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MULTI-PARADIGM SIMULATION FOR LAYOUT DEFINITION AND OPERATIONAL OPTIMIZATION AT TENARIS BAY CITY PRODUCTION FACILITY

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ABSTRACT

A worldwide leading supplier of tubes for energy industry and other industrial applications dealt with a huge business challenge during 2012: the construction of a new facility in Bay City, Texas, which would operate with an automatic system for WIP handling operation in their warehouse, a revolutionary management system for the company and the industry. A multi-paradigm simulation was developed to analyze different scenarios, define the best investment plan and minimize risks. Numerous heuristics were also used to generate the requirements for the future WMS. During 2018, once the facility started its operations, the simulation model was adjusted to the real operation conditions, allowing the study of the strategy to close the gap between the current and the optimal warehouse management. During 2019, a new challenge came up: use the simulation for daily operative optimization, giving visibility to potential limitations in the WH handling capacity.

1 INTRODUCTION

Tenaris is a leading global manufacturer and supplier of steel pipe products and related services for the world's energy industry and for other industrial applications. Its customers include most of the world's leading oil and gas companies as well as engineering companies engaged in constructing oil and gas gathering, transportation, processing and power generation facilities. Tenaris operates an integrated worldwide network of steel pipe manufacturing, research, finishing and service facilities with industrial operations in the Americas, Europe, Asia and Africa and a direct presence in most major oil and gas markets.

On the other hand, Buenos Aires Institute of Technology, ITBA, is a University located in Argentina, dedicated to engineering education. It counts with different research centers and CEOS is one of them. CEOS is the Center of Research in Optimization and Simulation, applying innovative analytical methodologies to collaborate with institutions, companies and the Government to solve complex problems.

In 2018, Tenaris and CEOS-ITBA, started a cooperation program to apply analytical methodologies to bring answers to business challenges. Tenaris started the planning of their new facility in Bay City, Texas, USA, during the last months of 2012. The project had huge engineering challenges and risk management was essential in a key market for the company, as the American market was. A new management system, a fully automatic one, was the main factor to raise the necessity for a strong analytical approach to compare different layout options, determine the number of cranes for handling the material and quantify the real

warehouse capacity. The operation involved many complexities: stacking the cassettes would generate material overlapping; too many cranes would generate interferences and low productivities; too many cassettes would drown the system for restricting movements; reallocations had large impact on service level; lines' cycle times required maximizing cranes´ utilization and optimal task selection sequence; among others. In this context, modeling and simulation appeared as an appropriate approach to such a complex system and business need for risk management in a strategic investment.

2 MULTI-PARADIGM SIMULATION MODEL AS METHODOLGY

During 2012 and 2014, different layers of a multi-paradigm simulation model was developed, accompanying Tenaris questions regarding the new facility to be built in Bay City. Cranes were modeled as agents, with decision trees to decide how to prioritize among all the requirements issued by the production lines. The algorithm developed considered the current position of each crane, the existence of emergencies or critical situations to attend, the productivities and workload of each line to define the most convenient task to take. Additionally, cranes communicate with each other to ask for displacement to access to a particular position and avoid any risk of collision.

Lines produced or took tubes transported in cassettes. Each cassette was an agent too. With variables and parameters as volumetric and weight capacity, number of tubes contained, tube type, production order, production batch for traceability and time measurement flags. Cassettes had also position information to identify their location and inform the crane agents for their pickup.

Using discrete event modeling, production lines were represented, including different working schedules, stochastic and programmed interruptions, setup times, different productivities and cycle times based on product characteristics. The model included the following lines: hot rolling mill, heat treatment, quality testing and finishing lines.

The simulation model was used during two years giving quantitative support to numerous questions at the design phase of the investment plan. Three demand scenarios were considered to analyze the workload impact on the facility and the investment strategy was separated in phases, going along with demand evolution. Different layout options had to be compared and the simulation model turned a vital tool to quantify the impact on KPIs like distance travelled by the crane and the consequence time delay to respond to each requirement. The simulation also allowed detailed studies regarding the stacking strategy and the optimal number of cassettes to operate the warehouse.

In 2018, a new project phase was released after the facility opening. The productivities observed were much lower than the expected ones and Tenaris had no clear ideas about the causes of this gap. The new project phase involved adapting the simulation model to the real operation conditions: cranes had different speeds, the market had changed and the production mix did not match the plan, the WMS developed by an IT provider did not followed the exact rules established during the design phase. Additionally, new operations were included and in/out ports were being used with no previous definition.

RESULTS

The project, by the use of a simulation model, allowed identifying the causes of the productivity gaps. It also guided the definition of priorities for intervention in order to upgrade the productivity level. Tenaris also viewed in the simulation a new possibility: the use of it, integrated to the daily operation, would allow the anticipation to handling capacity restrictions and lead adjustments to the production program of the lines.