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Production Optimization in Single Line Process by Simulation of Transfer Lines

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Abstract- **Plant Simulation software permits the simulation and optimisation of production systems and processes. using Plant Simulation, you'll optimize material flow, resource utilization and supplying for all levels of plant designing from global production facilities, through native plants, to specific lines.**
Plant Simulation analysis tools allow simple interpretation of simulation results. statistical analysis, graphs and charts show the use of buffers, machines and personnel. you'll generate in depth statistics and charts to support dynamic analysis of performance parameters as well as line employment, breakdowns, idle and repair time and proprietary key performance factors. To optimize the performance of existing production systems by taking measures that are verified in a very simulation environment before implementation. The parameters of every method that affects the productivity and that is taken into account as focus of productivity improvement.
Keywords- **SIM, PLM, Transfer Line, Production**

I. INTRODUCTION

Transfer line balancing is one of the components of manufacturing which consist of major tenants in lean manufacturing. The concept of line balancing itself is everyone is working together in a balance fashioned where everyone doing the same amount of work, the variation is smoothed, no one is overburden, no one is waiting and the work is done in a well single piece flow. Line balancing can also be defined as the assignment of sequential tasks to a line, called workstations, to optimize the use of work and equipment, thus minimizing downtime. Furthermore, balancing can be achieved by reorganizing the workstations and balancing the workload between the installers, so that all operations take about the same time. In addition, line compensation in many ways benefits an assembly area by minimizing the number of workers and the workstation, thereby reducing costs and space for the assembly area. Line balancing is also useful because it helps to identify the bottleneck process and standardizing work among operators can mitigate the bottleneck problem.

Line balancing simulation models are not yet widely used in the production assembly sector, as many still use the priority table and the standard job combination sheet. In contrast, the simulation model is a new and effective way to build the current situation of the assembly process. There are many types of simulation models that can help not only identify and reduce bottlenecks, but also virtually create the exact configuration of the installation. The simulation model is more realistic, the project for implementation in the assembly area is more precise and efficient.

Manufacturing systems have evolved rapidly since their inception and this transformation is expected to continue in a pursuit of optimum utility. A flow line may be synchronous or asynchronous. In synchronous lines, all parts move thorough the line at the same speed. In asynchronous lines, some parts have to wait before processing at the next station resulting in a buffer. The workstations are also not governed by cycle time [target time] limit. However, synchronous lines respect target time limit at each workstation. The workstations are connected by an automated material handling system, which causes the line to function as a single unit. The layout may be either straight or circular. Transfer lines have several benefits. They require less manpower and space. They ensure low work in progress and lower lead time. The process planning problem involves preparation of plan for performing machining operations in an optimal manner. Several technological constraints like inclusion and exclusion constraints are respected while solving this problem [1].

Operation sequencing and cutting tool allocation problems are part of process planning. The operation sequence generated ought to be feasible with respect to constraints and also serve as the optimal solution with respect to the objective [3].

II. LINE BALANCING

Both manual assembly line and transfer line classify as flow line production systems. A line balancing problem performs assignment of operations to workstations in order to optimize a criterion while respecting precedence and target time constraints. When the number of workstations is minimized while respecting a given cycle time, the problem is called time-oriented simple assembly line balancing problem [SALBP]. If skills of workers are differentiated and the total cost of the product is optimized, the problem is called cost-oriented assembly line balancing problem [COALBP] [2]. Depending upon the variety of products manufactured, the line may be classified as single-model, mixed-model [different units in arbitrary sequence] and multi-model [sequential batches of different units] [6]. When mixed-model production, equipment selection, cost objectives and parallel stations are considered in ALBP, the problem is called generalized assembly line balancing problem [GALBP] [7]. The assembly line design problem [ALDP] relates equipment selection to the operations assigned to a station and their execution. When ALBP is extended to apply to transfer lines, the problem is called transfer line balancing problem [TLBP]. In TLBP, operations are grouped together to form blocks and these blocks are allocated to workstations. The blocks on different workstations are executed simultaneously and the longest execution time among the blocks determines the pace of the line [8]. The problem considered here is analogous to the simple assembly line balancing problem and hence it is called a simple transfer line balancing problem.

