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SIMULATION AND CROSS DOCKING

Matthew Rohrer

AutoSimulations, Inc.
655 Medical Drive
Bountiful, Utah 84010, U.S.A.

ABSTRACT

Cross docking is a material handling and distribution concept in which goods move directly from receiving to shipping. In a typical cross docking system, the primary objective is to eliminate storage and excessive handling. As companies continue to streamline distribution functions, cross docking is becoming a more widely accepted distribution method. The benefits of cross docking include reduced inventory, increased customer responsiveness, and better control of the distribution operation.

By definition, cross docking systems require a close connection between receiving and shipping operations. This connection calls for robust hardware and software systems to solve the cross docking problem. Simulation reduces some of the risk involved with cross docking systems. This paper describes how simulation helps ensure success in cross docking systems by determining optimal hardware configuration and software control, as well as establishing failure strategies before cross docking problems are encountered. Modeling methods and issues are also discussed as they apply to cross docking.

This paper is oriented toward simulation practitioners who need to model cross docking systems, as well as distribution managers who are evaluating cross docking.

1 INTRODUCTION

In today's distribution environment, the pressure is on to manage more SKUs (Stock Keeping Units) and make more frequent shipments of fewer items in less time. Companies are cutting costs by reducing inventory at every step of the operation, including distribution. Customers are demanding better service, which translates into more accurate and timely shipments. Instead of waiting a week to get a product, most consumers expect to take delivery in one or two days. In most manufacturing environments, it is impossible to ship directly from the manufacturer to the customer. One intermediate point of supply chain management is the distribution center. Cross docking is a new method of distribution management that helps companies better control their distribution operations.

Cross docking is described as the flow of material directly from receiving to shipping, where the goal is minimal handling and virtually no storage. Cross docking applies to case and pallet handling done either automatically or manually. Information as well as inventory must flow quickly in a cross docking system.

Today cross docking is found mainly in the retail distribution environment (Kulwiec 1994); however, there are some manufacturing applications that use cross docking. An example is an automobile manufacturer wanting to reduce truck traffic around an assembly plant. The manufacturer set up a distribution facility at a remote location to receive vendor shipments. Material was then reorganized and shipped directly to the assembly line just in time. Other types of systems, like airport baggage handling, are similar to cross docking. Some issues discussed in this paper apply to these similar systems.

There are two types of cross docking: flow through and distributed. Flow through cross docking includes pallet handling systems, usually fork trucks or AGVs, moving pallets directly from receiving to shipping. Distributed cross docking is at the case level, and usually includes some picking and case conveyor material handling. Figures 1 and 2 show the flow of material in a typical cross docking operation.

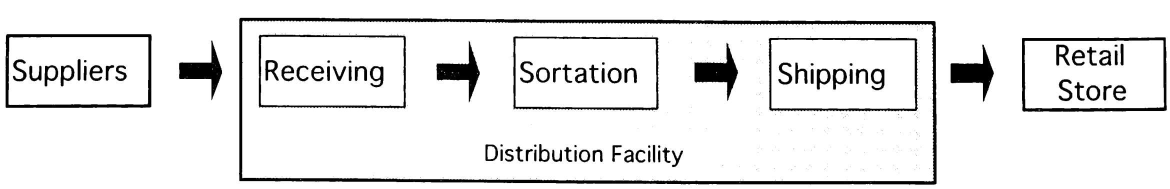

Figure 1: Typical cross docking flow

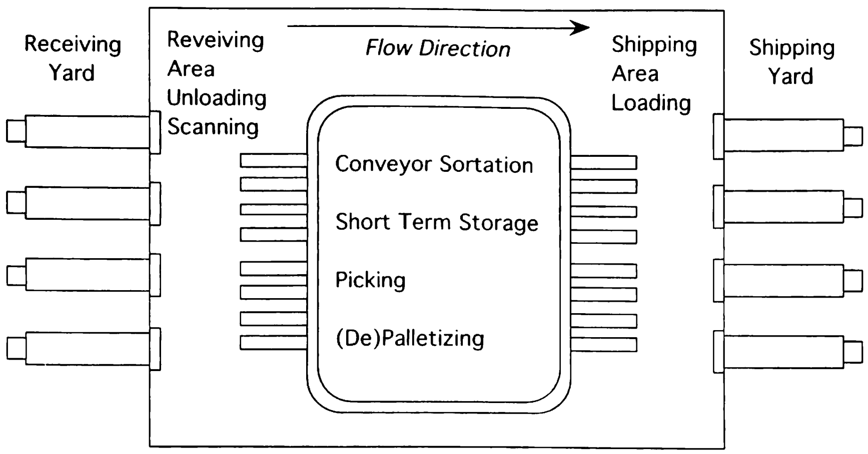

Figure 2: Typical Cross Docking Distribution Facility

2 IMPORTANCE OF SIMULATION IN CROSS DOCKING

For a cross docking solution to succeed, the current and future operations must be understood completely. Because simulation includes building a *virtual* distribution facility, it can provide additional insight beyond other design techniques. Thus, by simply building a simulation model, project team members will better understand their current and future operations. Likewise, the applicability of cross docking can be determined with a high degree of confidence.

Cross docking systems have two characteristics: configuration and control. *Configuration* is the hardware employed in the operation. Cross docking systems are highly automated, requiring equipment from different suppliers. The types of material handling equipment used in cross docking applications include

- case and pallet conveyors
- tilt tray sorters
- automated truck loading and unloading systems
- bar code scanners
- sizing and weighing equipment
- stretch wrappers
- automated guided vehicle systems
- carousels, and
- manually operated fork trucks.

