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A FLEXIBLE MATERIAL HANDLING NETWORK MODEL TO REFINE MAJOR CAPITAL DESIGN

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ABSTRACT

A steel manufacturer plans to expand a facility to become the largest single-location steel manufacturing facility in their country. The current capacity of the plant will be initially doubled within a year, and then doubled again within a few years. The central raw material handling system is located inside the plant area to supply raw material to all operating plants without interruption. Goldratt Research Labs worked with MOSIMTEC to develop a flexible AnyLogic simulation model, allowing the manufacturer to understand if planned material handling changes will be able to keep up with demand. The AnyLogic model allowed for understanding conveyor network requirements, along with replenishment policies. The Goldratt/MOSIMTEC engagement uncovered critical connections that were missing in the design. The simulation engagement ensured these connections were addressed during the design phase, as opposed to discovering it in the very costly operational phase.

1 OVERVIEW

A steel manufacturer plans to expand a facility to become the largest single-location steel manufacturing facility in their country. The current capacity of the plant will be initially doubled within a year, and then doubled again within a few years.

There are multiple processing plants at the site, each requiring different raw material types. The central raw material handling system is located inside the plant area to supply raw material to all operating plants without interruption. The material handling system is comprised of the following components:

1. Multiple types of arrival nodes (wagon tipplers, truck tipplers, dump trucks).
2. A flexible conveyor network where paths from origin / destination points can change over time by changing how segments connect at junction houses.
3. Stockpiles, organized in stockyards, where ore inventory is stored until needed at the processing plants.
4. Stacker Reclaimers that stack ore in the stockyard and then reclaim it when it is needed by the processing plants. Stacker reclaimers connect to the conveyor network.

The complex material handling system includes multiple raw material types arriving by different modes, each requiring different offloading equipment. Material is then either routed to intermediate storage or direct to internal customers, depending on material type and current system conditions. The conveyor network can change dynamically throughout the day, as junction houses are re-configured to create different connections. The production plants cannot be starved for material, as this creates shut-down conditions that are extremely expensive to recover from.

2 CHALLENGE

The system has a high degree of variability from arrivals not occurring on a precise schedule, processing times with variability, and random downtimes. In addition to a high degree of variability, components are inter-connected. Flow paths from one origin node to a destination node may change based on system conditions. The complexity of flow paths changing over time and random variability make this a system that would be extremely difficult, if not impossible, to model in a basic spreadsheet, while making the correct business decision. Due to the extremely large investment in the system, it was important that the team be confident that the system was capable of moving the required materials and keeping the processing plants from starving.

3 SOLUTION

With Goldratt Research Labs as the prime consultant, assisting the manufacturer in multiple related projects, MOSIMTEC developed a flexible, AnyLogic-based discrete event simulation model to allow running several different scenarios. Because the model was configurable with simple front end tables, the team was able to configure the model to the current state network and work with subject matter experts to ensure model results mimicked reality at a level that was sufficient for future decision making.

In the real system, the conveyor network is routinely changing based on system needs. The model was developed using dynamically instantiated links and nodes. During the simulation run, the model would find the shortest path from origin to destination, based on available links. Available links were those not currently being used as part of other active paths and those not in a failed state. All valid network paths and their costs (distance) were determined as a pre-processor to the model run, so that the ideal, available path could be determined very quickly throughout the model run.

In addition to intelligence regarding the conveyor network changing over time, the model also implemented decision logic to mimic the real system's key decisions in several areas. This included:

1. When to request replenishment from stockyard to processing plant.
2. When to go directly from arrival to processing plant, as opposed to storing in the stockyard.
3. Which stockpile new inventory should be stored in upon arrival, based on current inventory levels and the state of material handling equipment.

4 BENEFITS

During the analysis phase of the project, Goldratt and MOSIMTEC uncovered situations where the processing plants could not be adequately supplied by the material handling system. The model outputs illustrated that the conveyor network design was missing critical connections and would not be feasible in the live system. The design adjustments were relatively simple, as the expansion was still in the design phase and missing connections were minor from a change perspective.

While the missing connections were simple to fix on paper, they were absolutely critical and would have been difficult to fix in an operational system. If the future state material handling system and demand levels had not be simulated, the original design would have been built. This would have resulted in significant costs due to lost production and re-construction costs.