Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

FROM SIMULATION TO REAL-TIME TRACKING AND OPTIMIZATION

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ABSTRACT

Simulation software can be an effective tool to analyze and optimize process based operations. This abstract details the implementation of a warehouse simulation using the Simcad Pro dynamic simulation environment and its integrated data connectivity. The validated simulation model is then transformed to a real-time system providing live visibility, tracking, and real-time optimization of the warehouse. Details on connecting the model to RFID, Barcode, GPS, and WMS systems are also presented. Real-time visualization and optimization of the facility including; AGV behavior, picking, and replenishment are based on the real-time data received. Moreover, internal and unattended model transformation and optimization based on WMS feedback is explored.

1 INTRODUCTION

In every industry, from manufacturing to services, logistics and healthcare, there is an increasing need to do more with less, increase efficiency while reducing cost, and improve utilization while maximizing throughput. Manufacturing and logistics are at the forefront of this transformation, and changes implemented within their realm are finding their way into other industries.

Process improvement is a constant, never ending effort that strives to achieve better performance with current or reduced resources. As improvement in one area is achieved, other opportunities arise and new ideas are tested and implemented.

Improvement ideas do not always produce the desired results; some improve the performance of a sub-component while introducing negative consequences to the overall system.

To achieve the required enhancements, process improvement professionals and system designers have introduced automation and smart systems into their current environment. Automation, including AS/RS, Guided Vehicles, smart machinery, and intelligent conveyor systems have been implemented with great promises of exceptionally high OEE (Overall Equipment Effectiveness) and throughput numbers that seemingly make them a one stop solution to all issues.

Although automated systems have such great potential, they also need to perform within two key boundaries. First, they have to interact with human run systems. Humans do not have the robotic behavior of machinery, yet they are indispensable in any environment. Second, automated systems must be able to adapt to fluctuations in the operation, and to the interaction with other automation systems. Moreover, system malfunction, breakdowns and changeover of such systems can have a cascading negative effect on the operation.

This white paper addresses the role of Dynamic Simulation® in enabling designers and process improvement professionals to maximize their design investment, analyze the impact of new equipment, and be better prepared for future changes to their operation.

2 CHALLENGES

Why do current designs fail to achieve their promised performance?

Recurring questions often come up in meetings, offline discussions, and in the minds of all designers; how many guided vehicles do we need? Is our slotting optimized? How much buffering do we need to support a manual operation? How can we better schedule our tanks? What is the impact of the cleaning cycle? The list goes on. The fact is that there are many questions that need to be answered. Some are more

pressing than others, while most can have a negative impact on the performance of the system if not handled properly.

In the case of simple systems, where a single input, a single output and a constant feed rate produce a single product, computing the system throughput and OEE is simple. Unfortunately, a closed loop system with a single product type is seldom the case. Automated systems are built to handle multiple product types and variations in order to meet their ROI. To complicate things further, different products require different speed rates, change-over and sometimes labor requirements. All of these constraints contribute to the overall system throughput and OEE, making a simple formula computation an invalid and inaccurate representation.

A common negative effect of improper system throughput calculation is that operations are promising customer deliveries based on high OEE of individual components. Although each independent sub-component performs at the designed specifications, the overall system OEE is lower due to component interactions, product variations and other unexpected delays. Equipment ROI is not achieved, order delays become a common occurrence, and frustration sets in.

One example of improper identification of system inefficiencies is more apparent when identifying the optimum number of guided vehicles needed for an operation; a Sorting Transfer Vehicle (STV) loop that interacts with three systems, one unloading station driven by a human interface and two loading automated operations.

Historically, a quick math formula that takes into consideration the inbound rate, speed of loading/unloading, and STV speed is used to identify the number required. Then designers add an additional STV as “extra buffer”, or cushion, for the system. When the system goes online and external factors start to impact the STV loop its efficiency drops and all connected systems follow suit. In certain situations, the STV track is interacting with processes that have a manual component. With a limited number of available drop locations or inadequate buffer capacity at the manual stations, any inefficiency in the manual operation will have a cascading effect on the STV loop itself as loaded STVs need to complete additional loops on the track while waiting for a drop location to become available. When the majority of the STVs are loaded with products, it is assumed that the loop has reached its maximum throughput, and additional STVs are needed. The fact is that even though products are loaded on the STVs, the loop efficiency is low since multiple passes are needed before a drop can be made. As a result the STV loop is viewed as the choke point of the system, while, in reality, the STV loop efficiency is low due to inefficiencies in the interfacing systems. The solution is not achieved by adding STVs to the loop, but by finding the external conditions that are causing the reduced efficiency. The true system efficiency in this case is not measured based on how many guided vehicles have products, but by how many successful single pass moves are achieved.

The list of examples is endless, and systems, although designed with the best intention in mind, fail to meet the set expectations when implemented as part of a larger system. Two key problems are apparent. The first is related to systems interaction where the initial system design does not take into consideration the impact of other systems (both human and automated). The second is driven by the fact that all systems are evolving, and initial logic and interaction criteria will constantly change.

