Decision Science
Assessment 2 - Programming Assessment

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1 Introduction

This project report outlines the design and implementation of a discrete-event simulation model for a factory production line that builds lawnmowers on demand. This simulation aims to answer critical questions posed by the factory owner about production efficiency and potential system improvements. The manufacturing process consists of several steps, with a particular emphasis on the blade-fitting machine, which is the system's primary bottleneck.

The simulation is intended to mimic the factory's real-world operations by considering randomness and controlled variations in event timings. We model the system carefully for details like order processing, blade-fitting machine breakdowns, and repair times. We intend to provide insights into the impact of machine breakdowns, repair times, and the potential benefits of investing in a new machine by simulating the production process.

We present the conceptual model, code implementation, and simulation results in this report to help the factory owner make informed decisions about system improvement.

2 Part 1- Conceptual Model

2.1 Draw a schematic of the system.

Figure 1 (the next page) shows us the schematic of the system, with the components of the factory involved in the lawnmower's construction.

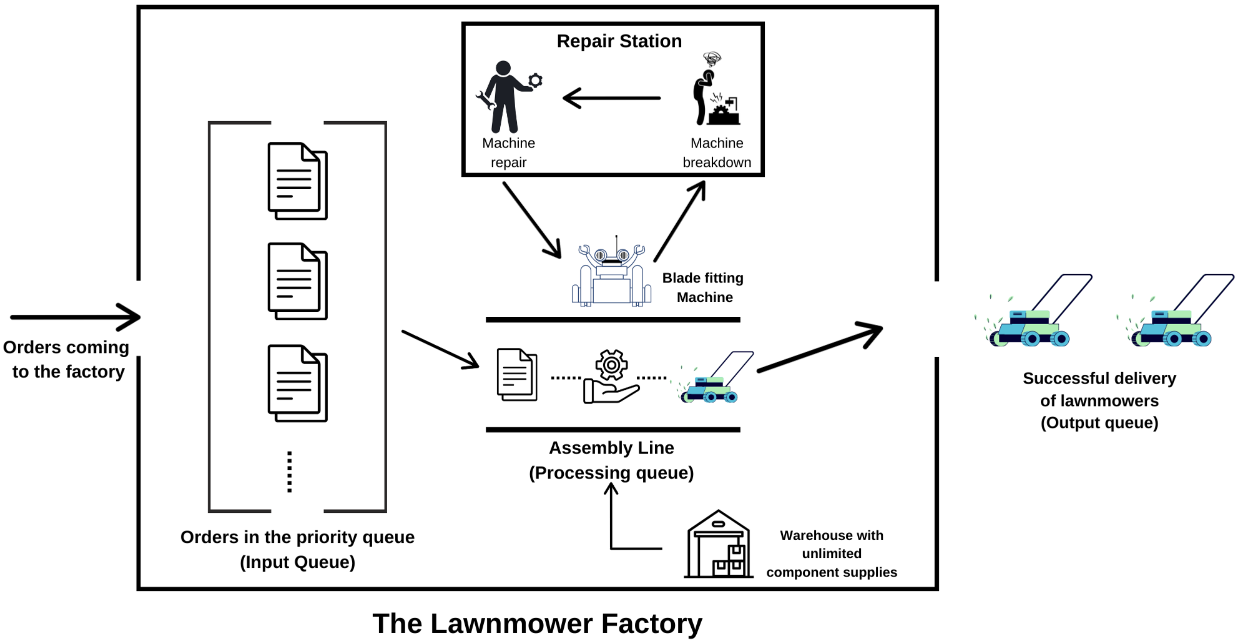

Figure 1: Schematic of our Factory

2.2 Describe the state(s) of the system.

- **Ready State:** This state signifies that the factory is in optimal working condition and is fully prepared to accept incoming orders. The processing queue is ready to receive orders in a First-In-First-Out (FIFO) sequence.

- **Processing State:** In this state, the factory is actively engaged in processing an order for a lawnmower. All components are operational, and the production process proceeds without any hindrances.

- **Breakdown State:** When the factory's blade-fitting machine experiences a breakdown, the assembly line comes to a standstill, causing a pause in production. The malfunctioning machine is removed from the production line and sent to the repair station for servicing. Production will resume from the exact point where it was interrupted once the machine has been successfully repaired.

