USING COMPUTER SIMULATION TO OPTIMIZE THE OPERATIONS FOR AN AUTOMOTIVE MANUFACTURING FACILITY

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ABSTRACT

This study describes an application of discrete-process simulation to an instrument panel (IP) assembly process within the automotive industry and to demonstrate the ability of AutoMOD simulation package as a flexible modeling tool. Material flow in a typical manufacturing facility is a critical activity in accomplishing timely product deliveries. There are many dynamic factors that impact the movement of material within a facility. Among those factors, delivery schedules, availability of material handling equipment, routes of movement, aisle utilization are the important ones. Simulation is the most suitable tool to capture such dynamic nature of operations.

1. INTRODUCTION

Simulation models of material handling systems like those found in automotive assembly systems often require many variables and complex operation logic. These systems have many different variables associated with them. The most important ones are: conveyor speeds, material handling equipment quantities, routing information, active and inactive station (dock) information, station operation times, and shift schedules. Material flow systems show many common characteristics for particularly systems that are characterized by discrete moves of a given quantity of material with a transport unit. A transport unit may be in a variety of forms from a human operator to an automated vehicle but the nature of the operation remains the same. In this paper, we present a generic modeling framework in Automod for modeling such systems. The model described in the paper can be used for analyzing similar systems by tailoring to a particular layout. The paper also includes some of the benefits of using simulation for analyzing material flow in a manufacturing plant.

In order for a simulation analyst to control or experiment with a material handling system, he or she will usually have to vary one or more of these variables. In the past, this has meant that these “hard-coded” variables would have to be changed one by one through menus for each material handling segment or system. This paper will address how users can use external data files to control these traditionally “hard-coded” variables, thereby allowing simulation analysts and their customers to drive their material handling systems as they have traditionally used external files to provide process information for their models.

The approach was to create a flexible and robust model that imports all of these system parameters from external data files. This allows for an increase in model efficiency if model experimentation is large and involves many different physical changes. Using this method, a potential customer can modify these parameters for experimentation with a run-time version of AutoMOD simulation software.

In this paper, we first state the benefits of the generic simulation model, and then provide an overview of the production system under study and then describe the development of the simulation model. We conclude by describing the use of simulation model for future analysis.

2. BENEFITS OF THE GENERIC SIMULATION MODEL

Discrete event simulation can be one of the most powerful tools available to industrial engineers. Simulation programs allow us to predict overall system performance like the throughput of a system. It is also beneficial in identifying bottlenecks, evaluating proposed alternatives for eliminating bottlenecks, identifying under utilized resources, and determining buffer sizes just to name a few. Simulation tools like AutoMOD offer users the ability to investigate many diverse process systems from automotive manufacturing plants to hospital operating wings.

Traditionally, simulations are developed based on a pre-determined base layout with appropriate assumptions and data. However, in the past few years, companies are starting to use simulation in the very early stages of process design. In this phase, many of the parameters that simulation modelers have come to expect to be available for use as an input to model are unavailable. During this phase, system variables such as location of conveyors or stations, operation times, pallet or carries counts, shift patterns, etc. are changing continuously. If all these variables and parameters are hard-coded into the model, too much time, resources, and overhead will be spent to make changes in the model. To prevent this, a flexible and reusable simulation model should be developed by simulation engineers.

Even if the model is created later in the design phase, creating flexible models becomes an important issue. Here more information is known about the process layout; however, behavior of that system under many different parameters may not be known. During the experimentation phase of an analysis, for example, most simulation engineers have to conduct different what-if scenarios and alternatives to determine the effect on system performance measures like the throughput of the system. Based on the findings and result of experiments, the customers may want to run more scenarios by changing the speed of a conveyor, the path of the material handling equipment, or the cycle time of the operator. With most software packages, the simulation engineer has to update many dialog boxes or menus to vary even the simplest parameters of a model. The probability of making errors can be very high leading to faulty results. In addition, if there is a gap between the time the model was originally created and the next time it is used, there is a greater possibility that the simulation engineer will not remember how to modify the simulation model. This will also increase the likelihood of an error.

3. OVERVIEW OF THE PRODUCTION SYSTEM

The production system under study comprises the plastic extrusion, component assembly, and final assembly operations within an instrument panel (IP) assembly plant. The client was reengineering its production, warehouse, and vehicle distribution system over North American automotive assembly plant network. The study was conducted to develop computer models of the production plant and distribution channels and to recommend and evaluate improvements in before mentioned systems.

