SIMULATION AS A SUPPORT TOOL FOR DESIGN OF MANUFACTURING SYSTEMS

Ing. Lucia Páchniková, PhD.
Katedra výrobnej techniky a robotiky
B. Nemcovej 32, 040 01 Košice
lucia.pachnikova@tuke.sk

Ing. Ľuboslava Šidlovská
Katedra výrobnej techniky a robotiky
B. Nemcovej 32, 040 01 Košice
luboslava.sidlovska@tuke.sk

Abstract

The article is based on assumption that simulation is the only reliable method for manufacturing system profiling, which is characterized by ability of capacity assessment, transport and storage system activities, information flow and control system at the same time before the construction of the system allows to eliminate the effect of local optimization, manifesting itself in a large number of variants having complexity evaluation. According to complexity of the design and layout of the manufacturing systems are the classic methods of profiling inappropriate. The best solution is to use simulation in the initial phases of manufacturing systems development. The article highlights how the simulation can affect each phase of manufacturing system development and which questions could be answered, describes the benefits of its use in framework of manufacturing system projection and the steps to follow.

Key words: simulation, manufacturing systems

INTRODUCTION

This method overcomes the limitations of analytical modeling procedures and its use is justified especially in cases where others solutions have failed and the constant growth of solution complexity, new requirements for flexibility across the enterprise organizational structure, a new decentralized, modular organizational units, new work organization (teamwork, simultaneous engineering), high investment and high risk of bad decisions, put more emphasis on their acceptance at more frequent intervals.

Objectives of manufacturing systems simulation can be grouped into two categories:
1. Analysis of existing production systems for the purpose of optimization.
2. Design and verification of the design of new production systems.

Using simulation in the design of manufacturing systems can answer the following questions:
- Where are the bottlenecks of the project?
- Where are the risks?
- Is possible to meet the deadline for implementation?
- What is the reason of the long production time?

There is looking for the bottlenecks, it is realized correction of errors and looking for options for improving of whole system. Figure 1.

Simulation of manufacturing systems allows:
1. Review of the manufacturing systems operation by the plan implementation.
2. Identify factors which influence the behavior of the system.
3. Design and validate a combination of factors, which leads to the desired value of criteria, for example maximum utilization of machines, minimum continuous period of product manufacturing and so on.

![Fig. 1 Integration of simulation in designing of production cells](image)

Type of simulation model depends on deterministic task or task with random elements. Stochastic or deterministic of simulation depends on the input data of task. The random character has for example incidence and duration of failures of machines and equipment. If this is important factor, it must be included into the model as a random quantity. The rate of general or model specification depends on the specific objectives of a simulation. For example: for draft review the simple model is
usually suffices. If, it is needed to follow the special features it is necessary to construct a model on a higher level of detail. Stages of production cell simulation illustrated in Fig. 2.

**Identification of the components spectrum, number and type of equipment**

In practice, it is confirmed that only the choice of group technology in manufacturing systems profiling is the best approach to question - how?

In order to make the whole manufacturing process as effective as possible, it is necessary to specify the types and numbers of robots, production and handling equipment, equipment of transport and storage system, to maximize the elimination of bottlenecks in production and make analysis of the needs of all these subsystems and place them in accordance with the material flow. To determination the number of machines is used capacitance calculations.

Simulation can be used to test the suitability of components of the manufacturing system and verify the technical parameters of the components, their suitability to work in manufacturing system at required capacity.

**Implementation of results into practice**

Simulation is an effective tool in solving the problems of components arrangement, the layout of manufacturing system from a technology and handling equipment needed.

Simulation can reveal the appropriateness of the deployment of components in the manufacturing system in terms of technological requirements for the handling and flow in the system. Layout in most simulation programs can be compiled simply by downloading components from a library of objects but also generate their own models, most of the programs cooperate with other CAD programs, which allows easy construction of hierarchical models. In the model, it is necessary to generate the movements of machines and robots, their speed and path, simulate and evaluate the results.

**Identification and optimization of technology and handling flow**

Most simulation tasks solved in the design of production systems, planning, management and scheduling of production is related to the problem of queuing systems. Most simulation models are models of queuing systems. Structure of a simple queuing system is on Fig. 3.
By designing of manufacturing system activity is necessary to consider the following criteria:

1. If the machining times of the parts are the same, respectively differences between them are very small, can be proposed cycle operation when the robot operates cyclically all machines from the first n-th, Fig. 4. a.

2. If the machining times of the parts are not the same and the differences between them are significant, then it is possible to propose acyclical operation of machines by robots, machines, Fig. 4. b.

In both cases it is necessary to make analysis of exploitation of machines and robots. And on the basis of the conclusions is necessary to choose the optimal structure of the manufacturing system.

**Optimization of operating procedures, taking into account the critical situations**

Critical situations may be breakdowns of manufacturing system equipment, the inclusion of new requirements into production, or lack or accumulation of material and so on. Functionality of manufacturing system is disturbed. Simulations programs allow us "play" in advance such situations and to prepare for them, design and optimize the possible variants of solutions of these situations.

There are a lot of methods for simulation optimization. Overview of the main methods is on fig. 5. Most developers enjoy heuristic methods. These are implemented in all software packages used for simulation optimization. Heuristic methods provide fast and good results achieved for a wide range of problems.

Complexity of simulation optimization makes it unusable without computer support. Software packages are designed as plug-in modules that are added to the basic simulation platform. Optimization packages are a part of the Witness simulation (Optimizer) or Arena (OptQuest).

**THE BENEFITS OF SIMULATION FOR THE PROFILING OF PRODUCTION CELLS**

The use of simulation in manufacturing systems profiling brings a lot of advantages. It allows development of complex structure of manufacturing system, verify its operation, and optimize it in a short time, to detect bottlenecks and critical situations that may occur and suggest possible alternatives for solving these situations. Simulation allows to verify different variants of these solutions.
Already the experience with the creation of the model can lead to improvements of simulation model structure. Another advantage of simulation in production cells profiling is that it gives us the greatest opportunity to influence the total investment, especially in the early stages of the project. Correct and timely decisions are incomparably greater than the benefits of optimization in the next stages of the project.

**CONCLUSION**

The article deals with question of the use of simulation in manufacturing systems profiling. Outlines the procedure of its application and submit questions to which the simulation can give an answer. The use of simulation in the early stages of manufacturing systems profiling provides the opportunity to verify the its functionality, the accuracy of disposal for deployment of components, material and information flow in the system, permits the identification of possible bottlenecks, identify and optimize the work of manufacturing systems in the critical and unexpected situations, and it all before how it will actually be implemented, which allows to significantly reduce costs.

**Literature**

