WAREHOUSE MANAGEMENT SYSTEMS TECHNOLOGIES:

Transforming Customer Satisfaction Through Better Inventory Management

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EXECUTIVE SUMMARY

This century will usher in the next generation of warehousing technology and information requirements. The improvements of the 1990s have allowed the warehouse to work smarter, not harder. The next technological level will allow even extremely customized demands to be met. This monograph is a powerful aid that provides insight into warehouse, labor, and transportation management technologies and their impact on supply chain visibility. As such, the information may be used to synthesize warehouse operations, customer satisfaction, and information quality. It can change an organization from reactive to proactive. Managing the warehouse and implementing the appropriate warehouse technology is a key ingredient in a business's success and an essential requirement for Supply Chain Excellence.

TABLE OF CONTENTS

1.0 AN INTRODUCTION TO WAREHOUSE MANAGEMENT SYSTEM TECHNOLOGIES

The majority of warehousing problems occur because of a lack of control of inventory, operations, and/or management. To become dynamic, successful and consistent, an organization must control its warehouse operations. A principal requirement for controlling the warehouse is harnessing the power of technology to maximize a facility's potential. Furthermore, the road to overall organizational excellence goes right through the warehouse door.

A control system is a means by which operations are managed. It can be manual or computerized. Its basic objectives are:

- To identify and coordinate the work
- To help maximize performance and customer satisfaction and minimize mistakes.
- To report the past, present, and future work status via activity-based costing.

A manual control system uses physical, paper-based technology to attempt to streamline warehousing operations. Due to the rate of change; demands for accurate real-time information; expectations of next-day service and marketplace competition, the use of manual systems in the 21st century is unrealistic. Today, the need to computerize is critical; tomorrow it will be too late.

A computerized warehouse management system (WMS) is the integration of bar coding technology, radio frequency (RF) communications equipment, hardware, and software. The sophistication of WMSs can vary from simple stock location control to systems that can nearly maximize customer satisfaction, space, labor, and equipment in the warehouse.

It is important to note that one should not confuse WMS technology with business systems applications that impact the warehouse. A mainframe inventory control application or module is not a WMS. A manufacturing resource planning (MRP II) system is not a WMS. A WMS is an operating tool that is based upon the needs of the warehouse operation and provides tools and information for the management of the warehouse.

1.1 The Functions of a Warehouse

In general, every warehouse performs four basic functions: (1) receive product, (2) store product, (3) pick product, and (4) ship product. These functions can be expanded into the following basic functions:

- Receive Product:
  - Packaging and raw materials from suppliers
  - Finished goods from manufacturers
  - Finished goods from other sources
  - Customer returns
- Store Product:
  - Quality inspection
  - Putaway
  - Location and lot control
  - Crossdock

- Pick Product:
  - Raw materials picking
  - Work in process picking
  - Finished goods picking
- Ship Product

Receiving Functionality

Generally, receiving operations have the following needs:

- The need to have accurate receipts with advanced notice (preferably electronic) of the anticipated receipts to facilitate quick and accurate receiving operations. Electronic downloading of detailed shipment information via EDI or XML from the host system directly to a WMS speedily translates receipt information into usable information for dock activity planning, order release, and inventory allocation.
- The need to reduce the time product spends in staging. After the incoming receipt's bill of lading has been checked, the warehouse and manufacturing must sometimes wait until quality assurance (QA) completes its inspection of the goods before these goods can be stored and/or used in manufacturing. If there is no QA inspection, product can sit in staging until a determination can be made as to where to store the product and who should store it. A WMS minimizes the time product sits in staging due to operator-directed putaway and system-directed putaway locations.
- The WMS must have the capability to direct receipt to outbound orders staged on the shipping dock and forward pick locations requiring replenishment (within stock rotation parameters).

Storage Functionality

The functional needs with respect to product storage include:

- The need to have positive identification and load-tracking of products that have been received and are ready for putaway. This tracking includes the need to identify whether a product is available for use or not.
- The need to have automatic storage location selection for pallet loads based on parameters designed to maximize space utilization and picking efficiency and minimize putaway labor. This storage location selection process should attempt to utilize an activity-based storage philosophy, re-warehouse product where necessary, and ensure lot integrity.
- The need for a stock location system that tracks the identity and quantity of each SKU by unique storage location. This feature is necessary to insure product traceability to the customer level.
- The ability to cycle count inventory by storage location as opposed to counting a total on-hand physical inventory. The WMS must also be able to correct discrepancies as they occur.
- The real-time update of inventory, lot, and stock location records to provide timely information upon which subsequent putaway, picking, and manufacturing decisions can be made. The more real-time the update, the greater the reduction of information lead-time.

