

A Study of Integrated Information System in an Automated Warehouse System

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ABSTRACT

There have been several papers to illustrate how an information system is used in an automated warehouse system. These papers, however, do not carefully address the role of warehouse planning/control systems nor do they recognize how to integrate the management planning/control systems, and automated warehouse system. This article addresses such issues and shows how a business computer system can be used to integrate and unify the warehouse planning/control systems and the automated warehouse system into a single and highly productive operating system.

1. Introduction

Automated warehouses are rapidly replacing conventional warehouses for the storage and movement of raw materials, parts, and finished goods. The possible benefits of an automated warehouse are to improve inventory record accuracy and customer service, reduce storage space requirements, increase inventory turnover, reduce inventory levels, reduce product loss and damages, and make lower operating costs. However, some warehouse managers still do not utilize all of the possible advantages. According to Huffman (1985), the major reason is that there is a lack of information flow between various management levels and warehouse opera-

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tions. To achieve the possible benefits of an advanced warehouse system over the conventional warehouse systems, Beal (1988) mentioned the necessity of an integration of both materials and information flows into an efficient and effective total system.

2. Integrated System

Computer systems serve four basic functions—as a planner, as an organizer, as a director, and as a controller of warehouse operations. An optimally automation warehouse is achieved by planning, scheduling, and monitoring all warehouse operations and by directing the handling equipment which moves materials from one installation to another. As shown in Figure 1, a proposed integrated system consists of warehouse planning and control systems (computer information system, advanced order processing system, management planning system, and operations control system) and automated warehouse. Subsystems must be linked to form an integrated whole. That is, the effectiveness of an automated warehouse system depends on how successfully all of the subsystems are integrated and directed toward a purposed goal.

2-1. Warehoused Planning and Control System

2-1-1. Computer Information System(CIS)

A computer information system does not constitute the technology of management in and of itself. Instead, a CIS is merely the part of the technology that delivers the appropriate information to the releveant decision makers. If the information system is inefficient, the entire operation runs inefficiently. So, it is important to realize that installing a computerized information system is not going to improve the warehouse operations and the decision making if the information system is inefficiently operated. Ease, accuracy, speed, and quality of the information flows within the factory should be kept to maximum levels to ensure increased customer service levels, lower operating costs, and more efficient and effective operations. In general the result of implementing an advanced information system in warehouse would be a significant increase in warehouse efficiency and a marked decrease in warehouse operating costs.

Improvements in automated warehouse management have been made possible by several developments in computer information systems (Magee, 1985).

These are :

- * More powerful and more inexpensive computers.
- * Significantly greater amounts of memory.
- * Better, expanded communications capabilities.
- * Wider availability of powerful software.
- * More easily accessible data bases.

These developments have, in time, led to the widespread use of computers and information technology in warehouses which have resulted in a variety of improvements in warehouse operations :

- * Reduce inventory levels while improving customer service level,
- * More accurate forecasts of the usage rate,
- * More efficient warehouse operations,
- * Better organization of delivery schedule and vehicle operations,
- * Better management of inventories and material flows,

Thus, the characteristics of the information system and the warehouse operations need to be jointly considered before an automated system is installed. With the continued growth and technological improvement in information systems, proper application of information technology will be useful for the long-term profitability of warehouse.

With a computerized information system, management is able to perform three fundamental and ultra important activities. First, a computerized information system provides management with immediate data retrieval, such as current customer order status, supplier updates and freight rates. Second, management can quickly and easily process data. The third activity that advanced information systems help perform is data analysis. The information system provides concise reports and information that management can use in planning and controlling decision making. Specifically, the management planning system focuses on the long-term profitability of warehouse. On the other hand, the operations control system tend to produce detailed results that are suited for warehouse operations. In particular, the operations control system output can serve as input into a management planning system. The major decisions and evaluation areas of the management planning and operations control systems will be discussed in the following two sections.

2-1-2. Management Planning System (MPS)

Management planning system is an important part of a company and can significantly influence its performance. A high level project team is the core of this system. Such a team would normally consist of the warehouse management team, logistics team, and production and manufacturing team. The main objective of this system is to achieve the long-term profitability of warehouse while interfacing with finance and marketing divisions.

The major decisions to be addressed by the MPS project team may be as followings

- * Public versus private warehousing
- * Size and location of warehouses
- * Number of warehouses
- * Extent of warehouse automation
- * Customer service levels and inventory stock levels
- * Forecast of demand
- * Transportation modes

To achieve the long-term profitability of the company, the management planning system needs to analyze and evaluate the current systems.

These are :

- * Warehouse operations efficiency and productivity
- * Efficiency of order processing system

- * Vendors
- * Transportation and distribution
- * Quality and speed of information flow within and between subsystems
- * Customer service levels and inventory stock levels

Some potential planning and analyzing models that may be useful in a warehousing system are :

- * Statistical models
- * Economic models
- * Accounting models
- * Management science models
- * MRP/MRP II
- * DRP/DRP II

2-1-3. Operations Control System (OPS)

An outstanding operations control is one key to successful warehousing. The operations control system is linked to management planning system, computer information system, advanced order processing system, and automated warehouse system. Information from these systems are used to monitor, control, and schedule the warehousing operations and transportation activities in the OPS. The OPS drives the material handling systems in warehouse by sending instructions to people or commands to equipment controllers, and by receiving feedback from the warehouse system.