III. SIMULATION OF PLANT

Simulations of production processes are getting widely extended due to possibilities of computer technology in last decades. Simulations are used in optimization, experiments, visualizations, development of factories. They save time and money of manufacturers, protects property and health of employees (ergonomic simulations). Simulation technology is an important tool for planning, implementation, and operating complex technical system. There are many simulation software created just to build the virtual layout of the assembly area such as WITNESS and ARENA software. However, the simulation used in this project is the Tecnomatix Plant Simulation software created by SIEMENS. Tecnomatix Plant Simulation can increase profitability of a facility by increasing throughput, resource utilization and utilization of the facility. Plant Simulation also able to decrease throughput times, required resources and storage requirement provided that all accurate data inserted in the analysis. Furthermore, Plant Simulation able to identify the bottlenecks, reduce WIP, evaluate the effects of capital investments or changes in processes and avoid planning errors as the simulation was done virtually without applying to the facilities first.

IV. RELATED WORK

Soumitra Bhale, M. Fazle Baki and Ahmed Azab et al. [1] tackle the problem of process planning and system design for transfer lines. To make optimal use of the machines, the design features are summarized and the processes are optimally coordinated. A balanced transfer line ensures maximum use of machine tools and increased productivity. A new mixed whole linear programming model has been developed to solve the problem hierarchically. The proposed method provides optimal results in a very short period of time.

Liu Xuemei, LI Aiping, and CHEN Zurui et al. [2] proposed feature group strategy and the polychromatic sets theory are used to establish constraint model. The "feature-operation" constraint matrix and the "feature group-station" constraint matrix are used to describe constrains. The heuristic algorithm is developed for the FMLBP, which consists of two steps: sequence operations in each feature group, assign operations to workstation for each feature group. The proposed approach is validated through a real industrial case. Experimental results show that the proposed approach can address the problem effectively and efficiently.

Hany Osman and M.F. Baki et al. [3] introduce a new mathematical formulation and solution algorithms to solve the TLB problem. The transfer line under study is designed to manufacture automotive parts, for example, engine cylinder head, cylinder block, etc. Proposed approach decomposes the TLB problem into an assignment sub-problem and a sequencing sub problem. The algorithm provides very good results with an optimality gap that does not exceed 4.04%, but the algorithm could not deal with large problem instances in a reasonable time.

Alexandre Dolgui, Nikolai Guschinsky and Genrikh Levin et al. [4] proposed an interesting MIP model for a new line design and balancing problem which dealt with modular machining lines with multi-spindle stations. The results proved its extreme efficiency because average total running times were decreased up to 1745 times.

Xavier Delorme, Alexandre Dolgui and Mikhail Y. Kovalyov et al. [5] studied of optimal equipment selection for transfer lines this problem is novel and motivated by practical industrial needs for which the use of methods from operations Research is significantly rewarding. This leads to simpler and more transparent models.

Tolio and Urgo et al. [6] presented a mixed integer linear program to consider design of flexible transfer lines. The equipment cost for a multi-model rotary transfer line is minimized while respecting design constraints.

Zhang et al. [7] provide a hierarchical process planning approach for flexible transfer line schematic design. The method includes the selection of manufacturing feature machining operation, part set-up planning, feature sequencing, operation sequencing and process plan generation.

Masood et al. [8] investigation on transfer line balancing is carried out by A case study is considered to improve cycle time performance and machine utilization. Re-sequencing of operations and tools is carried out to improve the throughput. The results are validated by simulation.

Das et al. [9] follow a hierarchical approach in their machine loading and tool allocation problem. Design features are grouped together at higher level assuming an operation sequence and the operation sequence is improved at lower level to repeat iteration. Long time is required to solve the small problem considered. Transportation time is not considered.

Osman and Baki et al. [10] consider a transfer line balancing problem to minimize non-productive time. A linearization and decomposition approach is adopted to sequence operations after grouping the features.

Babele et al. [11] discusses about different bottleneck balancing problem, process planning and line configuration. For optimize bottleneck is must to be design features of the product are grouped and machining operations are sequenced in an optimal manner. The objective is to find out problem and possible solution on the handling time fraction of the cycle time consisting mainly of orientation change time and tool change time in different bottleneck sequencing, which is used by industrial production.

V. PROPOSED WORK

The Product Lifecycle Management provides access to product and process knowledge in the frame of the whole life cycle of a product (conception, design, manufacture, transportation, utilization, disposal, recycling). The PLM is originally based on Computer-aided Design (CAD), Computer-aided Manufacturing (CAM) and Product Data Management (PDM).

