Proceedings of the 2022 Winter Simulation Conference
B. Feng, G. Pedrielli, Y. Peng, S. Shashaani, E. Song, C.G. Corlu, L.H. Lee, E.P. Chew, T. Roeder, and P. Lendermann, eds.

SYNCHRONOUS MANUFACTURING SIMULATION FOR REAL TIME DECISION MAKING

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ABSTRACT

The engineering applications in Product Lifecycle are becoming entwined with real time data, enabling faster and easier communication among global manufacturing organizations. In the age of the Industrial Internet of Things (IIoT), production resources on the shop floor are more connected than ever. Integrating IIOT with Discrete Event Simulation (DES) will help us to enhance manufacturing processes and gain insights on the potential pain areas of the system in real time.

This paper discusses the process simulation aspect of Digital Twin for a Manufacturing System and the data network which will support in taking smart decisions in real time. A manufacturing case study will be presented to demonstrate why Simulation as Digital Twin is a next generation cutting edge Technology.

1 INTRODUCTION

With increase in number of product variants, the manufacturing environment is becoming more and more complex. In order to create an accurate production line and reduce the complexity, it calls for quality and reliable data. Conventional simulation method is restricted to ideal state constraints and a lot of assumptions like resource availability, scheduled or predictive breakdowns, inventory is largely based on historic data.

Digital twin models, which rely on sensor data, work hand in hand with developments in Industry 4.0. According to Negria et al. (2017), the digital twin is a virtual representation of a genuine machine, system, or process that may be used to imitate its behavior. They have mostly been utilized in production layout design/modification, operation, and maintenance. A digital twin is synced using real-time data from the physical system, which is the main distinction between it and a typical simulation model.

2 MODEL DESIGN AND FRAMEWORK

The concept of Digital Twin was proved on an Assembly System linked with its test beds at the end. The main focus was to validate the allocation of workforces on the assembly line and maintain the order number at the end of test bed.

Initially conventional DES approach was applied. The conventional DES works on certain assumptions and constraints designed for an ideal manufacturing environment. However, certain elements (viz. material delivery delay, unplanned absenteeism, quality issues, introduction of unique product for different test) with low occurrence probability but significant impact on the KPIs are not captured.

To handle these events the approach was shifted to Digital Twin. Data collection infrastructure was installed to capture product arrival and departure at work centers using RFIDs/ Handheld scanner and relaying the order information through MQTT broker (Message Queuing Telemetry Transport). Order information along with time stamp was stored in an intermediatory database which in turn was connected to the Simulation Model. With each entry in the database the simulation is instructed to carry a specific set of tasks (Fig.1).

For instance: When product X arrives at Station A, the product data is captured and simulation would deploy appropriate work forces for processing. Station may be designed for employing two operators for 90% of orders. For remaining 10% the product may need only one operator. Digital Twin helped us to deploy only one operator and allocate others for a different value added task. Similarly, at the end of the assembly station the products are routed to different test benches by predicting the availability in real time. This would reduce sequence disruption and increase reliability.

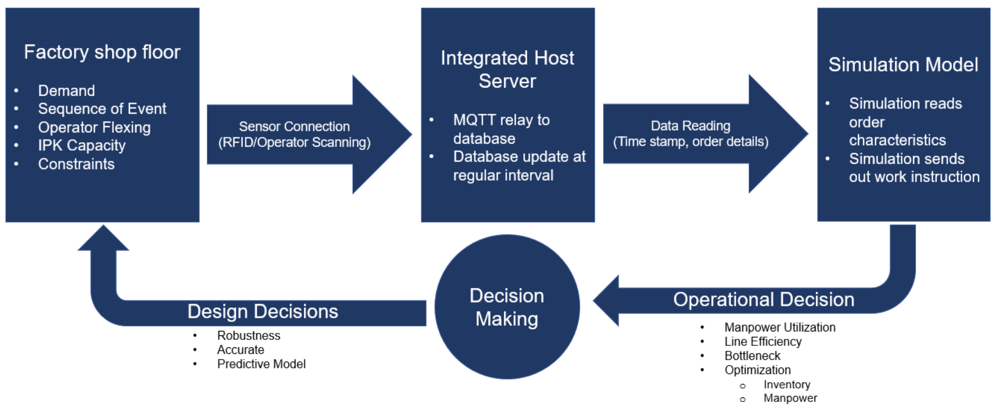

Figure 1: Simulation as Digital Twin Framework.

3 RESULTS

The conventional DES observed that operator utilization and system reliability was lower than the established benchmark. By running the simulation with real time data, management was able to identify the pain areas and made necessary decisions to enhance the manufacturing efficiency.

4 WAY FORWARD

Digital Twin clubbed with Simulation can be further integrated with capabilities like Artificial Intelligence or Reinforcement Learning in order to automate the decision making process. For Example: Product routing to test benches is currently done by an operator. The availability of testing work centers could be predicted using reinforcement learning and the PLC (programmable logic controller) can be signaled to route the product without human intervention.

REFERENCES

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