Simulation as a tool for supporting assembly systems

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Abstract. This article considers the first comprehensive introduction to simulation modeling of assembly systems, and considers the assumption that simulation is a reliable method for testing production and assembly systems. Simulation is an important software tool with which you can perform a large number of experiments with various system parameters. Simulation modeling allows to describe the structure of the system and its processes in a natural form, without resorting to use of complex formulas, equations, and strict mathematical dependencies. Modeling allows to detect and eliminate problems that manifest themselves in the early stages of commissioning the assembly system, which implies significant savings in costs and time [1]. This article provides a part of the theoretical base of the topic and a practical example of using modeling. For practical research software was used Tecnomatix Plant Simulation from the company SIEMENS.

1. Introduction

Considering that modeling is a theoretical and cognitive process based on the repetition of a real production situation, this term is ideally defined as the recognition of objects through other objects that are mostly created artificially. Modeling simulates the structure and behavior of a real system, and is a specific form of the cognitive process. The basic principle is to draw conclusions using modeling within a specific system with objects and their interactions and analyzing the results of the experiment.

Modeling programs, at present, are increasingly used in industrial enterprises [2]. The pressure of competition and customer requirements is steadily increasing, and therefore enterprises need to model production processes. Simulation programs are tools that test the effects of various model decisions, and then estimate production capacity, duration of operations, and other production parameters.

According to the authors R. Debnar and J. Koshtürkak, the main tasks of modeling are:

- Decision support in system design and operation.
- Analysis and optimization
- Forecasting and looking into the future
- Replacing the real system (training, testing, danger, etc.).

Under the simulation model, the authors understand - a mathematical method consisting of a set of logical and mathematical relationships that express the functional or other characteristics of the system [3].

Modeling assembly systems in the workplace helps in planning new and improving existing systems. It is also often used in decision-making processes, such as the size of investments, the cost of planned changes, analysis of production processes, etc. Modeling in assembly systems increases the

efficiency of the design phase. Currently, simulation accuracy can reach 99%. The accuracy depends on the input parameters and the reliability of the model [4].

Advantages of modeling:

- Testing innovative strategies in a risk-free virtual environment
- Maximum use of production resources
- Reduced investment risk due to fast modeling
- Quick identification of sources of problems in logistic and production areas
- Stock reduction by 20–60%
- Reduced investment costs by 5-20% for the new system
- The fast achievement of positive results and the identification of negative effects [5].

Simulation of assembly areas is currently used in robotized positions or in the area of assembly conveyors [6]. In addition, software is widely used to simulate the movements of personnel, to study the ergonomics of the workplace.

2. Practical results of modeling and analysis in the assembly system

This section discusses an example of designing and analyzing an assembly system consisting of one conveyor, three assembly positions, one accumulator, and one control position (Fig. 1 and 2). To simulate the assembly system, we used software from SIEMENS Tecnomatix Plant Simulation.

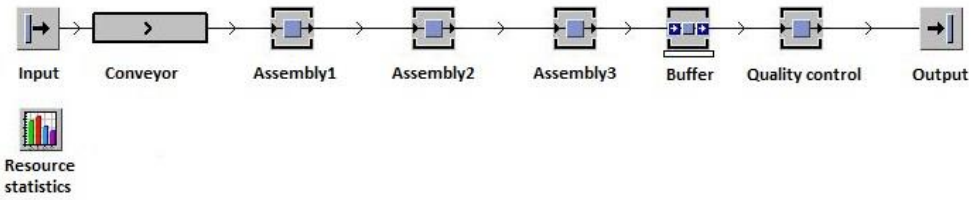

Figure 1. The basic model of the assembly system.

When testing the basic model of the assembly system, it was found that the bulk of the products accumulate after passing through the individual assembly positions at the control point. With the base model, for an eight-hour working day, 159 products were manufactured.

