injury from repetitive tasks.

Packaging

Damaged or unattractive packaging can drive a customer straight to a competitor's Web portal. That is the reason that packaging, while one of the last stages in order processing, also makes first impressions. Most of the items purchased from today's e-commerce sites are still relatively small in size. For example, there are much more books, pharmaceuticals and apparel going through the e-commerce supply chain than sofas and riding lawn mowers. This means that distribution centers are handling much more packaging of small cartons, bags and envelopes.

Modular and more flexible workstations capable of changing the design of packing area must replace standard, nonadjustable pack stations in order to handle frequent small order sizes (Saenz, 2001). Packing stations are ideally positioned at a spot that requires the least amount of handling once an order has been accumulated. In many facilities, the packing is done right at the accumulation chutes of a sortation system. Often the cartons are delivered by the sorter along with the merchandise.

Docks

Safety and speed are the watchwords at loading docks, no matter whether the enterprise is in e-commerce or old commerce. The truck-to-building gap at each dock will need to be bridged by some sort of lifting or leveling device. For small startup firms, initial investment costs can be hold down by selecting scissor lifts designed to take dock loads. But the more ideal, and preferred long-term solution – for safety and productivity reasons – is to spend more and select dock levelers for all dock positions.

Infostructure

"Infostructure" in this context can be defined as the collaborative network capable of

processing Internet orders and exchanging information via LAN/WAN across multi-platform information systems of business partners. Data capture and supply chain application systems are integral part of the infostructure.

Data capture

E-commerce has sprung automatic data capture (ADC) out of a box that has long trapped it. Now, bar codes, radio frequency based technologies and other forms of ADC are used to collect data that is used both within the facility and by other facilities including those of customers and suppliers. As e-commerce builds on its initial successes, it will increasingly rely on ever more detailed information to keep customers happy. This will require greater sophistication in data capture procedures in the distribution center, more extensive data files about individual items, and maximum availability of real-time data to all involved. Basically, the more data available to the customer and business partners, the better the e-commerce experience.

Supply chain enterprise systems

In the e-commerce fulfillment world, supply chain enterprise systems are the power behind the scenes. However, the traditional supply chain will have to be upgraded or rebuilt in order to accommodate the Internet and multiple platforms of e-logistics players. The supply chain should be able to manage and route all the right information from the order management center to the warehouse and back to the company's administrative databases. As a result, people using the Web site can be told not only what is in stock, but also how ready it is to be shipped to them and when their order is likely to arrive at its destination. Supply chain enterprise systems can be broken down into two categories – planning and execution. The former has two distinct software types. ERP is the planning backbone for a company's core business processes. ERP links together these far-flung processes using data from across the company. Supply chain planning (SCP) is the other leg of the planning system. It predicts, plans, and optimizes the future for a distribution center. Ultimately, all electronic processes must be physically enabled, resulting in increased collaboration with business partners to manage the flow of goods across multi-channel e-fulfillment centers (Sherman, 2000).

A third type of supply chain enterprise systems, order management systems (OMS), straddles the gap between the planning and execution system categories. An OMS plans how a particular set of orders should be handled as well as sets priorities for the execution system given the current set of conditions and expectations for shipment and delivery.

The execution sector is broken into two segments. WMSs manage activities and resources in the warehouse from receiving to shipping. Often, the WMS does this based on information passed on to it by an OMS. The other segment, transportation management system (TMS), manages the shipping process. This includes selecting the most cost-effective carrier as well as determining the best pattern for loading cartons.

Traditionally, each of the different segments of supply chain enterprise systems has worked in a stand-alone mode. But they work better when integrated with each other. Meanwhile, the power of speed in e-commerce makes the integration of all even more essential. As a result, enterprise system suppliers today are creating integrated systems.

Reverse logistics

An e-fulfillment operation's job is not over with the picking and shipping of products to the customer. Online buyers want e-commerce companies to provide them online information at the location of their product in the distribution channel. In addition to that, online retailers experience more returns than catalog merchants do. As an example, returns for online apparel retailers run as high as 45 percent of their orders (Cooke, 2000). Without the right reverse logistics, the reality of returned purchases will very likely choke an e-commerce warehouse. Consumers have been attracted to the Internet by the millions for reasons of convenience and ease of use. After all, one of the most attractive aspects of Web shopping is access to multiple sources of goods without ever having to leave home. But the front end of ordering and having something delivered to your doorstep is only half the story. The other half is returns when the wrong product arrives, an item is damaged, or the consumer just had a change

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of heart. The growth of e-commerce has given new urgency to the need for efficient strategies to handle returns and overstocks.

