DETERMINING THE OPTIMAL LOAD OF MACHINES AND DEVICES IN THE PRODUCTION SYSTEM

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Summary

A company operating nowadays is subject to constant pressure from methods aiming at optimizing processes and minimizing costs. An efficient use of resources such as business assets, human labour, know-how and management of material resources offers a possibility of obtaining a competitive advantage.

The paper examines a production system of bath sponges, for which, in order to properly use its technical infrastructure, a model was simulated in eM-Plant environment. The data from the accepted variant were transferred over to MS Project, in order to schedule work and appropriately allocate the plant's employees. The resulting schedule is used to monitor progress of the plant's operation and for efficient communication between resources in the production system.

Keywords: analysis of resource load, use of resources, simulation of the manufacturing process.

WYZNACZANIE OPTYMALNEGO OBCIĄŻENIA MASZYN I URZĄDZEŃ W SYSTEMIE PRODUKCYJNYM

Streszczenie

Współcześnie działające przedsiębiorstwo poddawane jest ciągłej presji związanej z optymalizacją przebiegu procesów oraz minimalizacją kosztów. Odpowiednie wykorzystanie posiadanych zasobów w postaci aktywów przedsiębiorstwa, pracy ludzkiej, know how oraz zarządzania zasobami materiałowymi daje możliwość uzyskania przewagi konkurencyjnej.

W artykule przeanalizowano system produkcyjny gąbek kąpielowych, dla którego w celu odpowiedniego wykorzystania posiadanej infrastruktury technicznej zasymulowano model w eM-Plant, a następnie dane z zaakceptowanego wariantu przetransportowano do MS Project, celem zaplanowania prac i odpowiedniej alokacji pracowników. Tak przygotowany harmonogram posłużył, jako podstawa do monitorowania postępu prac oraz sprawnej komunikacji między zasobami w systemie produkcyjnym.

Słowa kluczowe: analiza obciążenia zasobów, wykorzystanie zasobów, symulacja procesu produkcyjnego.

1. INTRODUCTION

From today's businesses, due to their size, capabilities and complexity, requires that management functions were an integral part of an organization [1].

Business success depends on proper management of its resources. The aim is to increase work efficiency and reduce manufacturing costs of the product, while maintaining an appropriate level of quality. To meet these objectives, a company should be subject to continuous improvement and elimination of inefficiency.

In a smooth running operation of a production system the elimination of non-technological breaks should occur immediately and should be combined with an analysis of the use of workstations

The basic production factors, such as human labour and technical infrastructure complement each other. Proportions between these factors should be such as to ensure their efficient use.

The use of modeling and simulation mechanisms of production processes makes it possible to optimally use their technical infrastructure and to select necessary staff, so as to balance the available means of production [2]. Such planning can be performed using the methodology of ERP systems. However, such systems are not always available, and the implementation costs are very high [3].

The paper presents a study of how corporate resources are used by means of two computer programs: eM-Plant and Microsoft Project.

The proposed solution does not generate significant costs for the company. On the contrary, owing to the method it is possible to quickly and easily diagnose how efficiently machinery, equipment and personnel are used in the process of calculating production costs, scheduling and controlling the workflow.

Exchanging data between the programs makes it possible to analyze the impact of a specific production task on the entire production process. It

is possible to analyze different models of the system by simulating connections of several work packages.

Proper selection of the factors of production, selection of an adequate flow of data in the system, maintain the principle of Just In Time, and continued to motivate staff to work effectively is necessary for the operation and competition in dynamically changing environment of internal and external business.

2. METHODS FOR SELECTING RESOURCES IN THE PRODUCTION PROCESS

To effectively control a production system it is necessary to analyze how its resources are used. This task must be considered in terms of hardware, material and human resources.

Machines' performance is determined by analyzing the performance of a specific machine, including its depreciation which is the reason for its stoppages due to breakdowns or technical inspections.

The reason for not meeting production plan deadlines could be an inadequate number of machines used for a given task or else too many machines used at another working station [4].

Another threat of failing to meet the deadline of a production plan is bad allocation of resources. While overloaded resources can be a problem, resources not loaded enough can also generate unnecessary costs.

There are many coefficients that describe the use and performance of a system. However, these coefficients do not consider all the features, which in some cases makes them inapplicable [5][6].