Tecnomatix is a part of the Siemens PLM Platform and it is categorized into groups such as:

- Part Planning and Validation - Part Manufacturing Planner, Machining Line Planner, Press Line Simulation, Virtual Machine Tool
- Assembly Planning and Validation - it is exploited in Process Designer, Process Planner, Process Simulate Assembly, Process Simulate Human, Jack (Control of assembly processes, ergonomics, etc.)
- Robotics and Automation Planning - it is exploited in Process Designer, Process
- Simulate Robotics, Robcad, Process Simulate Spot Weld (Robotic production process, etc.).
- Plant Design and Optimization - it is used in Factory Cad, Factory Flow, Plant Simulation (Optimization of production processes, etc.).
- Quality and Production Management - Dimensional Planning and Validation (DPV), Variation Analysis (VSA), CMM Inspection, Manufacturing Execution Systems (MES), HIM/SCADA

The First category surfaces data link and rough planning via Process Designer or TCM Process Planner. The second category surfaces simulation and detailed planning via Process Simulate Assembly, Process Simulate Robotics or Robcad, Process Simulate Human or Jack. The third category surfaces design and optimization via Factory CAD, Factory FLOW and Plant Simulation.

Software Factory CAD is a superstructure of AutoCad. We can use it to a quick modeling of a 3D layout of production and to project production halls, workstations etc. Factory FLOW is also a superstructure of AutoCad. We use it to representation of a material ow, graphical and numerical cost of transportation of individual variants etc. Plant Simulation is suitable for optimization of industrial factory processes in 2D layout. It contains dynamical simulation, exploiting of people and machines, identification of thin places in workstation, transport of supply, verification of strategies, occupancy of stores, optimization of production processes, etc.

Software Process Designer serves as a rough planner for operations, resources and products used in 3D simulation, balancing of product lines, etc. On the other hand Process Simulate serves as a detail planner for accurate analysis, simulation of operations, collision planning, time analysis, ergonomic analysis, Offine Programming of Robots (OLP), Virtual Commissioning (VC), etc.

When modelling a system of processes, a crucial part of the model is the data used. It is the data that fuels the model, hence if the data does not represent the modelled system well, the worthiness of the model’s result is endangered. When modelling a manufacturing system, suggests collection of the following data:

- Factory structural data (e.g. layout, means of productions, restrictions) Manufacturing data (e.g. use time, performance data, capacity)
- Material flow data (e.g. topology, conveyors, capacities)
- Accident data (e.g. functional accidents, availability)
- Organizational data (e.g. break scheme, shift scheme, strategy, restrictions)
- System load data (e.g. production orders, BOMs, working plans, volumes, transport)

VI. RESULT ANALYSIS

The study of methodologies analyses the working conditions with which staff is working as well as the material handling map for the jobs inside the premises of company which is used for the job from raw material to finished goods. While doing this we did the study for each machine operation by using the techniques of method study and time study which are related to the subject of industrial engineering.

In that we considered each part involved in machining process like job setting time, tool setting time, CNC program setting time, CNC program running time, speeds, feeds, depth of cuts used for the every operation, tool life, tool changing time, job unloading time etc. Primary aim of our project is to improve the productivity and the reduction in job manufacturing cost.

The result obtained from production failure investigation in many areas and identify is a consequence of investigation by plant simulation tool and considering real environment of transfer line. In a simple production line (transfer line) a model is created in simens technomatrix plant simulation where it observe the analytical results to improve the real environment in the production line as shown below.

Tecnomatix is a comprehensive portfolio of digital manufacturing solutions that deliver innovations by linking all manufacturing disciplines together with product engineering from process layout and design, process simulation and validation, to manufacturing execution. Tecnomatix is built upon the open Product Lifecycle Management (PLM) [4].