Simulation is required to determine whether all the proposed equipment will function together properly. Given the operating characteristics of each piece of equipment, it determines how the integrated system meets the handling needs of the distribution facility, both now and in the future. Simulation is also used to test different design alternatives to provide the best solution at the lowest overall cost.

If configuration is the hardware, then *control* is the software that keeps the cross docking system running smoothly. This includes truck loading and spotting algorithms, product tracking systems, and information transfer with vendors. Cross docking software must also interface with existing warehouse management systems. The control software for cross docking systems is not purchased *off the shelf*. Instead, custom software must be developed, and simulation provides a method of testing the software components before implementation.

Cross docking is relatively new technology, in terms of both configuration and control. Because of the lack of existing installations, simulation is the next best method of giving confidence that the proposed system will meet a company's requirements.

3 MODELING CROSS DOCKING SYSTEMS

Evaluating cross docking applications requires accurate and timely simulation modeling. Models must include sufficient detail to reflect reality. Likewise, if a model doesn't provide output statistics in the right format, it is difficult to make decisions based on the model results.

There are many possible inputs to a cross docking model. What is important is to retain as much of the detail as possible while still allowing for timely completion of the model.

Cross docking systems handle a high volume of items in a short amount of time. An example of how high this volume can get is the JC Penney Buena Park Distribution Facility, which handles 44,000 cartons in 7.5 hours (Witt, 1992). Wherever possible, a cross docking model should include actual delivery and shipping schedules. Using simplified *from-to* information containing average rates could result in inaccurate data. Where no actual data exists, models should be exercised with estimated peak rates to test system capacity. These estimates usually come in the form of forecasts, but care should be applied to their use in a model. It is important to understand how the forecasts were derived before including the information in a model.

Another aspect that is often overlooked is the truck yard outside the building. Cross docking systems rely on quick truck spotting at the receiving and shipping docks. At minimum, a model must include the delay time for truck spotting. This input should be made variable so that a sensitivity analysis can be performed easily. In most cross docking systems, truck spotting has a significant effect on performance. It is most desirable to model the actual truck movements in the yard; however, this level of detail may be time prohibitive.

The dock doors themselves are a finite resource and should be modeled as such. In some applications, the objective is to determine the number of dock doors required. The developer should build flexibility into the model so that the number of dock doors can be modified easily during model experimentation.

The intricacies of automated material handling equipment must be modeled precisely, as the high movement volumes required for cross docking are sensitive to small changes in equipment parameters. Conveyor system capacity, for example, is based on conveyor section velocity and the size of the package on the conveyor. Some conveyor systems, for example tilt tray sorters, have fixed windows into which cases are inducted. Conveyor merges must also be modeled accurately to determine whether enough accumulation has been provided prior to the merge. Neglect of these equipment handling details prevents accurate determination of true system performance.

Equipment failure and other downtimes should also be considered in a cross docking model. Understanding what happens to a system when downtime occurs helps during the development of recovery strategies to keep the system running. Some important downtime events include

- conveyor jams,
- personnel breaks, and
- bad shipments.

Inventory identification is done through bar code scanning, which occasionally fails because of misplaced labels or package orientation in the scanner. Scanner misreads typically run one to five percent and occur randomly. Mis-reads are either re-scanned or manually entered, and though the percentage is small, the number of mis-reads could be significant with high volumes of packages.

Every cross docking operation requires that some manual operations be performed. The randomness of these manual operations should be considered during model development. This includes collecting data on the operation itself and fitting a statistical distribution to the data. Additionally, wherever manual operators interact with automation, care should be taken to ensure modeling accuracy. In the absence of existing data, thorough sensitivity analysis should be performed.

Cross docking systems include software that makes decisions about how a facility should operate. This includes where to spot a truck (which loading or unloading dock), case or pallet routing, and fork truck task assignment. A good cross docking simulation model includes the algorithms on which the control system software will be based. This will provide an additional check that the software will be able to control the hardware.

4 CROSS DOCKING PERFORMANCE METRICS

In order for a simulation model to be useful, it must provide output that can be used to compare different scenarios. There are a few cross docking performance metrics that are provided by a good model.

At the truck docks, the time a truck spends loading and unloading should be tracked. If a truck must wait to be unloaded, then this time should be recorded to determine yard congestion. Also, dock door utilization is useful when determining the number of doors required.

For inventory moving through the system, such as pallets or cases, the time spent between receiving to shipping is an important measure of how the cross docking system is performing. Recirculation time should also be reported for cases that miss their diverts or must be rescanned.

Throughput of the system should be reported for individual areas as well as for the entire system. Timeline graphs of throughput per hour aid in determining when peak conditions occur.

Material handling equipment utilization should also be tracked:

- conveyor sections,
- fork trucks,
- tilt trays, and
- automated loading equipment.

For conveyor systems, case accumulation in key areas should be reported, and timeline graphs used to help communicate this information quickly.

5 SUMMARY

Cross docking is a relatively new material handling technology, and like other material handling concepts, simulation provides insurance that the system will work as designed. Some aspects of cross docking make it more important to simulate before you build. Including the appropriate information in a cross docking model is important to model accuracy and credibility. Likewise, reporting useful cross docking metrics will aid in the analysis of a cross docking system.

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AUTHOR BIOGRAPHY

MATTHEW ROHRER, Product Manager, joined AutoSimulations, Inc. in 1988. Serving as a Simulation Analyst for five years, Mr. Rohrer completed simulation projects in distribution, manufacturing, and material handling. As a user and developer of *AutoMod,* he has contributed to the enhancement of the product to make *AutoMod* the most powerful simulation product available. His main interest is in extending the use of simulation technology beyond its traditional application in planning and design. Mr. Rohrer received a B.S. in Mining Engineering from the University of Utah in 1983.