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AUTOMATED STORAGE & RETRIEVAL WAREHOUSING

OPERATING SYSTEM & POSTVALIDATION PROCESS OVERVIEW

Steven D. Miller
General Manager
Schering Corporation
2000 Galloping Hill Road
Kenilworth, N.J. 07033

Although technology has had a distinct impact on general warehousing methods, the principal objective of this business function has remained unchanged. To serve! Warehousing is a support activity. For the most part, it is irrelevant who we serve and why we serve them. The key lies in how well we provide this service.

The following information describes how one company has sought to improve upon their means of providing a more efficient warehousing service, and presents a detailed overview as to how their efforts are monitored from both a customer service and inventory control standpoint.

"Investment in an automated warehousing system is a decision that balances the return on investment against the risks involved. And frequently, the savings from an automated system will not arise from materials handling operations within the

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warehouse, but rather from improved control over materials handling operations."

Kenneth Ackerman

The Schering Corporation, the pharmaceutical arm of Schering-Plough Corporation, has recognized the benefits of investing in technology for the future. A multimillion-dollar automated warehouse completed in 1980 is one example. Here advanced technology combines both computer systems and materials-handling equipment in support of present and future strategic planning needs. Known as the Hi-Rise, the facility was constructed between 1978 and 1980 by the Eaton Kenway Corporation. A feasibility study was
buildings located some 15 miles from the manufacturing plant.

The decision to construct an automated versus conventional warehouse facility was based on three principal factors. First, a conventional facility large enough to meet forecasted increases in volume would occupy six times more ground space than an automated structure. The land available at the site of Schering's headquarters in Kenilworth, New Jersey, could not support a conventional warehouse. Second, the cost of labor necessary to support an intensive manual operation proved to be prohibitive. Third and foremost, Schering was willing to meet the operational challenges of our industry through the latest technological development at its disposal. All told, the operational and financial advantages inherent in an automated system justified Schering`s decision to pursue a state-of-the-art solution to the problem of warehousing: efficient use of land and space, elimination of lease holds, labor savings of 30 employees, accurate maintenance of inventory, and tax credit advantages.

The fundamental components of the automated warehouse are its racking, conveyors, robot stackers, and computer control system, which manages the inventory system. The structure itself is 464 ft. long, 165 ft. wide, and 90 ft. high. It is considered a rack supported equipment enclosure, which provides financial benefits. Because the warehouse is considered a piece of equipment rather than a building, there are both tax credit and depreciation advantages.

The building is environmentally controlled at between 50 and 86 F. It has storage space for 30,000 pallets, with 4 different bin sizes ranging from 37 to 73 in. in height. The maximum weight allowed on each pallet is 2500 lb. The storage area has 7 dedicated robot positions. The conveyor system consists of these components:

1. Input function-six two-pallet queue input storage slots.
2. Two discrete sizing/weight stations to measure height, weight, and overall diameter.
3. System-enforced double verification of pallet information before the pallet is stored.
4. Computer-controlled storage and retrieval function.
5. Four full-pallet output queue slots.
6. Four partial-pick output queue slots (less than a full pallet required).
7. Segregated quality control output queue slot for retrieving unreleased material.

The computer system controls the conveyor with an IBM Series 1, and the storage and retrieval warehouse function is managed by a Digital PDP 11/44 interfacing with our host mainframe computer. These two real-time, on line computer systems communicate with each other. The computer system also handles automatic robot stacker scheduling, location control, inventory control, and quality control status. A backup computer that can test software enhancements to the system is used if the primary computer is out of service.

The accuracy of Schering's inventory record is 98.9%. This level of accuracy is a key ingredient in maintaining Schering's manufacturing resource planning and distribution requirement planning systems.