A surprising deficiency in many warehousing operations today is the absence of a simple stock location system. Knowing not only what or how much is in the warehouse, but also where it is, is fundamental to the success of the operation. Many warehouse problems stem from the lack of an effective stock location system. With an effective stock location system, loads can be stored randomly, subject to practical parameters, in any available empty location. The result is a significant increase in storage location utilization.

Knowing where a product is stored will also have an inherently positive impact on product retrieval efficiency, though it does not necessarily increase putaway efficiency. By having the system automatically select the best location based on parameters such as cube size, product type, and frequency of order, and by having the system inform the putaway personnel of the assigned storage location, significant labor and space productivity can be gained. With the assigned location in hand, the putaway personnel are not forced to cruise through the warehouse searching for an empty location. Travel time is also reduced, particularly as the warehouse approaches maximum capacity. Furthermore, the possibility of mismatching loads to storage openings will be minimized, and overall cubic space utilization increases. Finally, the opportunity to combine partial pallets into larger locations increases. This re-warehousing helps to improve overall space utilization.

The absence of a stock location system typically requires that the warehouse inventory accuracy be confirmed by counting the entire on-hand inventory for an SKU. The first challenge is finding all of it. The second challenge is completing the count in a timely manner such that order processing is not hindered or record reconciliation of transactions completed during the count is not overly burdensome. A WMS provides the potential to cycle count by location. Recorded accuracy can be verified by location; there is no need to restrict transaction activity or reconcile transactions and total on-hand balances. The result is a drastic decrease in the time and labor required to maintain inventory records and a dramatic increase in inventory accuracy. At minimum, a stock location system is essential. Adding the directed putaway capabilities results in significant labor and space savings.

Picking Functionality

The typical picking needs of a warehouse include:

- The ability to pre-route and pre-post customer orders in storage location sequence to minimize picker travel distance and multiple handling during load building.
- The need to select specific storage locations for picking based on parameters such as lot number, stock rotation, primary pick location, and order quantity versus location quantity. The system must also be flexible to allow for variations in stock rotation requirements and location sequence.
- The need to perform case picking and broken-case picking.

As stated, the stock location system provides the foundation for efficient order picking. The picking functionality provided by a WMS is designed to exploit the existence of the stock location system to further maximize picking efficiency. The functional abilities of a computerized control system are designed to minimize picker travel time between picks and to maximize actual time spent picking during discrete picking. Utilizing zone picking allows pickers to specialize in certain types of storage or handling equipment, product types, or picking units (full pallets vs. full cases vs. broken cases). In multiple locations and zone picking envi-

ronments, location selection parameters are important to avoid product obsolescence and to minimize the number of locations that must be accessed to completely pick an order. Pre-routing items on either a paper or electronic pick list eliminates backtracking, particularly for pick lists with many line items. Batching orders together, particularly for full-case and broken-case picking in a primary or forward pick area, allows separate orders to be combined for picking to minimize pick time by minimizing travel between pick locations.

Shipping Functionality

The shipping needs of a warehouse typically include:

- Routing picked goods to specific staging lanes for order control and consolidation from multiple pick zones
- Automatic bill of lading generation
- Automatic updating of open customer order files throughout the day
- Automatic shipping notification via EDI

The shipping functions are designed to maximize control of orders moving through packing, checking, and loading. Additionally, packing list preparation, bill of lading generation, and customer order file updating are designed to minimize manual clerical tasks to reduce labor, improve accuracy, and heighten customer satisfaction.

Other Functionality

A number of other functional capabilities are needed in the warehouse. Including:

- Accumulating employee transaction activities as the basis for monitoring performance (activity-based costing)
- Creating an audit trail for all warehouse activities to facilitate error corrections
- Generating various activity reports used to report and manage warehouse performance
- Maintaining product data files
- Tracking and accessing order status from order entry through shipping
- Tracking raw materials from receipt through QA to manufacturing
- Providing manufacturing with product visibility and availability to facilitate efficient material replenishment
- Providing access as needed to maintain data security

All of these are value-adding functions and must be consistent with the objectives of the physical operations.

1.2 Real-Time Radio Frequency Communications

The primary benefits realized from real-time radio frequency (RF) communications are:

- **Information Availability—**status updates of receipts, manufacturing requests, and customer orders gives warehouse management the responsiveness to manage ongoing activities as they occur. This information availability allows the

warehouse to be responsive to changing needs and gives management the capability to re-deploy its labor, equipment, and space resources as required to maximize performance.

