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# MODELLING AND SIMULATION IN MANAGING OF PRODUCTION PROCESSES

*Production of products and offering services are the target of all economic activities. Production is not however realized in any method, but it is planned in detail, mostly with regard to effective utilization of resources. More and more substantial method which aids the production management becomes modelling and simulation. There are described examples of different simulation projects from production practice.*

## 1. INTRODUCTION

At production planning, it is not enough to determine how, what and when we should produce something but also to determine what, where and for whom we should produce it. Production planning is realized by starting with long-term tasks and short-term tasks planning and ending with the planning of the realization of the operation tasks. The planning of production can be understood as a creation of conditions for fluent and effective run of the production processes coming into existence. We should remember here about the costs and realization time, which should be made optimal [3].

One of the main elements warranting the effectiveness is the maximum utilization of the possessed production resources.

Development of the production control aiding systems is a result from the targets which were defined for the created systems. These targets were often quite different but if they were the same, they differed from each other with the assigned priorities. To the most important targets of the system aiding planning and managing of the production belong [2]:

- satisfying customers needs,
- keeping to the fixed time-terms,
- realization of technological requirements,
- maximum utilization of workplaces,
- minimization of the realization time of production orders,
- decreasing of production costs,
- correct settlement of series size,
- minimization of storage time,
- minimization of defective products,
- minimization of storages.

Activity of the company in the free market economy conditions makes managers undertake more and more complex and complicated tasks. The consequence this is the necessity of synchronisation of increasing quantities of the technological factors which brings looking for more effective methods of control of the production processes. Control of the production planning is one of the most important tasks of the company. The target of these activities is to manufacture the products at the planned time

Furthermore, they have to fulfil the qualitative requirements and their manufacture costs should be as low as possible.

The introduction of computers into companies was accompanied with the development of software aiding the production planning and control. PPC (Production Planning and Control) systems for the production planning at the operational level just appeared for this reason. Development of the PPC systems is connected with new data processing technologies. At present, they are characterised by the possibility of integration with other computer systems and with module structure.

New tendencies within the company organisational field, which have also an influence on the computer systems, have a meaningful influence on development of production planning and control. Among them, the most important are: Material Requirements Planning (MRP I), Manufacturing Resource Planning (MRP II), Enterprise Requirements Planning (ERP or MRP III), Just in Time (JIT), Kanban and Optimized Production Technology (OPT) [2].

Furthermore, modelling and simulation becomes more and more substantial method which aids the production management mainly in conditions of long-series production.

## 2. MODELLING AND SIMULATION

Computer technologies are the basic tool of accumulating and exchanging of information in contemporary enterprises. More and more commonly there are used methods of artificial intelligence and expert systems, in management processes. Persons managing of realized tasks in enterprise often give themselves two questions: „Why?" and „What will be, when?", wanting to make it the best of all, this means quickly, with lower costs and more effective.

The universal procedure used in methods of modelling and simulation, includes the following main stages [1]:

- problem's determination,
- model's building,
- preparation of input data,
- realisation of experiments on the model through implementing of different input data and observation of the model's behaviour,
- verification and modification,
- analysis of simulation results,
- working out the activity programme.

At the beginning of any analysis there is necessary to define input parameters of the analyzed system, which would collect, and output parameters, which will be a result of the conducted analyses and on the base of which there will be accomplished the opinion about analyzed system. There can occur two cases. First, in which for made assumptions of input parameters there will be conducted simulation of the system maintenance. Second, in which exist different collections of output data, in which exists problem of finding optimum, to produce articles with the best parameters from the point of view of the estimation criteria. It is difficult to find the optimum solution. There is necessary the proper planning of particular stages of experimental researches, finding of possible variants of solutions, and first of all proper settlement of estimation criteria.