There are several options when it comes to managing the returns cycle of e-commerce. One approach is to have a no returns policy that certainly runs counter to the "at your service" face that the Internet wears so well, which is the way that most people expect e-commerce to work. It may eliminate problems in the warehouse but also runs the significant risk of alienating customers. Another approach is to allow returns, but make them difficult for the consumer. Establishing a centralized return center would be another viable option where workers would receive returned products and decide whether the product is re-saleable or not.

Some analysts suggest that online merchants consider outsourcing product returns to a returns-management service. Such services operate local drop-off centers, located in existing grocery or retail outlets, where online shoppers can return merchandise themselves rather than ship it back to the return center (Cooke, 2000). The fact is that returns are considered to be an integral and most troubling part of e-commerce and the warehouse still has to find an effective strategy to deal with it. Because it is just as much a dollars and cents issue as it is a physical materials handling issue.

What does reverse logistics require of the e-retailer if it is going to handle return by itself? To begin, it needs a facility that is prepared with enough space for receiving and processing the returns. Any returns operation needs to be separate and distinct from what else happens in the fulfillment center. At the same time, it must be easily integrated with other warehouse operations when it comes time to re-introduce the returned goods to inventory.

Just as many e-commerce companies are turning the 3PLs to handle their fulfillment operations, they can do the same for returns. Beyond the traditional 3PLs that manage returns as part of order filling, there are certain companies that have made returns their business. One such example is TheReturnExchange (TRE) that provides end-to-end return process management to e-commerce retailers. Returns will never go away. The process is generally considered an essential element of customer service and satisfaction. Results of AMR Research's (2000) "Holiday fulfillment" (see Table I) indicate that in general consumers were satisfied with e-retailers even though problem related to fulfillment was significantly high (Harrington, 2000). It should be mentioned that only 5 percent returned items purchased online. However, if an e-firm tells its customers that there is no chance that they can return a product, they will probably leave the site and find another that offers a satisfactory return policy.

Table I Results of AMR Research's "Holiday fulfillment"

	Rating
1. Overall satisfaction with online retailers	9.04
2. Likelihood of shopping with the same online retailer again	9.11
	Percentage
1. Significant fulfillment problems	15
2. Desired item was out of stock	15
3. Returned item that was purchased online	5

Note: Rating based on a scale of 1 to 10, with 10 being the best
Source: AMR Research (2000)

Conclusions

To succeed in today's dynamic, fast-paced environment, the firm needs a system that not only manages its entire distribution and logistics process but also is agile enough to rapidly respond to personalized customer requirements. It also needs a system that can make-to-order and fulfill orders from both supplier managed and stored inventory. In other words, it is required to have a system that not only accepts returns, but also manages disposition. In short, e-fulfillment is more than just "pick, pack and ship". In the new economy, fulfillment is all about customer expectation and satisfaction – a process that begins with accepting customer demand and ends with each customer receiving exactly what they want, when and where they want it. Therefore, understanding demand nature and type of items demanded is the key to design an effective e-fulfillment center.

Although every distribution center has its unique operational requirements, there are models for efficient logistics systems designed for large numbers of smaller-quantity orders (see Chang and Dye, 1999; Cachon, 1999; Shemesh, 2000; Yang, 2000; Urban, 2000; Jaber and Bonney, 2001). They include automated material flow systems for handling

high-, medium-, and low-volume products as well as varying pick frequencies. It is a suggested design that may make or break an e-commerce fulfillment center. Start by developing a thorough model of the center's profiles, inventory levels, supplier capabilities, and delivery requirements to meet consumer needs. Then study the fundamentals of fulfillment center design-first principles. Follow this with an analysis and evaluation of how these basic design approaches apply to a firm's specific requirements both now and for the foreseeable future. Whether the system is developed in-house or purchased from a third-party vendor, implementation is typically a four-step process:

(1) validation;
(2) verification;
(3) formal systems "walk-through", and
(4) user training (Schell, 1998).

The winners in e-commerce are those companies that not only jump into the fray quickly, but also meet customers" high expectation for speed and accuracy.

In conclusion, it is obvious from the study that e-fulfillment is a complex process which requires accurate functioning of many components in order to achieve desired performance. Identifying key components and understanding how these components function and react in the system are prerequisites of development and implementation of a successful e-fulfillment process. Finally, this research also provides a sound base for the future research that will focus on:

- identifying e-shopping demand pattern, especially for B2C;
- simulation of an e-fulfillment process to measure various processing time and to identify various bottlenecks in the process; and
- analyzing the importance of partnership and/or outsourcing.

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