- **Labor Pacing—**communication between the system and the operator allows the system to pace the operator from one assigned task to the next. The operator does not need to return after each task to a central location to get the next instruction. The system can select the next task for an operator based on what needs to be done when, where the operator is, what the operator is doing, and what the operator is capable of doing. The result is workload management that maximizes task accomplishment and minimizes labor idle time.
- **Material Tracking—**allows verification of all transactions that affect material location. This verification updates status records used for future transactions, eliminates most material location errors, and provides immediate instructions for resolving errors that are identified. real-time communication allows the warehouse to operate more efficiently such that the system is immediately aware of empty storage locations as they are created and can assign them to putaway loads immediately, without manual searching of the rack.

Real-time RF communication is a very worthy operational enhancement. The opportunities afforded for improved inventory and stock location accuracy, labor management, and responsiveness to manufacturing result in quick, tangible savings. Warehouse installations of RF technology are plentiful–the technology is proven. Truck-mounted and hand-held RF terminals are relatively affordable and nearly all WMS packages will support RF communication.

It is important to remember that effective real-time communication will be dependent upon good response time by the WMS server. The volume of communication will impact the specifications of the system's computer. It is critical that the server not degrade the response time of existing applications, nor that the response time be excessive.

1.3 Bar Coding

The primary benefits from the use of bar coding are:

- **Labor Reduction—**Labor reductions exist through bar coding by reducing the time required to identify loads and locations to support the real-time RF communication transactions. Labor-intensive keystrokes are replaced by virtually instantaneous label scans.
- **Data Acquisition Accuracy—**the real-time RF communication transactions described above involve a series of load and location identifications. These identifications are critical to system operation; therefore, accuracy of data acquisition is essential. Keystroke data entry, with a typical error rate of one in 300 keystrokes, is both time-consuming and error-prone. Barcode data entry, with a typical error rate of one in one to two million scans, is both fast and highly accurate. Barcode data entry is important to the success of real-time RF communication.
- **Compliance Labeling—**just as bar coding benefits internal operations, customers are demanding bar-coded labels in standard formats on all products. This allows quick receipt and confirmation of receipts when combined with EDI shipment data.

The most significant benefit to be gained from the use of bar coding is the effective support of data collection and real-time RF communication. Without the bar code, data collection and real-time communication through manual terminal keystroke inputs will be burdensome to productivity and replete with errors. Bar code data acquisition offers a fast and accurate medium through which real-time communication can be achieved.

1.4 Emerging Technologies

- **XML Communication—**is a relatively new technology that is finding its way into the latest WMS technologies. XML, which stands for eXtensible Markup Language, is a communications means where trading partners can define and exchange information in a collaborative format. XML does not necessarily replace EDI. In fact, they can coexist. Although most information that is described in EDI can be described in XML, EDI supports semantics and significant processing framework such as security and message acknowledgement. However, what XML brings to the WMS technology is the capability of integration and exchange with other partners, suppliers, or customers' systems as well as ERP or other planning systems through the Internet. Combining this communication platform with critical warehouse operations functionality helps in driving inefficiencies and integration costs down in the total supply chain synthesis.
- **Web Visibility—**to facilitate information exchange and greater visibility, leading WMS vendors are developing Web-enabled software applications. This technology allows the users to access information such as receipts status, shipment dates, and inventory status remotely through the Internet. This Web-enabling capability is also allowing several vendors to host their WMS without physically implementing the software at a customer site. This approach may lower the overall cost of ownership for some customers.
- **Supply Chain Execution (SCE) Integration—**leading WMS vendors are integrating their WMS software to other SCE suites of products. This integration brings a benefit to the customer by reducing custom interface development with increased functionality. Among the more popular SCE integration offerings are the following:
  - **Labor Management—**this application facilitates further use of the WMS by providing workload productivity analyses, performance measurements, engineered standards, and other information to identify areas for improvement in the distribution centers.
  - **Slotting—**this application improves or optimizes the location of products in the warehouse by using mathematical techniques based on such criteria as product movement frequency, family, size, grouping, and other relevant parameters. This information is fed into the WMS for performing re-warehousing activity and reducing honeycombing, thus increasing picking efficiencies.
  - **Transportation Management System (TMS)—**perhaps the most widely used application that is integrated into the WMS is the TMS. This application provides the distribution systems with visibility to their inbound ship-

ment and allows for tracking of the outbound deliveries. The benefit comes in savings from economic order consolidation and load building. Also, the TMS is used to select carriers based on cost and service level.