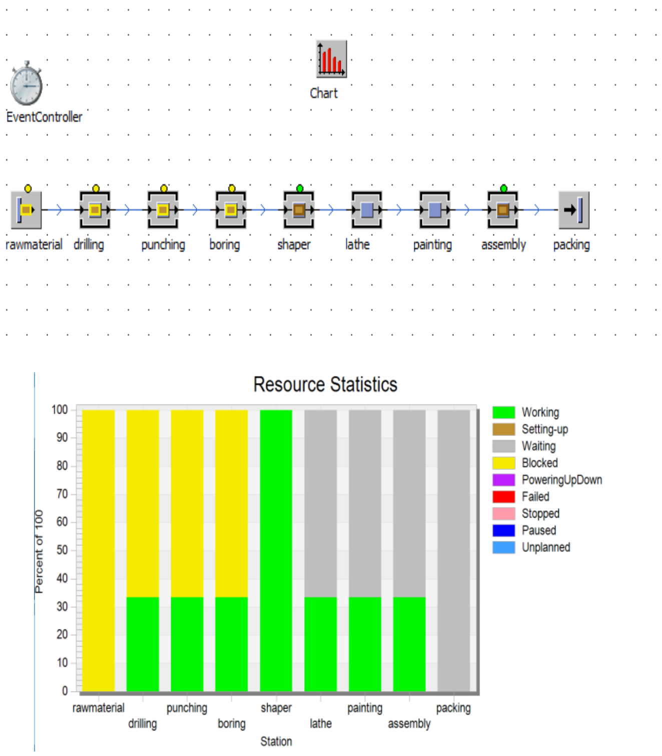


Fig. 1: Single Transfer Line for Multiple Operation

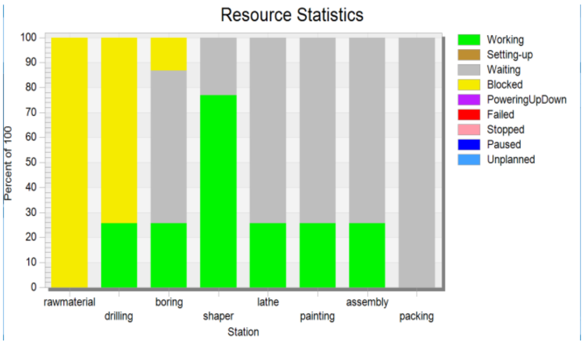
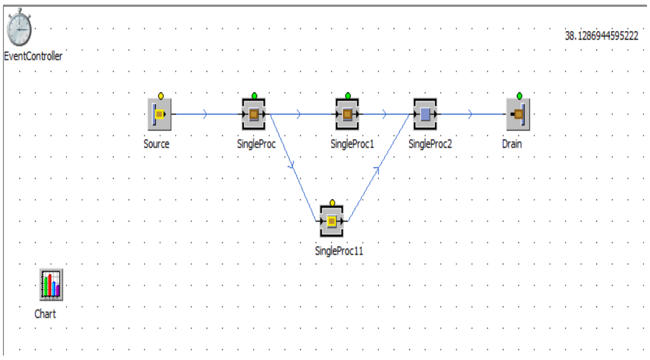


Fig.2: Single Transfer Line for Multiple Operation with Framework



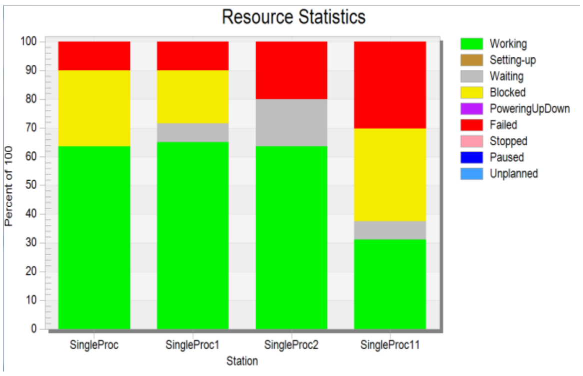
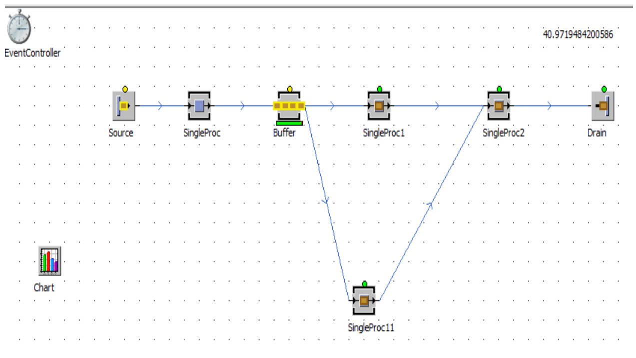


