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Design

Event-Based Simulation:

- Core Concept: This simulation is event-drive oriented in which events are set as a basis for describing the manufacturing process and include event on arrivals of raw materials into the factory floor, on completion of production phases, on machine breakdowns or on routine maintenance among others.
- Event Queue: The events are organized into two priority queues sorted with the time stamp so the priority is given to the events with the higher time stamp.

Production Line Modeling:

- Stages of Production: The various manufacturing process that are followed in industries include; processing of raw material, manufacturing operations, assembling, checking inspection and packaging.
- Resource Allocation: Every production phase has its required machines and human resources, which are assigned in accordance with the needs of the production and the existing constraints.

Product Types:

- Product Differentiation: It is possible for the system to accommodate for multiple product types depending on how they have to be processed where depending on the type, they have their own processing time, number of times the machines have to be set up, and the routes in the production line that they follow.
- Dynamic Product Routing: This means that the products are processed on the basis of the event type so that the type can route the product dynamically through the supply line.

Maintenance and Failure Handling:

- Machine Reliability: Random machine breakdowns are carried out in order to mimic real-life situations and hence disrupt the overall productivity of plant and machinery and call for a halt in production for machines to undergo checks and repairs.
- Scheduled Maintenance: Maintenance of the machinery is planned at a certain time in a periodic manner so as to avoid inhabitation of the machinery due to breakdown.

Implementation Details:

Event Processing:

- Event Types and Handling: In the event handling, an event is handled based on the type of that event and each type of event has its own logic for their handling like – arrival of the event, stage completion, change in set-up, failure event, maintenance event etc.
- Event Scheduling: Arrival events during the simulation are dynamic while the time span events occur at different time intervals On the arrival events, an exponential distribution is used to indicate that arrival tends to occur at random.

Machine Failure and Maintenance:

- Random Failure Generation: The breakdowns are then simulated randomly but uniformly across time in the shift with the break down time between times drawn from a pre-specified interval.
- Maintenance Scheduling: This process is carried out through fixed maintenance intervals which are used to periodically plan for maintenance activities thus making sure that maintenance is performed on the aspects that have not failed yet in a bid to prevent such aspects from failing in future.

Product Routing and Setup Changes:

- Dynamic Setup Changes: Sipline setting up changes occur when moving from one type of product to the other, so as to set up the flow in readiness for production for the different type of product.

- Product-Specific Routing: This enables the flow of the products through the events in the production line in a manner that depends with the type of product hence it is possible to have product specific passes through line with differing processing durations and applicable machines.

User Interaction:

- Input Parameters: There are number of parameters that the user can enter into the programme like number of machines at each stage of production, time taken for set-of change, time required for maintenance, shift duration etc. so that the programme runs to the model constructed by the user for a particular situation.
- Output Visualization: Externally, event logs are established such that users get to know the simulation's progress in form of event timestamp, type of event, and product types helps in analyzing plus evaluating the performance.
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Conclusion:

The model shown in this work is based on the event-simulation of the manufacturing system and is designed in a way to be easily extended and adapted to other manufacturing systems. Hence, there is always an interest in testing the system with different scenarios and performance parameters; this way, system designers can learn about the system or application performance of bottlenecks, and evaluate the possible strategies for the improvement of system throughput and utilization of its resources. The way of design and construction provides enough realism and accuracy of model to reflect a real production world and to provide insights into decision choices and efforts at improving the functioning of actual manufacturing systems.

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Findings and Recommendations:

- Throughput Optimization: Through use of the simulation one can experiment and analyze a maximal throughput by varying the number of machines and or the time taken to set up the machines as well as the period of time a machine takes before it's serviced.
- Bottleneck Identification: Concerning process optimization, event logs and performance metrics unveiled a lot about a production line, especially the avenues for improvement.
- Resource Utilization Analysis: Thus, the simulation offers knowledge about the usage of resources, medical devices, machines, and shifts that can be used for efficient schedule organization and appropriate distribution of machines.
- Product Diversification: To add another layer in the simulation when a company handles multiple types of its products, new event types and the processing algorithms have to be incorporated. This would include such as routing, controlling for product specific routing, change in setup, and management of machine allocation.
- Realistic Parameterization: More detailed data adapting the accurate MS processing times, failure rates, and the precise duration of maintenance would improve the matrix realism and usefulness of simulation.

From the above discussion, it is clear that this simulation is a useful tool in enhancing knowledge as well as practicing the management and operational decisions in manufacturing systems so as to spearhead effective process improvement efforts.