- **Yard Management**—normally sits between the WMS and the TMS and functions as dock manager. The yard management application assists the warehouse manager in reducing bottlenecks by scheduling inbound and outbound freight and feeding that information into the TMS and ultimately the WMS.
- **Order Management**—some WMS vendors have integrated the order management application where the WMS functions as an order-entry system as well as the warehouse execution system. This practice is used in smaller warehouses when the business system, order entry, product allocation, and delivery can be performed via one software system.
- **Advance Planning and Scheduling (APS)**—the leading WMS vendors are integrating their WMS with APS applications in order to provide the visibility to relevant limitations, rules, and objectives governing physical distribution. The WMS has visibility within the four walls through such information as inventory on-hand, expected receipts, and committed inventory. What APS offers is an extension outside of the four walls by providing visibility to operational attributes such as costs, availability, current and forecast utilization, forecasted demand, and other planning factors. By integrating the information from the WMS and APS, the system provides opportunities for the DC manager to improve planning and utilization of the DC capacity, labor requirement, and overall operation.
- **Material Handling Integration**—several major WMS vendors have integrated their software with middleware material handling control systems, such as the Tompkins Control System (TCS), in order to minimize interface development and therefore reduce the integration cost. This integration provides a bridge between the WMS and material handling equipment such as carousels, conveyors, palletizers, and sortation trays.

1.5 Typical System Justifications

- Increase lift truck operator productivity by:
  - Decreasing operator time spent searching for a product or open location
  - Optimizing the pick-path distances
  - Reducing honeycombing
  - Introducing an activity-based storage philosophy
- Reduce key-entry labor
- Increase savings by reducing labor spent on performing a physical inventory
- Reduce safety stock levels
- Reduce lost sales due to inaccurate inventory
- Reduce backorders due to inaccurate inventory
- Reduce inventory write-offs
- Reduce manufacturing overruns due to inaccurate inventory levels
- Reduce manufacturing disruption costs due to material outages/inaccurate inventory

These are just some of the potential savings to be expected from a WMS. The key is to properly document the magnitude of these savings. Only then can the true financial benefits of a WMS be fully appreciated.

A company can dramatically improve its operations by gaining warehouse control. But how does a business gain true warehouse control? The answer is through the use of a WMS. The next step is to identify the warehouse's needs and get the ball rolling.

2.0 PLANNING AND IMPLEMENTING INTELLIGENT WAREHOUSE MANAGEMENT SYSTEMS

Only when warehouses have quality information can they become truly prepared. After they have developed methods and procedures to apply this information, warehouses are ready to become "intelligent." When warehouses become intelligent, operations continually improve. As operations improve, a company prospers.

What then, is an intelligent warehouse? What are the elements of an intelligent warehouse? How does an intelligent warehouse function? How does one create an intelligent facility?

An intelligent warehouse integrates computer systems, material handling equipment, storage equipment, and people into a single cohesive working element. The quality of information is vastly improved. The improvement in information quality, in turn, results in fewer errors. High information quality also minimizes unproductive labor hours. Minimizing errors and improving labor productivity results in increased customer satisfaction that results in higher sales. Higher sales promote growth. Figure 2.1 illustrates the path to intelligent warehousing.