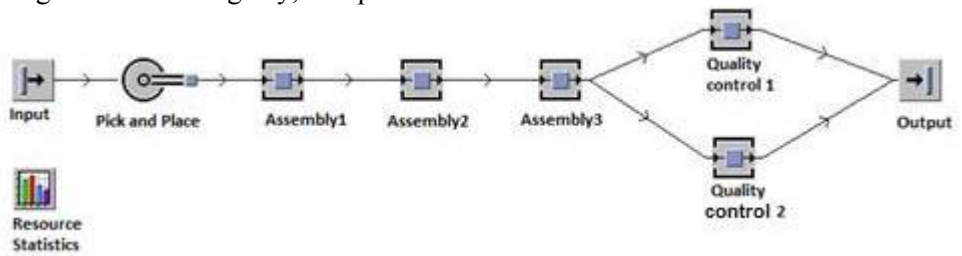

Figure 2. Improved build system model.

After finalizing the model, in the course of analyzing the simulation results, it was found that with the same planned parameters, 409 products were manufactured, which is more than the base model by 250 pieces. It follows from this that productivity increased by 267.78%.

The change in the performance statistics of the assembly systems, before and after tuning, is presented in Figure 3. From the right diagram, you can see that the assembly position at number 3 is not blocked after the model has been refined. The addition of an additional monitoring station reduced the load and allowed an increase in system capacity.

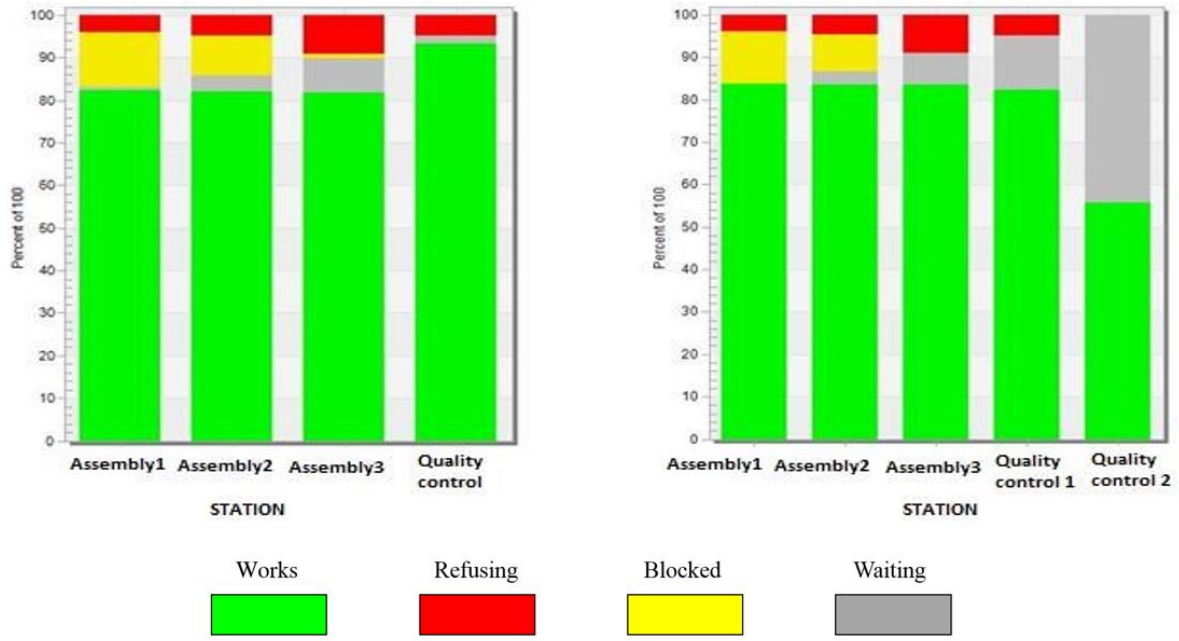

Figure 3. Resource statistics. Base model (left), modified model (right).

3. Results and conclusions.

According to the results of the development of a practical example in the software Tecnomatix Plant Simulation, a number of advantages of assembly modeling were established.

In developing the model, standard objects of the used software were used, which reduces the design time of the assembly system.

Working in a virtual environment and saving intermediate results allowed us to test several versions of the build system and select the most optimal and balanced version. It follows from this that constructive errors can be eliminated before their commissioning.

Tracking and analyzing the output results in the form of diagrams made it possible to increase the capacity of the assembly system by 267.78%, which indicates the possibility of optimizing the production indicators of the assembly system.

Currently, simulation is increasingly used in assembly, especially during the development phase of assembly systems. With the development of IT in the world, modeling is becoming increasingly noticeable, and we can expect that the simulation of the assembly will become one of the main tasks of the software development team.

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