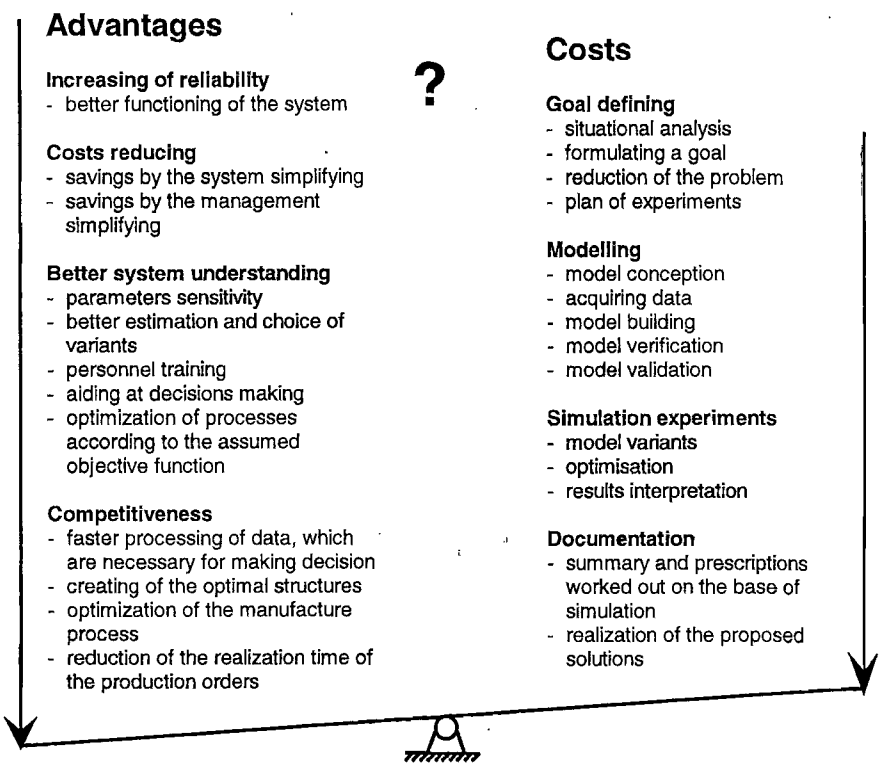


Fig.1. Advantages contra costs in the modelling and simulation method

In case, when during modelling and simulation there comes into being many variants of proposed solutions, researches of all possible combinations, all possible arrangements of the value of studied factors are very time-consuming. If it is not possible to examine all arrangements, there should study only these variants, which are chosen on the base of subjective opinion of researcher, his intuition and knowledge about the object of researches.

## 3. EXAMPLES OF MODELLING AND SIMULATION OF THE PRODUCTION PROCESS RUN

***Example 1 – supply, manufacturing and sale***

In the analysed system there are produced office furniture: the two-partial office wardrobe with shifted doors and the desk with cabinet on circles [4].

The aim of realized analysis was the test of present system functioning and checking of different possibilities of development.

On the first stage there was analysed the production process. Different production programmes were compared. The duty of available resources was analysed and on the base of test data there was accomplished calculation of costs. For different variants of possible changes, there were compared material and workplaces costs. For example in next simulation models there were chosen operations (cutting of panels, assembly) which were realized in cooperation, through this there was achieved shorter time of production process realization.

There is possible to create next variants of the analysed production system still comparing and estimating results from conducted simulation.

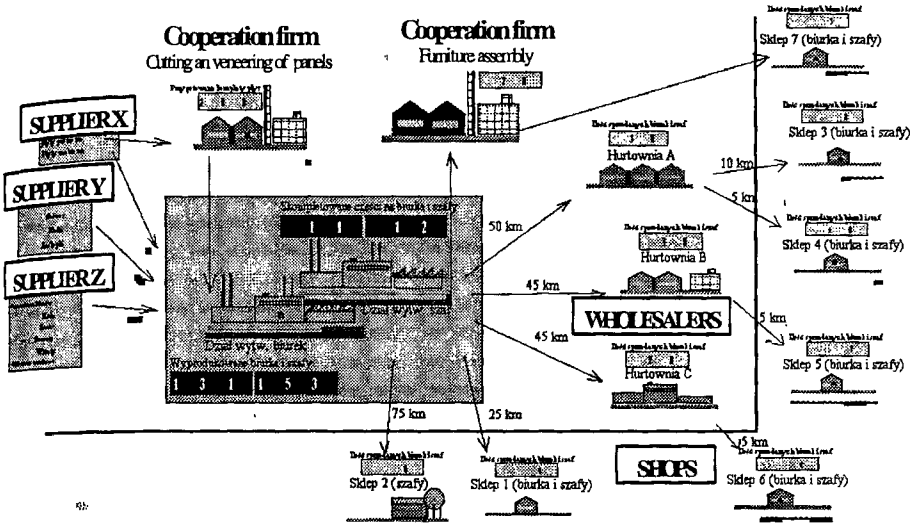


Fig.2. Simulation model – supply, manufacturing and sale

Results from simulation made possible to compare different variants of proposed changes in the analysed production system. They were compared from point of view of times and costs of orders' realization. The possessed production resources make possible production increasing about 10% without necessity of additional financial expenditures. There is necessary to execute a part of works in cooperation (cutting and veneering of panels and furniture assembly).

On the fig.2 there is introduced the variant of simulation model with two cooperating firms: the firm, which cuts and veneers panels and the firm, which assemblies the compiled in our firm parts. This simulation model was worked out in ARENA packet.

***Example 2 – production process run***

Second example is connected with the production process run, which is realized in the company where the toothed gears are manufactured [5].

The present organizational structure did not fulfill the market's requirements. Production cycle was too long. The changes to improve the production processes realization were necessary. Proposals of the possible organizational changes were analyzed by the modelling and simulation method. The simulation of realization of the same production order in different organizational conditions, makes the comparison of the proposed solutions possible.

The carried out simulations allowed to check the possibilities for realization of the proposed production plan and to trace the utilization of the company's production

resources more exactly. The simulation results allowed for the efficient finding of bottlenecks and indication of the unused elements in the production system.