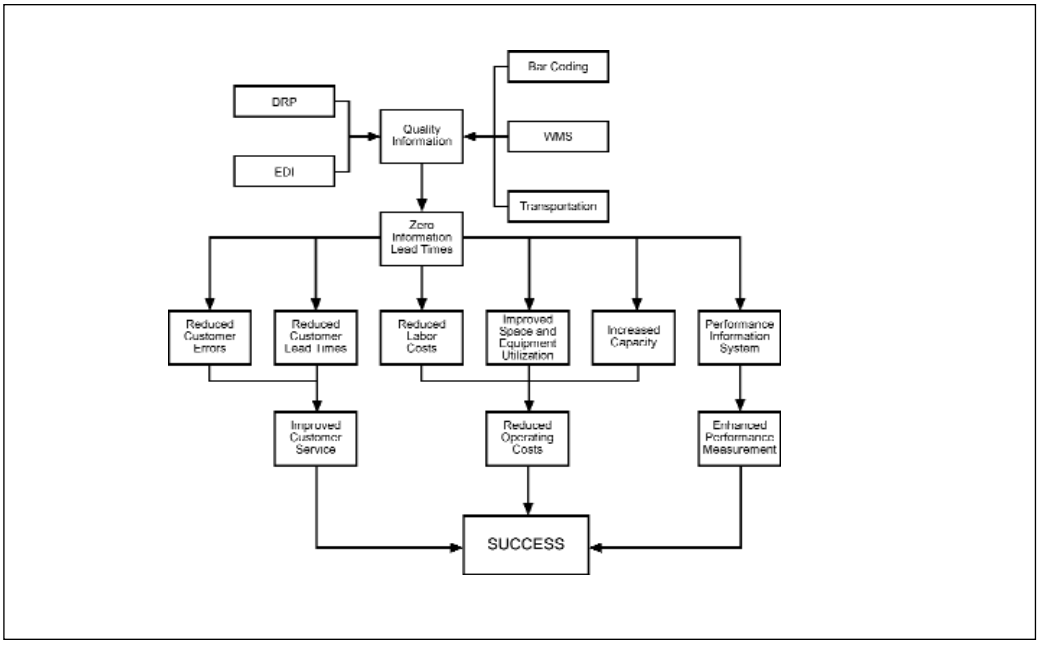

Figure 2.1: *The Path to Intelligent Warehousing*

After quality information has been attained, a reduction in information lead-times occurs that provides a faster response to customers. This further perpetuates customer satisfaction and continued growth. Once errors are eliminated and information lead-times are minimized, customer satisfaction is almost guaranteed. The warehouse has accomplished its goal. The warehouse becomes a truly efficient unit that maximizes customer satisfaction. The final step then, is to use this information to optimize the use of space, equipment, and labor.

Material handling and storage solutions must be integrated within the framework of this new available information. Accurate information will allow for the condensing of operations, the use of alternative storage and handling methods, and the creation of a truly intelligent warehouse system. Information will change the context in which one looks at material handling and storage solutions. If the operation can be simplified or condensed due to the availability of quality information, then these changes should occur. Conventional wisdom will change.

2.1 Characteristics of Intelligent Systems

Once the evolution of an intelligent warehouse is understood, a company must ask itself the following questions: "How do we acquire quality information? How do we optimize our labor? How do we optimize our material handling equipment? How do we eliminate errors?" To answer these questions, one must first understand the four characteristics of intelligent systems: zero information errors, zero information lead-times, maximum labor productivity, and maximum space utilization.

Zero Information Errors

The first characteristic of an intelligent system is zero information errors. Two types of errors exist: errors that affect customer satisfaction and errors that affect warehouse operations. Both must be eliminated.

The first method by which an intelligent warehouse achieves zero errors is through 100 percent information verification. A warehouse receives, stores, picks, and ships goods. When a product is initially received, it is verified, bar coded, and entered into the control system. All future movements are tracked against that bar code. The product has now been uniquely identified. A significant chance for tracking errors has been eliminated.

The second method by which an intelligent warehouse achieves zero customer satisfaction errors is through system-directed operations. Every receiving, putaway, picking, and shipping operation is system-directed. Product will only move if it is system-directed, and the operator can only complete the move and go on to the next operation if the previous operation has been verified as correct. Operator errors associated with misplaced inventory and operator carelessness are eliminated.

The third method by which an intelligent warehouse achieves zero customer satisfaction errors is through continuous cycle counting. Since every operation in an intelligent warehouse is system-directed, the system knows every location's status. When the system directs a pallet to a location and that location is not empty, then the operator uses the system to rectify that location's inventory on demand. Inventory errors will be caught at the first opportunity. As a result, backorders due to inventory discrepancies will be virtually eliminated.

Zero Information Lead-Times

Total information verification results in quality information. Once quality information is attained, the information lead-time must decrease. Eventually, the information lead-time will approach zero.

There are two types of information lead-times: customer-oriented information lead-times and warehouse-oriented information lead-times. Customer-oriented lead-times relate to the time it takes to transfer customer order information to and from the warehouse. Customer-oriented information going to the warehouse generally refers to information that is entered either manually or through electronic data interchange (EDI) into the corporate data entry system. This information is then transferred by paper or electronically to the warehouse. To achieve zero customer-oriented information lead-times, the information must be electronically transferred as it is received into the corporate system.

Customer-oriented information flowing from the warehouse refers to shipping information that is transmitted by paper or electronically to the customer. Bills of lading and packing lists are not preprinted. They are printed as the order is completed, so as to represent an accurate count of the material shipped. This information is then transferred electronically to the customer so that the customer can plan for the anticipated receipt.

The second type of information is warehouse operations-related. This data that is used to guide the intelligent system. This information is transaction-based and provides feedback about what was picked or put away. By recording the transaction and by interfacing with the customer-oriented information, a variety of calculations can be performed. Examples include: truck loading plans, freight rating, personnel requirements, and order prioritization. The warehouse information lead-time must be zero if these tasks are to be optimized.

At this point, the quality of information is high and information lead-time is low. Customer satisfaction has improved. The next step is to improve operations.

Maximum Labor Productivity

The first step to improving warehouse operations is to increase labor productivity. The increase in computer processing speeds allowed for the development of algorithms that maximize labor productivity by allowing more decisions to be evaluated prior to the assignment of the next work task. It has already been determined that system directed operations are required to reduce errors. Directed operations also improve labor productivity.

Operators no longer have to think about the next operation. The system does the thinking. The more pending tasks the system can draw upon to make a decision, the more efficient the decision. Intelligent warehouse management systems will use labor task interleaving techniques to maximize labor productivity.