Control of warehouse operations and inventories are perhaps the most important responsibility of this system. Computer-based inventory reports, updated either on-line or in a batch mode, provide the basis for corporate production and procurement decisions. The operations control system dictates the execution of daily warehouse operations, such as :

- * Receiving orders
- * Inspection orders
- * Storage orders
- * Picking orders
- * Packing orders
- * Warehouse stock transfer

The operations control system is also used to generate or determine a variety of transportation activities, such as :

- * Rate freight bills
- * Vehicle scheduling
- * Shipment planning
- * Carrier selection

Thus, the application of computer information to this system can save enormous amounts of time and effort and generate considerable savings in the overall warehouse system. To improve the efficiency of warehouse operations, the operations control system needs to analyze and evaluate the current warehousing operations. These are :

- * Handling equipment utilization
- * Smoothness in material flow
- * Balance in inventory turnover ratio
- * Working hours
- * Handling equipment control procedure and movement pattern
- * Warehouse layout and design
- * Space utilization

The OPS will use a wide range of operating control models to carry out its responsibilities. Some of these models are :

- * Statistical models
- * Queuing/simulation models
- * Inventory models
- * Transportation and transshipment models
- * Storage system design models
- * Handling equipment travel time models
- * MRP/MRP II
- * DRP/DRP II

2-1-4. Advanced Order Processing System

Order processing is the specific part of warehouse operations that tells who, what, and when to complete order demand. Stock and Lambert (1987) broke down the order processing into three groups. The first is operational elements, which consists of entry/editing, scheduling, order-shipping, set preparation, and invoicing. The second is communication elements which are order modification, order status inquiries, tracing, error correction, and product information requests. The third is credit and collection elements. These are credit checking, accounts receivable, and processing and collecting.

The most important factors in order processing system are speed and accuracy. When a firm has speed and accuracy with their order processing system, they will increase their customer service level while keeping the inventory levels low. An advanced order processing system will decrease the time (order cycle time) from when an order is made to when the order is shipped and received by the customer. A decrease in order cycle time may allow the customer to hold less inventory and thus increase the possibility of higher sales growth. This would also improve the customer relations.

The advanced order processing system provides important information for the management planning and operations control systems to make better decisions. This system aids management in how to set up intermediate and long terms planning strategies to exploit new markets, choose between transportation carriers, establish profitable customer service levels, determine the number of warehouse needed. The information that can be retrieved from the automated order processing system is also useful for operational control decision making. It also provides quick access of information on customer credit, updated inventory levels, picking and shipping instructions, and other relevant documentations.

2-2. Automated Warehouse System

Automated materials handling equipment can be utilized to transport materials through the warehouse and serve all operations in the six major functional areas—receiving and quality inspection, identify goods, storage and retrieval, selecting and picking, sorting, and shipping. The computer integrates all handling systems and identification systems for all operations in an automated warehouse.

The most popular computer—integrated handling system in modern automated warehouse is an Automated Storage/Retrieval Systems (AS/RS). The system provides an efficient way of storing a variety of products with different shapes and sizes. AS/RS combines equipments and controls which handles, stores, and retrieves materials with precision, accuracy, and speed under a defined degree of automation. Even though AS/RS requires large initial outlays of capital, the long run benefit of reductions in operating expenses may be much greater. The most important advantages of this system are : savings in storage space, lower operation costs, better control of inventory and reduction in labor costs. Improvements in efficiency and productivity would also be achieved. This in turn would increase profitability and customer service levels. The components are generally S/R machine, conveyor, rack structure, and control system.

The automated warehouse system also includes the automatic identification, which has principally been used for material identification but also has used for vendor identification and a variety of other applications. The three most common types of automatic identification systems are bar codes, optical character recognition, and magnetic stripes. All of these systems can dramatically improve the speed and accuracy of warehousing operations and information flow.

Nelson (1984) illustrated the major information that can be transmitted directly between operations control system and warehouse system. The information consists of : shipping orders, inventory status, warehouse activity levels, warehouse stock transfer shipments, and other administrative matters. Typical reports that can be generated at the warehouse are on—line inventory status information, replenishment lists, stock locations, picking lists, packing lists, shipping schedules, and warehouse productivity reports.

3. The Systems of the Future

The integrated information system is obviously a significant improvement in an automated warehouse systems. There are still significant improvements that can be made in tomorrow's information system in an automated warehouse. These are :

- * full integration of real—time information system in manufacturing, management systems, and automated warehouse systems,
- * development of unified, integrated information systems, available other parts of the company.
- * better decision—making techniques, resulting form improved computer—based information system.

- * decrease the order cycle time and variability,
- * development of employee training programs for new technology application,

4. Concluding Remarks

The approach presented in this paper has attempted to show how computer systems integrate and unify the warehouse planning/control systems and automated warehouse systems in planning, scheduling and monitoring all warehouse operations. It is a complex and difficult problem, requiring the simultaneous consideration of a multitude of factors. There are still potential development areas. It is still, nevertheless, an additional tool that a manager can use for assistance in this complex environment.

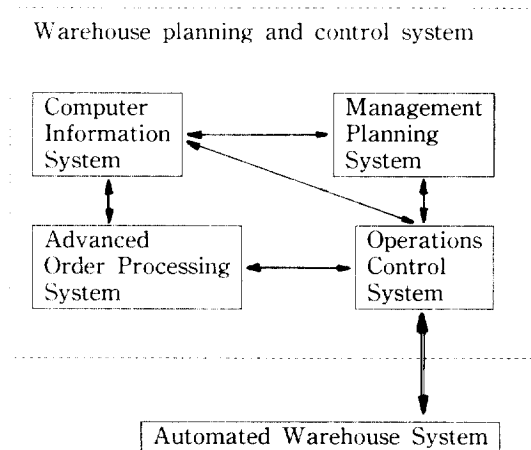


Figure 1. Integrated System in Automated Warehouse

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