The solution is to use modeling and simulation, which makes it possible to analyze the functioning of a given system .

In the eM-Plant simulation environment it is possible to build a hierarchical, fully object-oriented structure of a manufacturing process and dynamically seek the best solutions of the preset criteria [7]. The environment provides tools for optimizing material flow, resources utilization and logistic processes both at a basic detail level and at the level of global enterprises.

The designed simulation model of the production system shows its behavior without the need of conducting expensive experiments on real objects [8].

Microsoft Project is an application supporting management of projects, resources, time and finances. It is a tool to develop and manage schedules.

After the allocation of resources to respective tasks it is possible to balance that and analyze the use of workers in view of scheduled tasks and the use of machinery in view of its availability. It also provides the ability to coordinate the progress of work checking for deviations from the plan and respond to-date on emerging risks associated with their jobs.

3. SIMULATION OF MANUFACTURING LINE IN EM-PLANT ENVIRONMENT

The purpose of the analysis is to develop a simulation model of a production system characterized with a high use of its machinery and devices.

The load of machinery and devices as well as processes were simulated in eM-Plant environment. This is a utility object which can simulate discrete events.

A sponge bath production line has been analyzed. The production is divided into three shifts. The flow of material in individual slots in the system is pipelined.

Polyurethane foam block is cut into slabs on a rotary saw, and then it is transported to the production station, where an automatic spray of glue and connection of the bottom and top layers of sponge take place. After gluing is completed the slab is cut into individual sponges on a vertical saw.

The basis for modeling the production system and for the harmonization of scheduling tasks is a operation diagram of the system presented in Figure 1.