2.3 Determine the entities in the system in relation to the state.

The entities associated with this scenario are the **lawnmower orders**. However, it is possible that we could model factory components such as machines, repair stations and staff as entities as well, but these aren't required, particularly because we can keep track of when they are occupied by knowing how occupied our factory is.

2.4 List the types of events in your model

- **Arrival Event**:

  - **Description**: An Arrival Event signifies the arrival of a new lawnmower order at the factory's processing system.
  - **State Change**: This event alters the system's state by adding the new order entity to the customer queue, indicating that it is ready for processing.
  - **Event Consequence**: The Arrival Event may lead to the creation of a new Arrival Event, simulating the continuous arrival of orders based on an exponential distribution of inter-arrival times. Thus, it models the ongoing flow of customer orders into the system.

- **Breakdown Event**:
  - **Description**: The Breakdown Event occurs when the blade-fitting machine experiences a malfunction or failure, rendering it non-operational.
  - **State Change**: This event modifies the system's state by marking the machine as non-operational, halting the production process.
  - **Event Consequence**: A Breakdown Event may lead to the creation of a Repair Event, simulating the need for maintenance when the machine breaks down. It models the system's vulnerability to unexpected breakdowns and repair requirements.

- **Repair Event**:
  - **Description**: The Repair Event represents the repair and restoration of the blade-fitting machine to operational status.
  - **State Change**: This event updates the system's state by marking the machine as operational again, allowing the production process to resume.
  - **Event Consequence**: A Repair Event may lead to the creation of a Breakdown Event, simulating the possibility of future breakdowns. It captures the cyclic nature of machine breakdowns and repairs in the system.

- **Completion Event**:
  - **Description**: A Completion Event occurs when a lawnmower order has been fully assembled and is ready for delivery.
  - **State Change**: This event changes the system's state by removing the completed order entity from the system, indicating that it has been successfully processed.
  - **Event Consequence**: The Completion Event does not lead to the creation of new events. It marks the successful culmination of an order's journey through the production process.

2.5 Draw a flow chart illustrating your simulation structure.

The figure 3 on the next page shows us the flowchart of our factory system. The figure has been set to the next page for better viewing.