Fig. 3: Graph on Parallel or Mixed Transfer Line for Multiple Operation



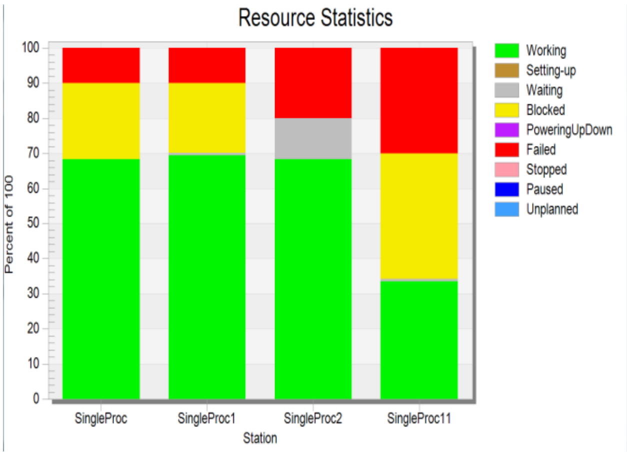


Fig. 4: Parallel or Mixed Transfer Line for Multiple Operation with Single Buffer

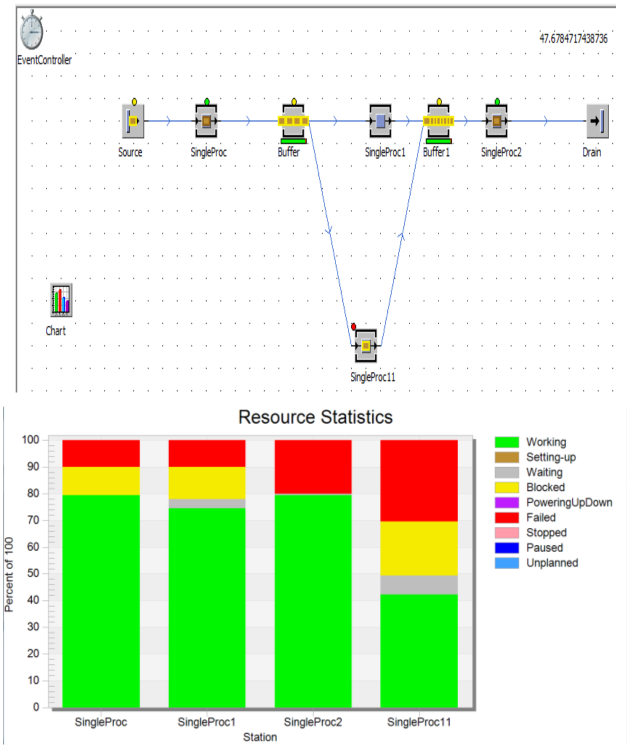
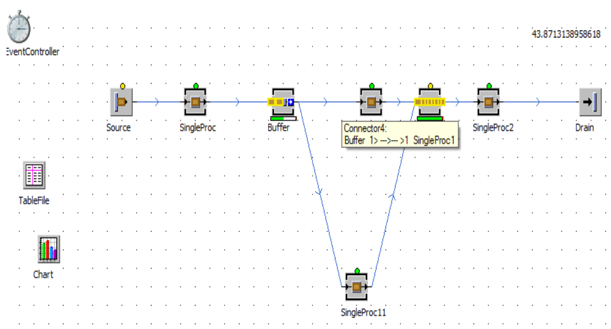


Fig. 5: Parallel or Mixed Transfer Line for Multiple Operation with Multiple Buffer



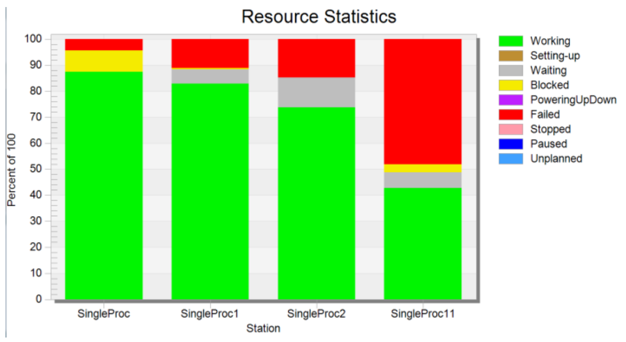


Fig. 6: Parallel or Mixed Transfer Line for Multiple Operation with Multiple Buffer