The main objectives for this study were:

1. Create a flexible and robust simulation model of IP Production System that can be handed off to the client for use via a run-time only version of AutoMOD simulation software.
2. In this model, utilize appropriate variables to allow key parameters to be changed and experimented with model runs. The initially determined questions to answer using the model were:
   a) the comparison of the push and pull material replenishment system in the facility
   b) the optimum number of the material handling equipments (forklifts, tow trucks, etc.) for each department for the proposed replenishment system
   c) the optimum routing of the each material handling equipment in order to get equally congested aisles to prevent accidents in the facility
   d) the optimal number of docks and schedules for the incoming and outgoing delivery trucks which transports raw material, semi-finished, and finished products.
   e) The best storage locations and quantities for all materials and products traveling in the system
   f) The optimal reorder point quantity for each material used in the assembly lines
   g) The optimum speed of 18 instrument panel assembly lines
   h) The number of finished-good shipments per week for each instrument panel type

In order to satisfy these objectives, it is decided to include following parameters and variables as an input data in the simulation model:

A) System Variables

1) Part Types
2) Part Volume
3) Container specifications (# of parts in a box, box type, # of parts in a container, container type)
4) Material handling device quantity
5) Material handling device route for each part (intersection by intersection)
6) Parking and empties location of each part in the system
7) Dedicated material handling devices for each part type or area
8) Material handling device capacity
9) Material handling device speed
10) Valuable versus non-valuable time for material handling devices (Delivery time vs. battery charge time)
11) Storage system or buffer area locations and capacities for each part
12) Loading and unloading time of each material handling device for each part
13) Assembly line names, types and speeds
14) Assembly line scheduled start and finished times
15) Transportation supplier name, # of trucks dedicated for the facility, trucks capacities,

16) Docks and gates supplier trucks may approach for receiving and shipping of parts
17) Transportation supplier tardiness frequency, tardiness amount, under-delivery frequency and under-delivery percentage
18) Push or pull replenishment system switch toggle

B) Station(Pick-Up & Drop-off Points) Variables

1) Pick-Up & Drop-off Points for each part
2) Active/Inactive station toggle effect
3) Station load/unload cycle times
4) Intersection control logic

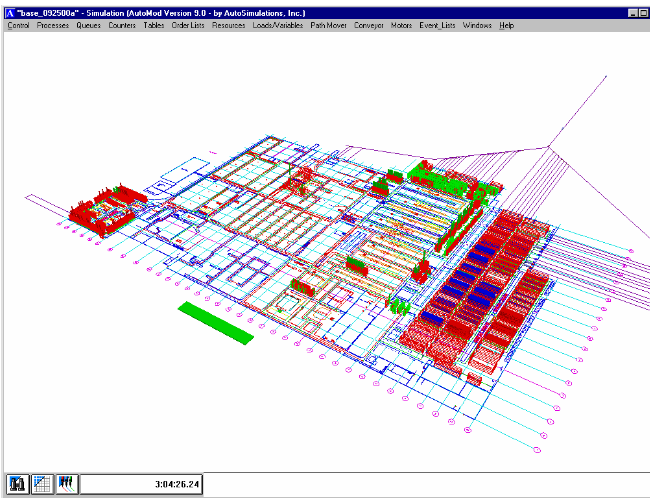
C) Shift Variables

1) Shift operating patterns
2) Individual shift events (shift lengths, breaks, time between shifts)
3) Model run length (up to X day run length)

D) Output Reporting

1) M.H device utilization, # of times each material handling device was used throughout specified time period
2) Path utilization
3) Congestion rates
4) Dock utilization
5) Buffer utilization
6) Intersection utilization
7) Path locations for each part (TBD)
8) Load/unload station rates

In addition, it was agreed that the data would be entered in to the model by using Microsoft Excel Spread Sheet including macro for user-friendly interface. 3D Animation of the model including layout of the facility, material handling equipment movements and storage area dynamics were output of the study.



4. USE OF SIMULATION MODEL

After development stage of the model, in order to capture optimal facility design parameters and to satisfy material flow requirements, several scenarios were conducted. The client used the simulation to understand the relationships between a layout and the material flow in a facility, the movements of material from receiving docks to intermediate storage and to consumption points analyzed by considering the distances and the volumes. Then, by analyzing the frequency of movements between various points of a plant layout, a quantitative assessment of its efficiency were made in relation to the flow of materials. Production schedules, variation in product mixes, availability of material handling equipment, routings, transportation supplier capacity and delivery schedules created varying loads on the system. A simulation model were built to study the effectiveness of different forms of material handling equipment by considering their detailed parameters such as speed, acceleration, movement paths, and traffic and control logic. In addition, simulation also helped to make dynamic analyses of aisle congestion, buffer space utilization, and traffic congestion at critical intersections. Clearly, dynamic analyses were utilized in evaluating the efficiency of a layout in terms of flow of materials for complete, accurate, and timely analyses.

An appropriately designed flexible simulation helped to do the analysis quickly and easily. The model creator also handed off their work to non-simulation experts. These attributes were particularly attractive to customers who have only a runtime simulation. It was also beneficial when the same model must be reused for future investigations. The software should also have the ability to update the animation of the model as the data values change. This will help the end user to understand the results of particular scenarios and minimize confusion associated with model data changes.

APPENDIX: TRADEMARKS

AutoMOD is a registered trademark of AutoSimulations, Incorporated.

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