3 BUILDING A DYNAMIC SIMULATION MODEL

3.1 Model Building

A dynamic simulator's model building environment provides constructs that allow users to define the model without relying on code, and without generating code in the background. In an automated warehousing environment, start by defining a single ASRS storage unit, the AGV/STV interaction loop, conveying system and other manual racks. For ease of model building, a single entity of each component is built and validated before the full model is expanded.

Location and initial state information is retrieved per product SKU and the ASRS storage unit is expanded to support the proper behavior. The next step is to define the AGV interaction logic. Keep in mind that the model data will need to vary after the model connects to live data systems, therefore the model needs to define the entity behavior and logic.

Expand the conveying behavior for the remaining entities and inbound/outbound interfaces to the STV/AGV loop. This section will be driven by the WMS data feed at a later model stage.

In between each step, validate the model using data retrieved from existing systems. A data example may be a daily storage and retrieval schedule from the ASRS to and from inbound/outbound areas. For the model to be valid, its output must match the actual system output.

A common mistake is to force the model to generate the required throughput using injected wait times that are unique to the data set being used. This type of implementation must be avoided at all cost as it impacts the model validation and every decision made going forward.

3.2 Model Validation and Interaction

With the base model built, perform a complete validation on the defined system components. This is an important step to make sure that all the components are implemented correctly, and that no constraint is added that is not part of the actual system behavior.

With the components validated, the ASRS is now expanded to support all locations needed, along with travel distances to each location. In a dynamic simulator, the distances should be automatically computed and ASRS speed is the only input into the model. Expand the remaining entities by duplicating already validated behavior.

Run a full validation of the model and start interacting with the simulated environment in order to validate the final behavior and verify that all constraints have been implemented.

An example interaction scenario is to play the what-if game live, while the rest of the system reacts and the simulation is running. Using the STV example, dynamically break down AGVs/STVs, create a delay on the ASRS, or pause unloading processes of the system. Since the above interactions are performed live, during the simulation run, the model reaction can be visualized through its animation and reaction compared to the actual system behavior.

At this point, the model may be used to analyze new scenarios, identify improvement areas, and perform capacity analysis.

3.3 Connectivity

As with the interactive environment, Dynamic simulators have an integrated ability to connect to data systems at run time, and do not preload the data into their environment. Use the integrated features to directly pull data from the external systems (WMS, RFID, PLCs, Barcode scans …). The dynamic interaction that was performed on the simulation manually is now performed directly through the integrated data connectivity making the model a live replica of the warehouse. By making the model aware of the current state of the warehouse, and its historical performance, it can, within a high degree of accuracy, consistently predict the future of each component performance and overall system schedules.

Two key advantages are apparent;

- There is no limit to the amount of data or data sources available to the simulator. In other words, since the system can connect to existing ERP, MRP, WCS, and WMS systems, pull in the current state, previous behavior, and future orders it can perform a simulation analysis without requiring any model changes.
- The developed model can also be used for daily scheduling and analysis activities. Since the model is already developed and connected to actual systems, a daily run can provide insight on the day outlook and allow managers to be better prepared to handle any potential problems that may arise.

3.4 Analysis and Visualization

By utilizing the built features of a Dynamic simulator, all required analysis values for the model are generated. Lead times, utilization, efficiency, throughput rates and cycle times are all integral parts of the model and can be displayed or analyzed as part of the model view.

From a visualization perspective, the animated environment of a dynamic simulator is more effective since it represents the current state of the simulation engine. What is animated on the screen is what the simulation engine is doing, including how current constraints are impacting the system behavior and analytics.

3.5 Dynamic Value Stream and Other Views

Data generated by the live model can now be displayed in different formats from overall performance metrics to section specific information. In addition, the system can display current deviation from standards, a dynamic value stream based on current numbers and other metrics required to effectively manage the operation.

3.6 Expandability

As all systems evolve and change through time, the model needs to be constantly adapt to the changes in the actual environment. By using the capabilities of dynamic simulators, the model can evolve dynamically as live systems evolve. When new locations are added, a new machine defined, or an extra AGV inserted in the system, the model dynamically changes behavior and applies the necessary changes on the model with minimal human interaction.

4 SUMMARY

Using Dynamic Simulators provide the proper tools and analytics required to analyze and troubleshoot today’s complex systems. As new constraints are identified, designers change their dynamic models and use the interactive reporting and visualization in order to define and validate new solutions.

With data connectivity and tracking systems becoming the norm, dynamic simulators are finding their way into the daily routine of designers, managers, operators, and process improvement specialists. Due to their design openness, dynamic simulators can interact with tracking systems (RFID, Barcode, GPS, etc.), and machine PLCs to dynamically create a visual picture of the present, accurately replay past events for analysis, and forecast the future of the operation.

Dynamic simulators, coupled with integrated dashboards and alerts, provide a rich and more complete environment that rivals the analysis and forecasting of current MES systems on the market today. Moreover, the ROI of dynamic simulators far exceeds their implementation cost as they provide optimization of the current state while providing an efficient analysis path for all future changes to the operation.

CreateASoft Inc. is the developer of Simcad Pro® Dynamic Simulator and SimTrack® Dynamic Visibility tool. More information can be found on our website https://www.createasoft.com/

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