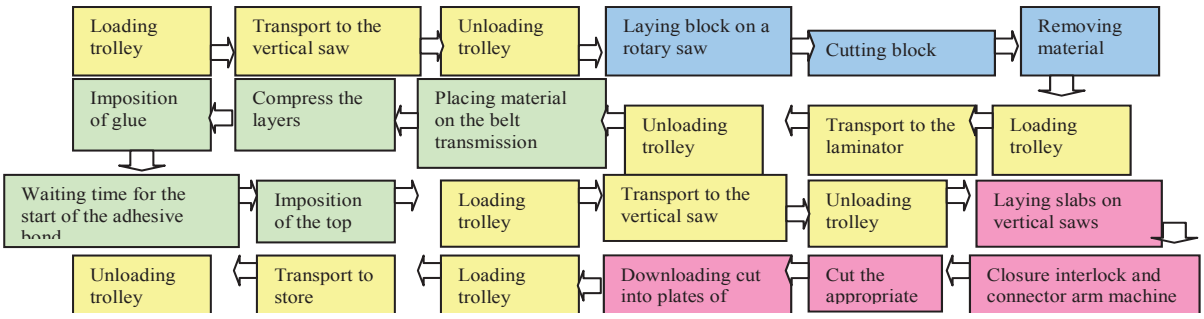

Fig. 1. Production process of bath sponges

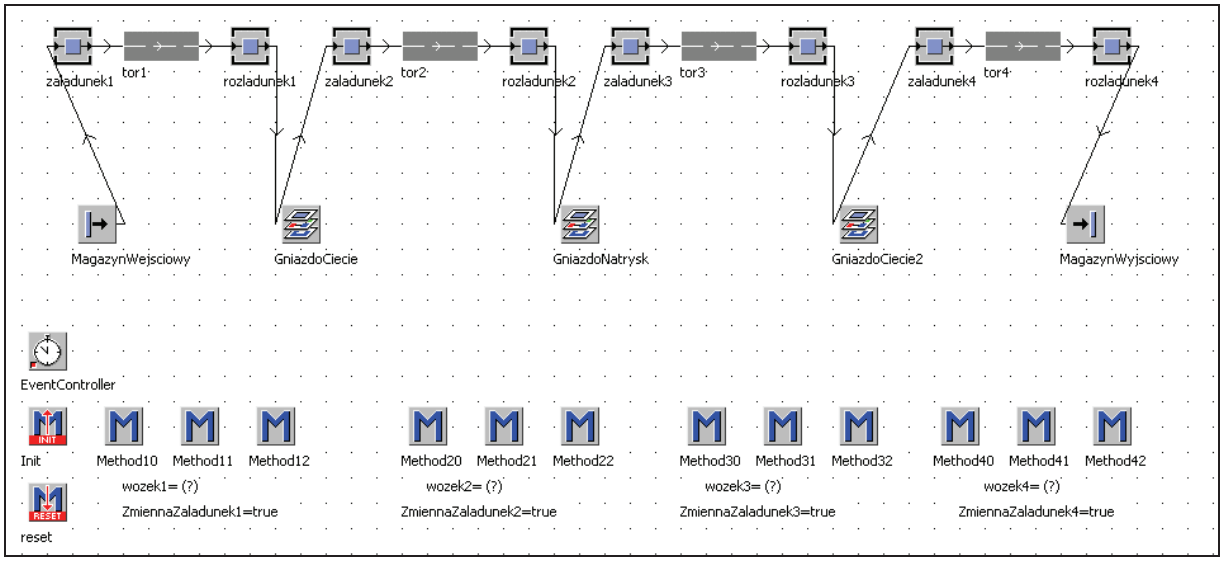

Fig. 2. Simulation model of production line implemented in eM-Plant program

Assumptions for the construction of the model:
- Simulation of the process will be carried out for one shift, i.e. 8 hours of work,
- Time duration of various phases of the process (Table 1) was adopted according to data provided by the manufacturer,
- Truck after unloading returns to fetch another element,
- Ready-made components are transported to an external storage.

Table 1. Characteristics of the manufacturing process

Process Step	Object Model **eMplant**	Working time **[min]**
Loading trolley No 1	*zaladunek 1*	5
Transport to the vertical saw	*tor 1*	5
Unloading the truck No 1	*rozladunek 1*	5
Laying block on a rotary saw	*G1*	4
Cutting block	*G2*	3
Removing material from the machine	*G3*	5
Loading trolley No 2	*zaladunek 2*	5
Transport to the laminator	*tor2*	6
Unloading the truck No 2	*rozladunek 2*	5
Placing material on the belt transmission	*G4*	5
Compress the layers and downloading from the machine	*G5*	4
Imposition of glue	*G6*	4
Waiting time for the start of the adhesive bond	*G7*	5
Imposition of the top layer	*G8*	5
Loading trolley No 3	*zaladunek 3*	5
Transport to the vertical saw	*tor 3*	6
Unloading the truck No 3	*rozladunek 3*	2
Laying slabs on vertical saws	*G9*	5
Closure interlock and connector arm machine	*G10*	5
Cut the appropriate	*G11*	3
Downloading cut into plates of sponge	*G12*	5
Loading trolley No 4	*zaladunek 4*	5
Transport to store	*tor4*	6
Unloading the truck No 4	*rozladunek 4*	3

The model has a two-layer structure. The second layer is formed by a frame-type model objects known in the model as: Gniazdo Cięcie, Gniazdo natrysk, Gniazdo Ciecie2, which model various stages of manufacturing processes: cutting on the
rotary saw, gluing the sponge layers and cutting individual products out of the sponge slab on the vertical saw.

The model of the system is shown in Figure 2.

During the simulation characteristic parameters for a given process (transportation, facilities utilization rates, number of items produced, etc.) are generated and calculated. Several simulation experiments with different number of transportation batches were carried out. For further analysis in MS Project the organizational variant was selected ensuring the most efficient use of the technological stations.

An analysis of the system operation is possible owing to statistics produced in eM-Plant environment, which are generated for each individual object. A sample statistics is presented in Figure 3.

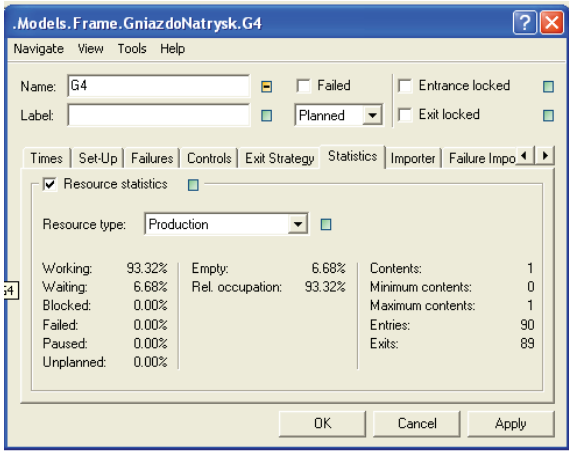

Fig. 3. Statistic for neck „natrysk"

Statistics include information about the number of items that were sent over to a machine or device, the efficiency level of its use and its stoppages. For example, an average use of machinery of the slot "natrysk" amounted to 84.2%. The summary of statistics of the technical resources of the manufacturing system is presented in Figure 4.