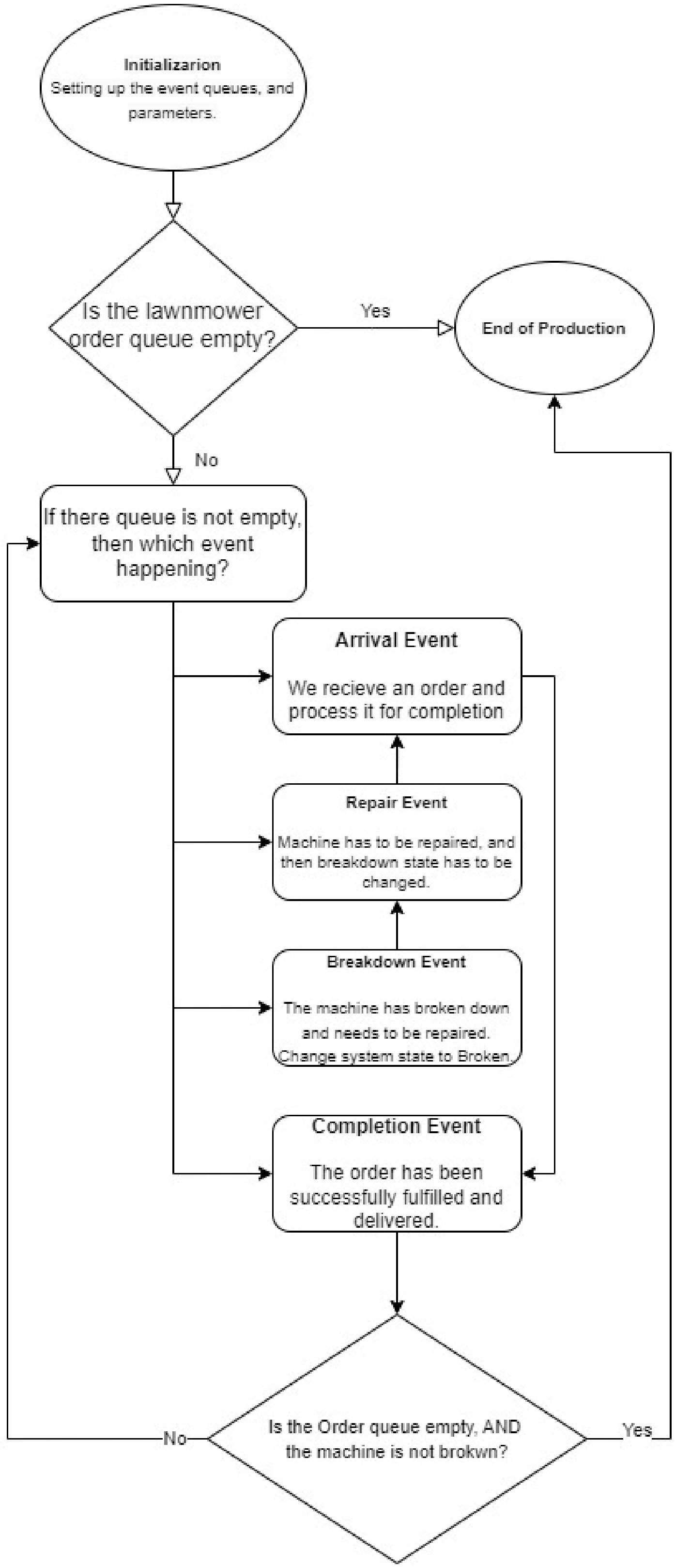

Figure 2: Flowchart of our system

3 Draw a state diagram of the system.

Our simulation's state diagram has five key states: Order Arrival, Machine Processing, Machine Broken, Machine Under Repair, and Order Completed. These states represent the critical stages of our factory's operation, from new order arrivals to machine breakdowns, repairs, and order fulfilment. Each state is a critical component of our system's behaviour and transitions.

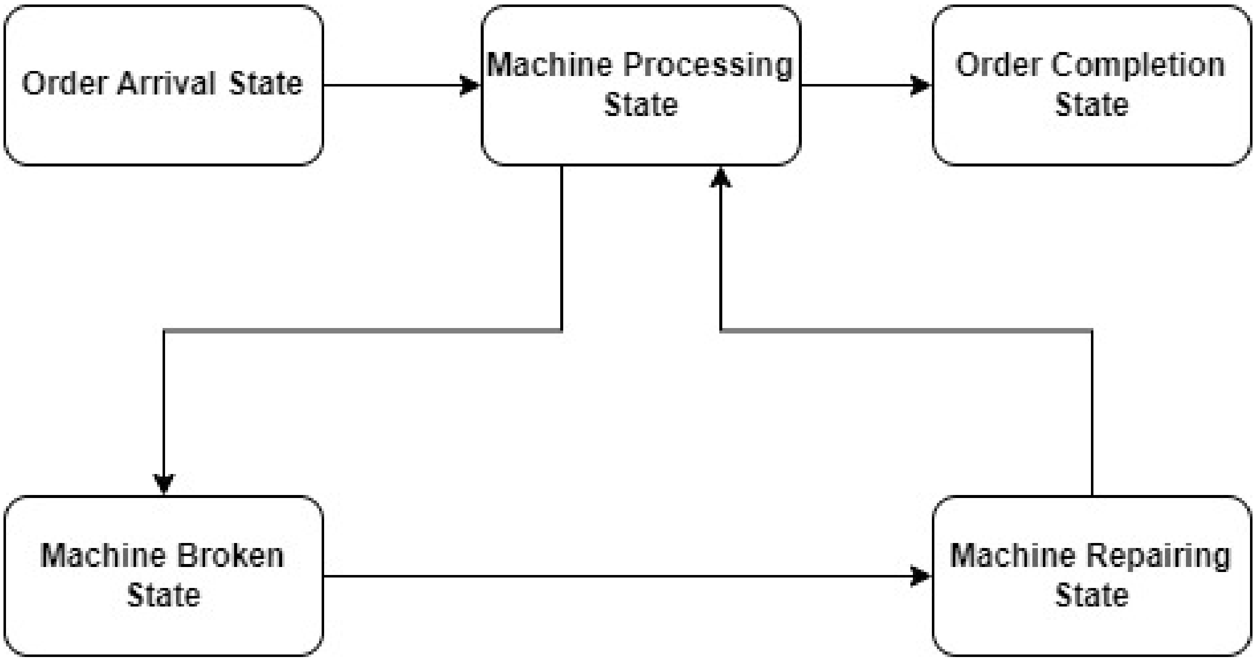

Figure 3: State Diagram of our factory System