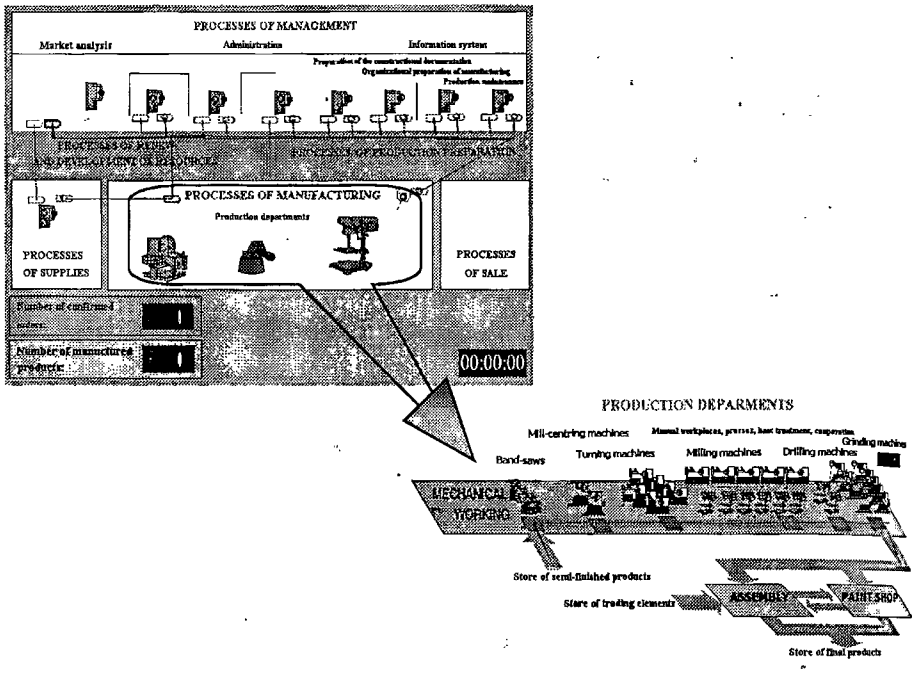


Fig. 3. Simulation model of the production process run

***Example 3 – production subsystem***

Third example is connected with the shaft treating department [5].

From the simulation of monthly production one obtains information about duty of workplaces, about manufacturing costs of various types of the shafts and about the time of the orders realization.

This modelled production system can be still improved, conducting further simulations for various variants of the system (new machines, different production orders, various quantity of worked elements, different size of buffers, foreseen disturbances and possible breaks e.g. connected with planned repairs of machines, alternative processes of manufacture).

## Manufacture processes, machines

| Op. | Name of operation | Workplace (quantity of machines) |
|---|---|---|
| 1 | Cutting on length | Band-saw (2) |
| 2 | Facing on length and centring | Mill-centring machine (1) |
| 3 | Turning | Turning machine DFS 450 NC (2) |
| 4 | Grinding | Centre-type grinder (4) |
| 5 | Slot milling | Sequence milling machine (3) |
| 6 | Grease conservation | Manual workplace |

## Simulation model

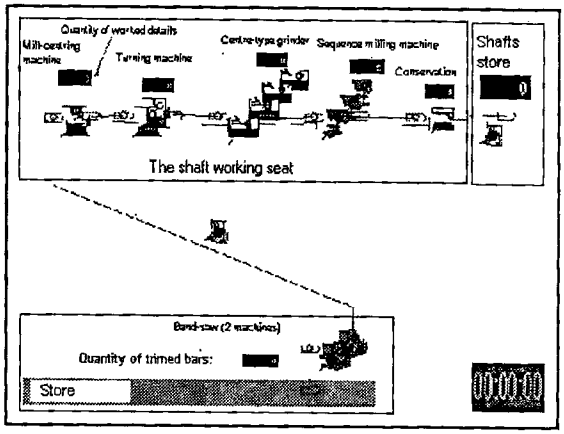


Fig. 4. Simulation model of the shaft seat

## 4. SUMMARY

The modelling and simulation is an universal technique, what inflicts, that it finds more and more wider use in enterprises. It is more and more important aiding technique for designing of new production systems, and also aiding production management. It makes possible tracing of the production functioning and detection of weak points. Tracing of effects of proposed changes makes possible also. It makes the choice of the best variant of solution easier. Simulation can be using to manage of production processes also – as a tool for checking of possibility of different production orders realization at different available resources. It can take into account not only manufacturing process, but also supply and sale processes. For building of such complex model, it can approach in two ways: by creating of generalized model of the whole system, and then extend particular subsystems. On other side there is possible first to create models of subsystems, which will become joint later into one.

Simulation permits on execution of researches on the worked out model, and not on "live" system. Thanks such researches there is possible increasing of efficiency of the production system functioning mainly thanks to possibility of solving of problems in short time. Possibility of verification of accomplished assumptions before use in practice is the next advantage. The introduced example and mentioned above advantages from her use testify about large usefulness of the modelling and simulation method in dissolving of problems connected with managing of production processes.

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