The Hi-Rise inventory system automatically interfaces computer-to-computer with these systems in other divisions: the material-control system (MRP II), financial system, purchasing system (purchase order status), distribution requirement planning system, and quality control system. Once data are keyed into any of the remote terminals located in the warehouse area packaging departments, central weigh operation, or pharmaceutical operations, they are automatically transmitted to the proper operating computer systems (figure 1).

Special quality assurance features include an isolated conveyor spur for segregated delivery of unreleased material. Additionally, a note is sent to the quality control Hi-Rise printer, providing a hard-copy record of the unreleased material being retrieved from the warehouse. Quality control personnel then verify this withdrawal notification against a copy of their original (signed) authorization to transfer the unreleased material. Another feature is the on-line host interface, which allows the quality control computer system automatically to pass status information via the host computer into the warehouse computer six times daily. The computer system is protected by limited CRT entry access and password security; quality control is the only group that can change inventory status within the Hi-Rise system.

The automated warehouse system supports pharmaceutical, packaging, manufacturing, and distribution operations, randomly storing raw materials, packaging supplies, Inprocess material, and finished goods that are awaiting allocation to Schering's five distribution centers. Throughput averages 105 pallets (stored and retrieved) per hour during a 10-hour day.

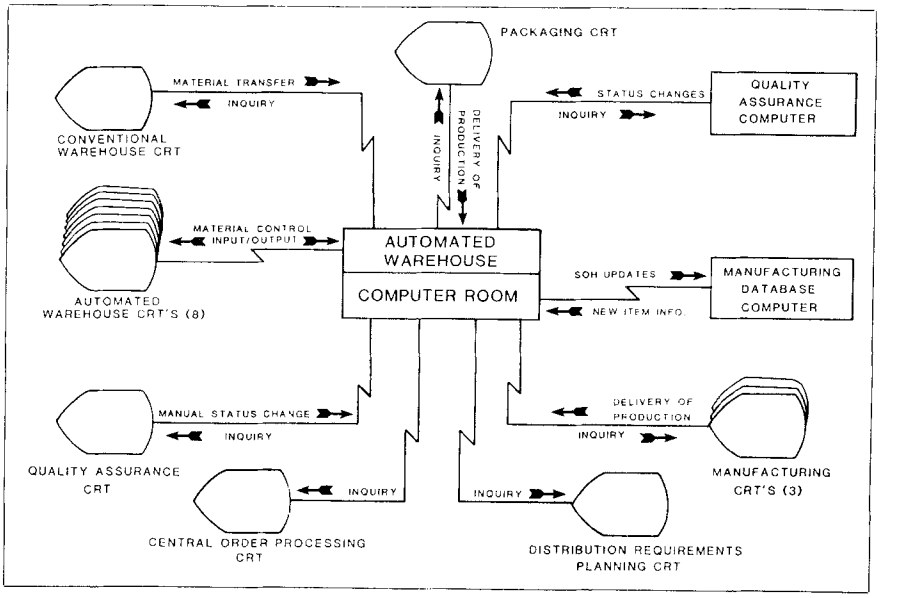

Figure 1: Computer terminals and interfaces.

Material arrives at the warehouse from outside vendors, subcontractors, and manufacturers, as well as from the packaging and research areas. The quality control status of most material being entered is unsampled, and one of the following statuses will occur: Unrealeased, Released, Impounded, or Rejected. Quality control status is updated six times daily. Again, this status update is a computer-to-computer feature, but it can be manually keyed as a backup feature.

The mechanical and computer uptime averages 95% of available time. The computer room has two backup power systems in case of electrical power failure. The first system relies on battery power and will activate for 20 minutes; the second is a power generator that takes over for the battery system to ensure the integrity of the computer software and the real-time communication system. One key factor in maintaining the facility is the dedicated maintenance and system personnel that are on site to respond immediately to all downtime situation.

Today, six years after project start-up, the Hi-Rise Operation finds itself in a postvalidation mode. Having endured the qualification and testing phases, focus is presently placed on preserving the operational integrity of the entire computerized system. The on-going evaluation process employed may be summarized in four categories; Inventory/ Data Monitoring, Preventive Maintenance, Change Control and Operational Auditing.

