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VIRTUAL FACTORY FOR FORMULATION PLANTS IN LIFE SCIENCE MANUFACTURING

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ABSTRACT

This case study provides an overview of the Virtual Factory concept developed for Chemical and Pharmaceutical Manufacturing Facilities at Bayer AG. First, we will outline the process optimization challenges of formulation plants for crop protection agents as well as pharmaceutical products. Then we will cover input data analysis, the modeling concept of the Virtual Factories, what-if-scenario optimizations, real-time data connection procedures, and simulation-based planning & scheduling. We will conclude by providing our practitioner's viewpoint on the various future opportunities and the road to Digital Twins.

1 INTRODUCTION

Life Science Manufacturing consists of two major production activities 1) the active ingredient manufacturing 2) the product formulation. The formulation plants produce finished goods or drug products. These manufacturing facilities receive the active ingredients, combine them with e.g. stabilizers, binders and solvents, and pack the products for the delivery to the costumers or patients. Bayer has various formulation plants world-wide for both crop protection and pharmaceutical products.

At Bayer, we consider a Virtual Factory as an integrated simulation-based optimization environment of an entire existing or future production plant based on both production procedures and data. A Virtual Factory provides advanced decision support capability on-site. It is applicable for both active (pharmaceutical) ingredients and formulations. The focus of this talk lies on formulation plants.

2 PROCESS OVERVIEW

Process challenges in formulation plants include among others: multi-purpose production with a variety of products in the same facilities, series of batching operations, campaign planning and scheduling, interdependency with logistics and supply chain management, varying processing rates based product and packaging line, sequence dependent set up, among several others were all considered and captured in the Virtual Factory implementation.

3 VIRTUAL FACTORY ARCHITECURE

3.1 Purpose

We are currently using Virtual Factories for formulation plants to support capital investments (process development and product transfer projects), to improve the operational workflows and process operations, as well as to facilitate detailed planning & scheduling.

3.2 Virtual Factory Development

We use various data processing and analysis environments to pre-process the input data. The core of the Virtual Factory consists of material flow simulation and discrete-event simulation platforms, which are selected depending on the type of process (flow-oriented or entity orientated). Furthermore, we apply advanced visualization tools to make simulations results available and move towards cloud-based user environments to facilitate the on-site application for planning and scheduling.

3.3 Results

On various plants we were able to use Virtual Factories to support the decision-making in a risk-free environment. Among others we were able to support quantitatively decisions upon the adjustments of operational the work-flow of plants (efficiency analysis) as well as future investments and the use of assets (asset analysis). Furthermore, we introduced Virtual Factory as on-site user-tool for current and future planning (on-site use).

4 DISCUSSION

We see Virtual Factories as the back-bone of Digital Twins, i.e. simulation models that are connected to online production data and provide real-time optimization in the facilities. One of the major challenges is the integration of Virtual Factories with production data systems and other corporate simulation environment (such as supply chain modeling tools), ensuring a high integrity and quality of various data elements. Hence, it is important to ensure the trust of the Virtual Factory simulation outcome in an orchestrated corporate data systems and global simulation environment. The simulation-based approach provides tremendous business opportunities and can serve as an enabler for future innovations, inventions, and process improvements.