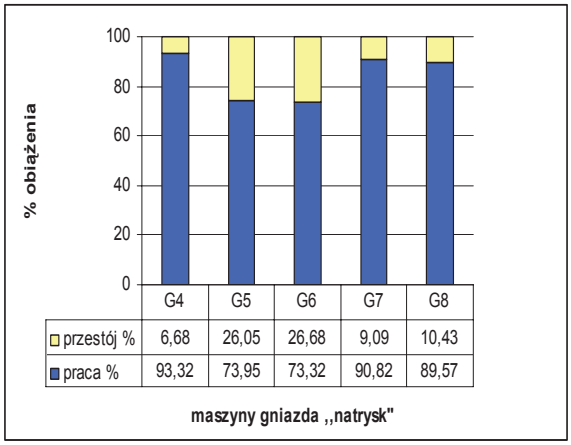

Fig. 4. Characteristic of using technical resources for 'natrysk" neck

4. ANALYSIS OF THE USE OF HUMAN RESOURCES IN MICROSOFT PROJECT

Having a model which can efficiently use machinery and equipment, the allocation of human resources was conducted.

MS Project was used for the purpose. This is a commonly used planning tool, allowing to generate a Gantt chart, balance resources and analyze critical tasks of the project. For the scheduled operations human resources had been assigned, and then the performance of their work was examined.

In the production of sponge baths four employees are employed: a warehouse employee, a vertical saw operator, a rotary saw operator, an operator of the laminator. The employees are assigned to their respective tasks, bearing in mind that when it is necessary they will be delegated to perform other tasks.

High productivity can be achieved owing to the generated allocations. The average workload of human resources assigned to all the tasks was 85.9%.

Figure 5 shows the workload of human resources for this process.

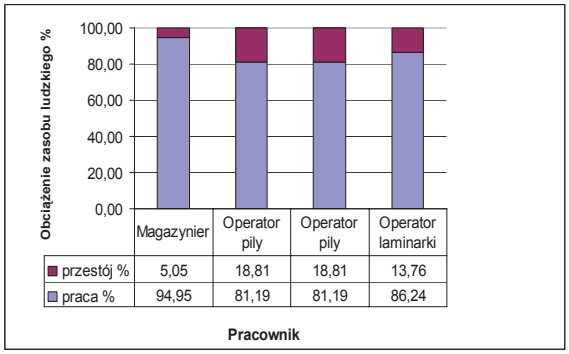

Fig. 5. Use of human resources

The resulting schedule provides a basis for monitoring the implementation of production, rapid response to errors and allows changes in the functioning system.

Resource management involves tracking progress, identifying and solving problems of allocation, management of shared resources, and creating reports of its progress.

MS Project is a helpful tool in managing the system. It shows a current status of a given task, differences between the work done and planned, the estimated time of completion of each task and the entire project.

5. CONCLUSION

Management of a production system relies in seeking optimal solutions for a given machinery and performance of its employees. Taking into consideration an appropriate use of the available resources it is possible to shorten a production cycle and reduce the costs.

An implementation of the model in eM-Plant environment provided a solution to the presented problem. The machinery and devices were simulated using batches of a size that would ensure obtaining the highest degree of using the machines. Following on from that, the data were exported to MS Project. MS Project was used in the study because the manufacturing firm had this very program. So far, planning data were imported as values of Microsoft Excel. Their treatment did not ensure a proper balancing of resources, which was the cause of discrepancies between the planned and actually obtained values.

The allocation of staff was conducted using MS Project. A schedule prepared in this way was a basis for monitoring progress of work and use of resources. The schedule also made it possible to

generate reports and statistics to be used both on the production line and used as the summary and control material available for senior managers.

The analysis of the production system conducted by means of the above described programs shows that both the machine utilization, and human resources at specified conditions, is at a high level.

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