CASE STUDY

Automated Warehouse Design Material Flow Analysis

PROJECT SUMMARY

A simulation model was built to evaluate the performance of an automatic warehousing system under different values of design parameters and operational policies. The automatic warehousing system considered was composed of two main segments: the AS/RS and marshaling system. The AS/RS included the stacker cranes, storage racks (bins), input buffers, and output buffers. The marshaling system included the output dock, input dock, pick loop, and the input/output conveyor. The two systems interfaced at the input and output buffers of AS/RS. The performance of the warehousing system was observed under a large number of design parameters and operational policies including the number of aisles in AS/RS, the number of horizontal and vertical bins in each aisle, aisle assignment policies, bin assignment rules, and conveyor and stacker crane speeds.

SYSTEM DESCRIPTION

The incoming parts are first loaded to (input) pallets and the contents of each input pallet are communicated to the central computer. The computer assigns an aisle number and a bin (rack) location to each input pallet. The input pallets queue at the input dock. Whenever an empty place is detected on the conveyor, the input pallet is transferred to the conveyor. When the input pallet reaches its designated aisle, the computer checks for an empty place in the input buffer of the aisle. If an empty place in detected, the input pallet is automatically transferred to the buffer. Otherwise, the input pallet makes one complete cycle and tries again to enter to its designated aisle. The automatic stacker crane of the aisle finally picks the pallet from the input buffer and stores it to its assigned bin.

When an item is requested from the system, the computer selects the aisle and the rack location of the (output) pallet. The stacker crane picks the output pallet from its bin and transfers it to the output buffer. Whenever an empty place is found on the conveyor, the output pallet is moved to the conveyor and transported to the output dock. The output pallet may then enter a pick loop or it may be emptied and returned to the incoming stock location for reuse. The pallets that enter the pick loop are sent back to the AS/RS after their contents are altered.

OPPORTUNITY

The client, a major automotive manufacturer, wanted to verify the throughput of the system under different conditions. The performance of the warehousing system as demand (store and retrieve requests) doubled and tripled was to be observed. The number of aisles (stacker cranes), the capacity of each aisle, and the rules for selection of the store and retrieve requests for processing by the system had to be decided.

APPROACH

The overall objective was to design an automatic warehousing system that was efficient and flexible. The best values of a number of system variables and operational policies had to be decided which included:

- Number of aisles
- Vertical positions of input and output buffers of each aisle

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- Capacity of input and output buffers
- Number of vertical and horizontal bins at each aisle
- Policy for storing different part types (based on part turnover frequency) at the aisles
- Policy for storing different part types (based on part bin size requirements) at the aisles
- Horizontal and vertical maximum/minimum stacker crane speeds
- Conveyor speed
- Store and retrieve request profiles for each part type
- Bin assignment rules for store and retrieve requests (closest - open location rule, first-stored, first retrieved rule, closest - full location rule, frequency class-based closest - open location rule)
- Position of input and output docks.

SOLUTION

The results of the simulation determined that:

- Crane speeds can affect the throughput rate of the system by 30 percent.
- Closest - full location bin assignment rule increases throughput by 10 percent when compared to first-stored, first-retrieved bin assignment rule for the retrieve requests.
- A 3 - aisle system degrades the throughput of the system by about 10 percent when compared to a 4 - aisle system.
- The proposed 4 - aisle system can perform under acceptable conditions even if the demand for the system increases by three hundred percent.