To insure that the data which is processed through the Hi-Rise and its respective interfaces is in constant accord with the parent validation plan, a series of inventory monitoring programs have been instituted. Weekly cycle counts are conducted, whereby select Hi-Rise inventory data is compared against that contained in the MRP II Material Control System module Quality Assurance status and balance discrepancies are highlighted through this process, and quickly allow one to distinguish whether or not validation protocol has been maintained. As previously mentioned, the accuracy of the Hi-Rise inventory system for calendar year 1985 was 98.9%.

Another control measure employed, material exception reporting, has proved to be a valuable "in-house" monitoring tool. The Hi-Rise system has been programed to produce a series of lot comparison reports, which depict inconsistencies in such key fields of data as FIFO dating, expiration dating and quality assurance status. These material exception reports are reviewed, on an ongoing basis by department personnel, with corrective action taken when necessary.

One of the principal manners in which the validation protocol of a system is supported is through the institution of a detailed preventive maintenance program. Both the mechanical and computerized components of the Hi-Rise are serviced and tested on a scheduled basis in an effort to attain a qualitative percentage of uptime. The computer room has two backup power stations in case of electrical power failure; the first of which relies on battery power. The

second is a power generator that takes over for the battery system to ensure the integrity of the computer software and the real-time communication system. Periodic downtime drills are purposely conducted to review backup and recovery procedures. These drills allow us to examine our response to a system failure and ability to return the system to an appropriate state of control.

The IBM and Digital Computers are maintained under separate vendor service contracts. Routine service audits are conducted on both the system. The potential of equipment failure is greatly reduced through this practice and provides for increased visibility toward future areas of concern. In addition, appropriate corrective measures are taken upon any/all distinguished problem areas which could have a degradation impact upon the performance of the system.

As the IBM computer controls the activity of the Hi-Rise conveyor, while the Digital commands the storage and retrieval cranes, it is imperative that these two pieces of equipment are maintained in addition to the computers which drive them. Through the support of our in-house maintenance staff, routine, have a degradation impact on and on-call service is provided for our stacker cranes and conveyor. Any malfunction of these two pieces of equipment is recorded on an on-going basis so that the same may be analyzed during bi-monthly performance review meetings. All pertinent data accumulated from this process is filed for historical reference as well.

To support the ever-changing demands placed on our warehousing function, it is often necessary to alter certain programs in the operating system. If a change is deemed necessary, it must first be reviewed by representatives of Schering`s warehousing and information systems groups. All aspects of a change recommendation are analyzed with in depth focus placed upon 1) the anticipated benefit to be realized and 2) the potential ramifications such change might have on other programs.

Once a change recommendation has been formally approved a qualified programmer shall implement the enhancement and commence testing it upon the back-up system of the Hi-Rise. Here, the change is reviewed to determine if the program meets its' anticipated objective and whether or not any impact has been witnessed in accordance with our validation protocol. If a change to program affects said protocol in any fashion, appropriate re-qualification measures are employed. It is not until these action steps have been successfully completed, that subject enhancement shall be introduced to the production system for final testing and sign-off.

Since 1980, over one hundred (100) program changes have been implemented within the operating system. These enhancements have helped to consolidate pertinent data, expedite our flow of material and information, and cultivate a more conducive "tie-in" to the other systems with which the Hi-Rise system interfaces.

Although the operating system of the Hi-Rise is constantly monitored by warehouse and information systems personnel, it is essential that independent audits are conducted. Periodically, a select team of financial auditors reviews our validated system to determine whether standards are available, sufficient and consistently adhered to. This practice allows us to reinforce evidence that the system's integrity is intact, in addition to evaluating its' overall performance.

Today, the Hi-Rise is viewed as a solvent and integral support function to our domestic manufacturing operation.