Simulation of a Material Handling System using Arena

This project models a manufacturing system that incorporates material handling, developed using Rockwell Arena. The simulation analyzes the flow of parts through processing, quality control, and rework stations, with a focus on the impact of conveyors and transporters on system performance.

📝 Problem Statement

Parts enter the system for processing at two sequential stations: a **CNC lathe** and a **CNC milling machine**. Upon leaving the milling machine, finished products undergo a quality check.

- **Successful Quality Check:** Products that pass the quality check are transported to a wire house by **Transporter 1**.
- **Failed Quality Check:** Products that fail are sent to a rework station via **Transporter 2**.
- **Post-Rework:** After rework, parts are moved to the wire house by **Transporter 3**.
- **Material Handling:** Parts are moved between the arrival point, lathe, and milling machine by a **conveyor**. All transporters and the conveyor operate at a velocity of **15 m/min**.

The system operates with the following parameters:

- **Part Inter-arrival Time:** Follows an **exponential distribution** with a mean of 2 minutes (EXP(2)).
- **Processing Times (in minutes):**
  - **CNC Lathe:** Triangular distribution TRIA(7, 9, 11)
  - **CNC Milling:** Triangular distribution TRIA(10, 12, 15)
  - **Rework Station:** Triangular distribution TRIA(2, 3, 5)

Distances and Material Handling

From Station	To Station	Distance (m)	Material Handling Equipment
Arrival	CNC lathe		Conveyor
CNC lathe	CNC milling		Conveyor
Quality check	Wire house	100 m	Transporter 1
Quality check	Rework	100 m	Transporter 2

Rework	Wire house	100 m	Transporter 3

🎯 Project Objectives

The primary goals of this simulation are:

1. **Develop a Model:** Construct a comprehensive model of the manufacturing and material handling system using Arena.
2. **Simulate and Visualize:** Run the simulation to observe the system's dynamics and visualize the movement of parts.
3. **Analyze Performance:** Evaluate key performance measures by running the simulation for a specified number of replications.

🛠️ Model Details & System Logic

- **System Requirements:** Windows OS and Rockwell Arena simulation software.
- **Entities:** Parts.
- **Resources:** Lathe operator, Milling operator, Rework operator.
- **Processes/Machines:** CNC Lathe, CNC Milling, Rework.
- **Stations:** Station 1 (and others as required for routing).
- **Process Action:** The core logic for operations is **Seize Delay Release**.
- **Queue Discipline:** All queues follow a **First-Come, First-Served (FCFS)** discipline.

Arena Modules Used

The model is built using a combination of the following Arena modules:

- Create
- Assign
- Station
- Leave
- Enter
- Process
- Decide
- Dispose

🚀 How to Run the Simulation

1. Ensure you have **Rockwell Arena** installed on a **Windows** operating system.
2. Clone this repository or download the .doe model file.
3. Open the file in Arena.
4. Configure the simulation to run for the desired number of replications.
5. Run the simulation to generate the results report.

📊 Results & Analysis

After the simulation completes, Arena will provide a detailed report. This report can be used to analyze performance metrics such as resource utilization, throughput, cycle times, and queue lengths. Analyzing the results across multiple replications will provide statistically significant insights into the system's stability and efficiency.