There are five factors that must be considered to optimize labor: operator location, equipment availability, task prioritization, queue times, and task importance. An intelligent warehouse must address and optimize these factors. The method by which an intelligent warehouse optimizes labor is through labor/task interleaving. Labor/task interleaving is the ability to optimize labor and equipment assignments based on queued labor tasks. Interleaving refers to the fact that the system must have the ability to select the next labor task from a queue of all pending activities, and not just from one module or labor sub group. Interleaving expands the pool of tasks available to an operator and , thus, minimizes travel distance. Minimizing travel distances results in a direct labor

productivity increase. Several other capabilities of the intelligent warehouse system must exist if the system is to task interleaf. The system must time stamp and manage task times in the queue, contain a travel path methodology, and operate in a real-time manner. If these requirements are met, then task interleaving is possible. Without interleaving, full labor optimization is not possible.

Maximum Space Utilization

The fourth characteristic of an intelligent warehouse system is improved space utilization. Because inventory is more accurate, more locations are available for putaway and storage. Improved inventory accuracy and system-directed operations allow for higher storage densities. The traditional problem of worker productivity suffering as storage utilization increases is diminished. The hunting and searching aspects of picking and putaway are eliminated.

In addition to improving space utilization, dock-staging requirements are reduced. Product does not have to sit as long in staging. As soon as a pallet has been bar-coded and verified, it is available for putaway. This faster turnover results in smaller staging requirements.

Intelligent systems also use crossdocking techniques to reduce handling and storage requirements. Crossdocked material is received, staged, and shipped without ever being placed in storage. Because product is not actually put away, storage requirements are reduced. Only an intelligent system that has visibility to anticipate receipts, customer orders, and material movements can maximize crossdocking opportunities.

Finally, an intelligent warehouse reduces storage and handling requirements through re-warehousing. When the overall storage utilization falls below an acceptable level due to honeycombing, the system may trigger a re-warehousing program on demand. Partial locations are combined and deep-lane storage materials are re-warehoused to their proper lane depths. Honeycombing is minimized. As a result, space utilization is improved.

2.2 Designing an Intelligent Warehouse Management System

The first step to design an intelligent WMS is to document needs. Documenting needs will require a complete understanding of the methods by which the warehouse operates. The "needs document" should attempt to maximize operations regardless of existing constraints. Operations must not let its paradigms restrict its potential. Just because things have always been done the same way, or because they are the business operating norm does not mean that the rules cannot be changed. The needs definition must reflect unconstrained thinking. If an organization cannot perform this type of thinking, then it should consider an independent consultant to help define requirements.

The second design step is to translate needs into a functional bid specification. A functional bid specification document clearly defines needs in a format that will allow vendors to make educated quotes. The specification must be concise, yet not restrictive. Figure 2.2 is a sample table of contents from a functional bid specification.

The functional bid specification will prove to be the project crossroads. A poorly written specification results in ambiguity and can result in disaster. Two completely different

Figure 2.2: *Sample Table of Contents for Functional Bid Specifications*

interpretations can be drawn from a single illustration. These problems can be avoided by clearly understanding and documenting the company's needs before making any formal commitment.

The third design step is to select a vendor. As long as an adequate vendor is selected, the implementation of the WMS should proceed smoothly.

It's still possible, even while executing the three steps, to scuttle an implementation. Be mindful of the following six pitfalls:

1. Failure to identify the needs completly
2. Placing design ahead of function
3. Forgetting who is the boss
4. Unrealistic scheduling
5. Customizing the common
6. Insufficient testing

Section 3 will look at those potential missteps in more detail.

The future of warehousing is bright. Intelligent warehouse systems will revolutionize future operations. The warehouse will become a customer-driven operation with virtually instantaneous access to information. If any company wishes to survive, it cannot afford to stand on the sidelines while its competitors prosper from management systems impovements.

3.0 MISTAKES NOT TO MAKE

As outlined briefly above, there are pitfalls that can trip up a WMS implementation or even cause it to fail completely. This monograph has explained before that planning ahead is the key to a successful outcome, but it bears repeating here as we look at the pitfalls in more detail. Understand the needs and perspectives of everyone who will be involved in living with the WMS and making it a useful tool, not a burden or a source of bickering.

Far removed from the air conditioned, clean, controlled environment of command central lies the heart and soul of the distribution operation. The warehouse views the IT department as a black hole where program requests go in, but they never seem to come back out. Warehouse managers speak of computer project completion dates in terms of years. IT personnel, on the other hand, view themselves as an overworked, understaffed organization that is the nervous system of the distribution operation. IT views the warehouse as another customer placing demands on their operations. A bit of truth can be found in all of these impressions.

