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APPLICATION OF DISCRETE EVENT SIMULATION AT EASTMAN CHEMICAL COMPANY

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ABSTRACT

Inventory optimization is a common problem for most process and manufacturing industries. Higher inventory levels ensure sustained operation and high customer service levels but they tie up the working capital. While identifying optimal inventory levels using standard safety stock calculations is fairly straightforward, it becomes a cumbersome task for complex supply chains with multiple constraints and interactions. Eastman has applied discrete event simulation to understand one of its crucial supply chains by capturing key factors of the inter-related supply chain including demand uncertainty and uncontrollable events. The use of simulation provided an efficient heuristic solution and a platform to understand overall supply chain reliability by evaluating critical bottlenecks and testing different “what-if” scenarios.

1 INTRODUCTION

Eastman is a global specialty chemical company that produces a broad range of advanced materials, additive functional products, specialty chemicals, and fibers that are found in products people use daily. Eastman had 2013 revenue of approximately $9.4 billion and is serving customers in approximately 100 countries. The company is based in Kingsport, Tennessee, USA, and employs approximately 13,500 people around the world.

2 PROBLEM DESCRIPTION

Eastman highly values reliable and responsive supply chains while continuously improving its processes. The objective of this study was to identify key bottlenecks in a critical supply chain and recommend optimal inventory levels for raw materials, intermediates and finished goods of inter-related businesses while taking into account the supply and demand risks. The key decision makers also wanted to study the effects of logistics reliability as well as the impact of long-term shutdowns of critical suppliers on Eastman’s supply chain capabilities. The raw material considered spans across many different businesses within Eastman influencing at least 40 different finished product groups.
Multi-level inventory optimization is not a new subject. A quick literature review proposed non-linear programming and dynamic programming solutions to obtain exact solutions to the NP hard problem. However, the following characteristics of the supply chain had to be incorporated:

- The raw material comes in different quality/grade from various suppliers. Some production processes take a mix of raw materials of various grades for production while others take unique grades for their production.
- There are multiple manufacturing processes in the supply chain. Every production unit has unique ordering and information sharing policy.
- Production processes are campaigned to produce multiple products on shared resources. When there is a changeover from one product to another, the asset must be cleaned by being flushed with chemicals. After each changeover, the process produces some off-class material for a short

period of time before it stabilizes. Thus, production is sequence-dependent to minimize changeover cost and off class production.

- Some products can be produced on multiple assets.
- Depending upon the type of defect and nature of the product, off-class material during production is treated in a variety of ways: rework, reclassification and scrapping.

The solution proposed had to include all the above mentioned factors and provide a high level of customization and flexibility for the client.

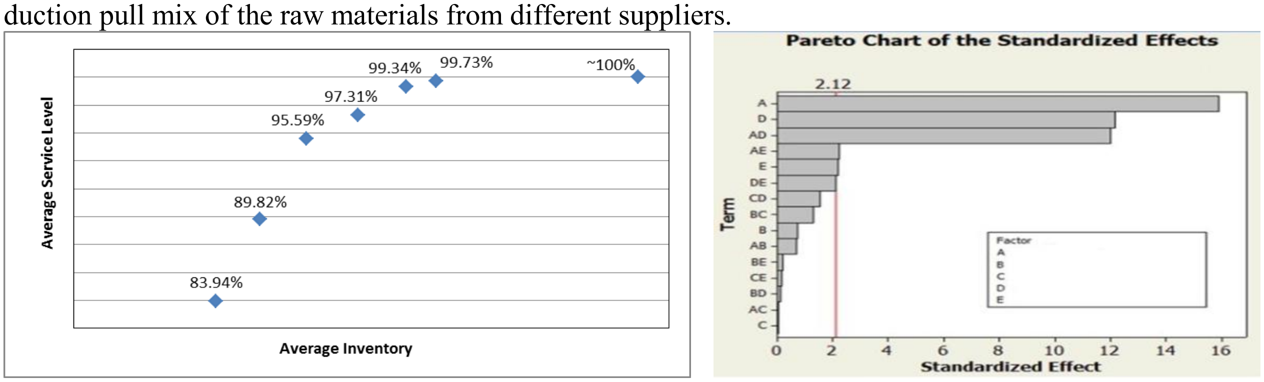
3 METHODOLOGY

Considering all the factors and the timeline, discrete event simulation was chosen. The following steps were taken in the process:

- First, an understanding of the "As-Is" state of the supply process was developed by creating process maps. The greatest value of these maps was to initiate discussion and identify data needed for model inputs for each functional area. In addition, they were used as a starting point to identify failure modes and probability of failure of each part of the system.
- Next, a simulation model of the "As-Is" system was developed using Rockwell Software's simulation engine, Arena®, based on the process maps, historical data, and subject matter experts knowledge. The model predicted the frequency of failures that will occur based on the base system information. The model was run for 30-50 replications for 5 years with one year warm up period.
- Finally, potential improvement projects and inventory levels were identified and modeled as scenarios. Each scenario was evaluated based on improvement and cost/benefit. The Opt quest Add-in of Arena® was utilized to recommend optimal inventory levels for desired customer service level. The model run time was changed depending on the scenarios tested.

4 KEY FINDINGS AND RECOMMENDATIONS

The model helped to quantify the tradeoff between various inventory levels and desired customer service levels. Using the analysis, recommendations were made to use inventory levels beyond which there were no significant improvements in customer service levels. Scenarios were tested to study the effect of long-term supplier outages and to define inventory levels required to offset the risks. The model also served as a test bed to rank various factors including the effects of adding/removing a supplier, changing the production pull mix of the raw materials from different suppliers.



(A) (B)

Figure 1: Sample snapshots of the results: (A) Average inventory level vs. customer service level (B) Pareto analysis of the various factors affecting supply chain reliability