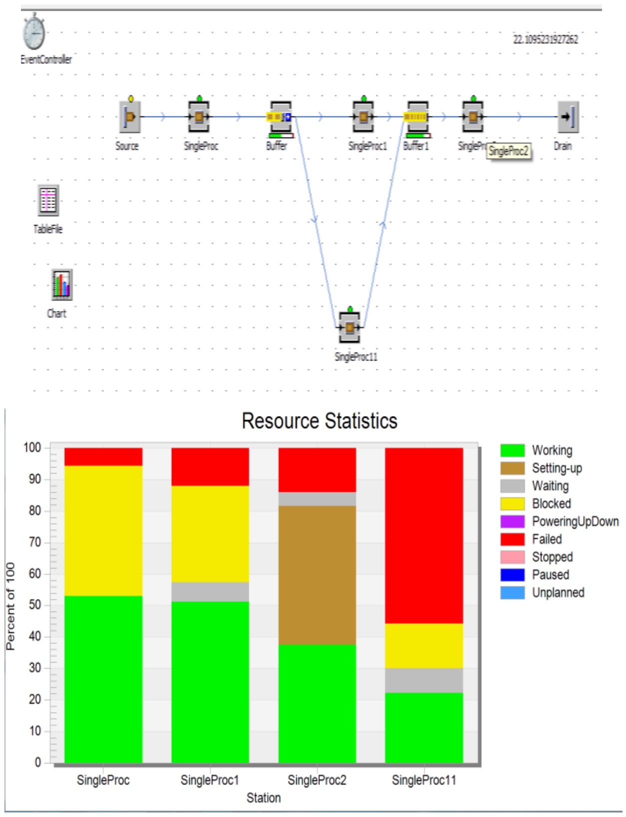
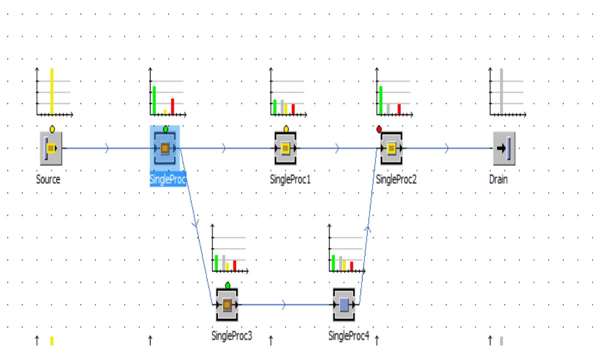


Fig. 7: Parallel or Mixed Transfer Line for Multiple Operation with Multiple Buffer and experimental setup



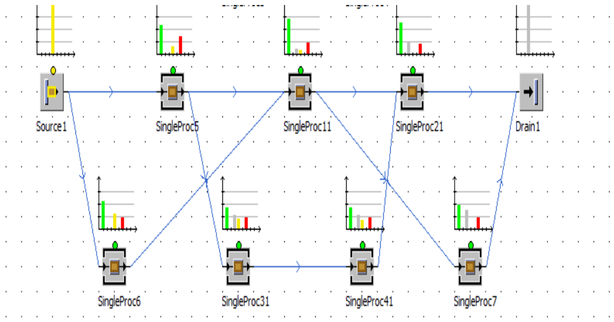


Fig. 8: Parallel or Mixed Transfer Line for Multiple Operation with Bottleneck Analysis and Multiple Single Process

VII. CONCLUSION

Plant Simulation simulations are used to optimize output, relieve bottlenecks and minimize work-in-process. The simulation models take into thought internal and external offer chains, production resources and business processes, permitting you to investigate the impact of various production variations. In times of increasing value and time pressures in production, alongside current globalization, supply has become a key consider the success of a corporation. the requirement to deliver JIT (just-in-time)/ JIS (just-in-sequence), introduce Kanban, arrange and build new production lines and manage international production networks (to name a few) needs objective call criteria to assist management value and compare different approaches. Plant Simulation helps produce digital models of logistical systems (e.g., production) to explore the systems' characteristics and to optimize their performance. in depth analysis tools, statistics and charts let users value different producing situations and build quick, reliable selections within the early stages of production designing. Plant Simulation helps users to observe and eliminate issues that otherwise would need value- and time consuming correction measures throughout production build up Minimize the investment cost of production lines while not jeopardizing needed output.

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