Today, software plays a major role in successful warehouse operations. Most equipment that is purchased requires some type of computer interfacing, and these requirements tax skills. The time will inevitably come to provide input to future system requirements and implement the system. Companies will have to live with the chosen system. Poor and hastily made decisions will have a dramatic impact on operations. There are dozens of documented success stories however. These tell how warehouse computerization works, but do not tell of the struggles involved to become successful. Success stories and case studies are useful but do not prepare the warehouse manager for the challenges that lie ahead.

3.1 Misunderstanding the Benefits of a Warehouse Management System

A WMS is more than an inventory locator system. A locator system locates, tracks, and manages inventory. A WMS manages warehouse operations. A WMS is an integrated package whose components consist of RF communications; dedicated, localized computer hardware; automatic identification equipment; and the necessary applications software. A WMS works to minimize the costs associated with space, equipment, and labor while maximizing customer satisfaction. A WMS, performing in real-time, directs and manages labor, maximizes equipment utilization, and tracks and controls inventory.

The significant difference is that the locator system does not manage the labor. While it is true that a locator system can minimize pick path requirements, the locator system cannot optimize all labor by directing puts, picks, and other tasks in the warehouse. A lift truck operator can spend over 50 percent of his or her time deadheading in the warehouse. A WMS can help recapture some of this time by combining put tasks with pick tasks in a real-time environment. A simple locator system cannot.

3.2 Failure to Identify Needs

If a company fails to document its needs, how can it know what is required of the system? For example, if when buying a new delivery truck, a company does not have a budget in mind and has not done preliminary investigative work, how will it buy the right truck? It will probably buy a truck on impulse—not based on value or need. Therefore, the truck salesperson will determine the need and options. This, unfortunately, is how many companies buy a WMS.

Many companies will begin to contact WMS vendors before they understand their needs. This approach causes problems for both the buyer and the seller. The vendor must spend considerable time helping to identify needs. This costs the vendor time and money. If the vendor is presented with a vague or poorly defined specification, the vendor will have to develop the quote based on that speculation. This speculative quote will contain a "fudge factor" to reflect uncertainty in the system's definition. The vendor spends considerable money in putting a bid specification together, and someone has to pay for that time. It benefits a company to make the vendor's job easier in providing a quote.

Problems are also created by selecting a single vendor to help identify needs. A sole source approach to selecting a WMS will result in a needs requirements document that fits the parameters of that vendor's particular solution. That vendor's solution may not be the best or most cost-effective solution for a company's unique situation. The vendor's solution is the best solution that fits within his system parameters, but not necessarily the parameters of the company in question. A company must determine its own needs. If it is not comfortable determining its needs, then it should hire an unbiased party who can help define needs. It is a mistake to limit options or fail to solve problems by shortcutting the needs definition development.

3.3 Function vs. Design

The desire to develop a design bid specification as opposed to a functional bid specification can be disastrous. Who knows more about a company's operations than its own staff? Who is the expert in the design of the WMS software? The vendor is. Why should a company tell the vendor how to design its software? Conversely, why should the vendor tell a company how its operations should function? Tell the vendor what the functional requirements are. The vendor can then rely on its experience and software package to determine how it will meet functionality requirements. If the vendor is given some latitude, it can minimize the amount of customization that will be required. By minimizing customization, it can keep the software development cost down. This, in turn, can result in savings and in a better system.

The second problem with a design bid specification is that the burden is now placed on the buyer to specify how the needs are to be met. The vendor knows the requirements and how to get it done. It will then provide a system that meets these needs. Will this system optimize the solutions? Probably not. Will a functional bid specification that allows the vendor some degree of design latitude provide a system that performs the required functions? If the correct vendor is selected, the answer is yes. The key is to remember who is the expert in which field.

3.4 Forgetting Who's The Boss

Understanding the roles of the warehouse and the IT department is the key to successful implementation. The IT department supports the value-adding functions of warehousing and manufacturing. Every product has three values: a function value, a time value, and a place value. Manufacturing adds the value of function by producing a product that satisfies the customer's needs. Warehousing provides a time and place value by getting the product to the correct location at the correct time. The IT department provides information to support the operations that provide the value. However, without a warehouse or manufacturing operation, there is no product and therefore no product value. The product is what makes a company profitable. When designing and implementing a WMS, the warehouse is the boss. Information is something that is not to be guarded by the few, but shared by the many. This information is intended to support, not isolate, the groups who would most benefit from this information.

3.5 Unrealistic Scheduling

Ambitious scheduling of a project may look good on paper, but it can become a painful reminder when that schedule is not met. Expectations, operational decisions, and future sales strategies all hinge on the anticipated completion date. It is important to be honest with the people involved with these decisions and strategies. An ambitious schedule can affect many more areas than just the warehouse. Equally important though, the schedule should not reflect a distant, unsafe and unrealistic completion date. If the project is a nine-month project, then state that the project is a nine-month project. A six-month project may disrupt operations when the goal is not met, but a 15-month projection may doom the proj-

ect to failure before it ever gets approved. Don't be pressured one way or the other into making an unrealistic estimate of the project cycle time.

3.6 Customizing the Common

Wouldn't it be great if the WMS could schedule important shipments according to the safety record of the carrier? That would be ideal, but would it be cost effective? It's great to have high expectations when documenting the needs of the WMS, but it's important to stay on the ground when determining the functionality of the system. The desire to use a customized software package can be ruinous. If it is possible to alter the functionality of the existing system to solve problems through proven solutions, then an attempt should be made to have the functionality addressed by the proven solution. Do not micromanage or overshoot the solution. Once a customized package begins to fall apart, it becomes very time-consuming to reverse the process. The software is unique, the problem is unique, and the solution to the problem then becomes unique.

3.7 Testing

The preferred method of testing is to apply acceptance-testing parameters at the beginning of the project. Software development is an inexact science. There will, more likely than not, be bugs or quirks in the software that will have to be fixed. Do not come down to the end of the project and leave the testing criteria as the last topic of discussion. Tie the final payments to the testing plan. This will ensure that the vendor, who is 95 percent complete, will stay with the job until it is finished. The testing criteria are the last measure of protection. Do not be foolish and squander this safeguard. Use unbiased personnel who are familiar with the software functionality and warehouse operations to execute the tests.

3.8 Selling

Warehouse managers do not like to think of themselves as salesmen. But if the proposed system is the best solution, it is necessary to sell it. There will probably be resistance to this proposal, and other personnel will think that they know what is best. But by defining the specific needs, the seller will be in a strong position to sell the proposed system. This will increase the chances of getting the required system. The most important thing about a warehouse system is function, function, function. These are the key selling points. To sell the proposed system, preparation is everything.

3.9 System Design Inflexibility

One of the single biggest challenges the warehouse must overcome in designing a WMS is the force feeding of a hardware platform and software system to the warehouse by the IT department. The warehouse manager must first determine the needs before finding a solution to those needs. If two times two is four and two plus two is four, does that make three plus three equal to nine? Of course not. Each solution to every application must be determined. In identifying the needs, it is true that some solutions may be similar, but in

most cases, problems will be like the addition and multiplication tables. All the needs will have to be identified and understood before a hardware platform and software system can be defined. All the answers cannot be four.

4.0 CONCLUSION

The key to a company's success is customer satisfaction. Customer satisfaction is largely based upon the ability to control the warehouse. A WMS will allow companies to control and optimize a warehouse's operating efficiency. Therefore, a key to achieving customer satisfaction and assuring the company's long-term success is the proper implementation and utilization of a quality WMS.

With the right WMS in place, a warehouse is on track to stay highly competitive in a future that will only become more demanding. Supply Chain Excellence depends not only on the warehouse, but on its warehousing technology.

APPENDIX
Background Information

TOMPKINS ASSOCIATES: Supply Chain Excellence

Tompkins Associates is the global leader in Total Supply Chain Solutions for operations consulting, technology implementation, and integration. For nearly three decades, Tompkins has provided expertise in warehousing, logistics, procurement, inventory, manufacturing, organizational excellence, quality, and maintenance.

Tompkins Associates is headquartered in Raleigh, N.C., and has offices throughout the United States and in the UK, continental Europe, Mexico, and Australia. Worldwide, Tompkins helps clients succeed through a combination of focused knowledge of best practices and tailored solutions. Tompkins prepares businesses to harness the energy of continuous change to achieve Supply Chain Excellence.

Tompkins Associates understands your unique needs. Tompkins' supply chain expertise helps clients work seamlessly with their supply chain partners to provide the service they need to satisfy their customers. No other firm has the capability to melt the links in your supply chain-taking you from business as usual to collaboration to velocity.

Tompkins provides solutions that are faster than fast.

Our publishing arm, Tompkins Press, delivers the knowledge today's business leaders need. Tompkins consultants have written more than 500 industry articles and given more than 3,000 presentations worldwide. As a result, Tompkins Press has the inside track on the supply chain issues facing businesses today as well as the issues they'll deal with tomorrow. We're an aggressive publisher of leading edge, pro-technical, user-friendly books and audio products.

Tompkins focuses on delivering results–integration of your supply chain, a more profitable costs-to-revenue ratio, enhanced customer satisfaction, greater operations reliability, and the release of trapped capital. Our results speak for themselves, with over 70 percent of our business coming from past clients.

Begin your journey to Supply Chain Excellence. Tompkins Associates will make it all happen.

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