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STRATEGY OF MANUFACTURING PROGRAMME OPTIMIZATION IN MANUFACTURING SYSTEM

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Abstract: *The contribution presents a design of time minimization in products distribution by means of the Dantzig's Method. A model of products supply scheduling is used in the system based on a Kanban system.*
Key words: *minimization, product, distribution, manufacturing, programme*

1. INTRODUCTION

In the field of technological processes, the primarily goal of the firms is accurate and reliable fulfilment of customers' demands and according to such approach to production planning, the firms belong to those using Just-in-Time manufacturing system. The manufacturing system is required to accept customers' demands and at the same time to fulfil the firm's targets, including cost minimisations. In the analyzed firm, a manufacturing programme is elaborated based on customers' requirements and to ensure cost minimization is a demanding problem. By means of a mathematical model it is possible to verify various strategies designs of manufacturing control as well as the implementation of the manufacturing programme. Based on the analysis of an actual manufacturing process and a mathematical description resulting from it, a deductive, deterministic model is designed. The advantage of a deductive model is that its utility is not limited by an experiment extent. A deductive mathematical model applied to a manufacturing process is limited by the rules, laws, eventually manufacturing conditions valid in a given period of time.

2. OPTIMIZATION OF PRODUCTS

The manufacturing programme analyzed in the paper contains plastic parts manufacturing used in white goods. Parts pressing are provided by the most modern technology. The firm receives orders much time in advance and completed products are supplied in regular (relatively short) time intervals in a volume that corresponds to the amount of products ordered for the following week. Not later than one working day before the beginning of the week (on Friday) the products have to be prepared. Since the manufacturing is automated, it is possible to optimize the products preparation for the customers and products taking delivery by the customers. The aim is to minimize time (time cost) spent on the order processing and delivery of ordered goods to the customers. Optimization of products arrangement for a taking delivery by a customer will be modelled by the Dantzig's Northwest Corner Method. We are searching for such amounts x_{ij} which have to be supplied from the *i*-th manufacturing plant to the *j*-th consumer so that a total time cost q_{ij} is minimum, where time q_{ij} is determined based on the relation (1). The designed problem is a combination of the problem related to the manufacturing planning and products distribution, where the cost function will express the solution target - time consumption (time cost) minimization with the products distribution. We will minimize the cost needed to process orders q_{ij}, a total value is expressed by the cost function

$$J = q_{11}x_{11} + q_{12}x_{12} + \ldots + q_{1n}x_{1n} + q_{21}x_{21} + q_{21}x_{21} + q_{22}x_{22} + \ldots$$
$$+ q_{2n}x_{2n} + \ldots + q_{m1}x_{m1} + q_{m2}x_{m2} + \cdots + q_{mn}x_{mn}$$
$$J = \sum_{i=1}^{m}\sum_{j=1}^{n} q_{ij}x_{ij} \qquad (2)$$

3. TIME SPENT TO PROCESS THE ORDER AND PRODUCT DISTRIBUTION

In the defined relation

$$q = e.(v/a) + y.E.T + d + z.c + (b-1)c + r + (v-c) \qquad (1)$$

q is time spent to process a file card(known in practice as time of a card circulation in a loop) (Macura, 2003). The variables meaning and some standard values of variables of the relation (1): v time spent on manufacturing , r possible repair, z number of preparatory plants, $T = v/A$ time of all ordered products, manufacturing (in practice called tact time), A customers' total demands , a customer's demands, b number of pieces /packages, c cycle, d version change, w 10% time needed to change the version manufacturing time, E batch dimension, $e = d/(wc)$ batch dimension, e/b number of file cards batch dimension (Macura, 2005).

4. A GENERALIZED PROCEDURE OF A DEDUCTIVE MATHEMATICAL MODEL DESIGN APPLIED TO A MANUFACTURING PROGRAMME

The model presented in the paper expresses substantial elements and properties of a part of a manufacturing programme. It is not possible to include all the properties because they may affect parts of the manufacturing programme as well as unknown processes and effects. We investigate the relations between the inputs and outputs of the manufacturing programme. In the first stage of the model designing, we analyze the manufacturing programme, in this case we determine the substance of products supply to the customers based on the demand. We specify the effects that are considered principal when designing the mathematical model. We use simplifications of some events, make decisions about individual phases and the extent in which they will participate in the

resulting model. The simplification phase is expressed by means of several suppositions:

- the process is divided into simpler parts that are analyzed individually taking into .consideration their mutual connections,
- we suppose independence on the effects of external temperature, pressure, etc.
- we suppose that the elements of the manufacturing programme are of a homogeneous and isotropic material,
- losses are neglected,
- in a certain defined area, nonlinear dependences are linearization,
- investigated dependences between the values are of an empiric character.

5. PROCESSES MODELING

The aim of the paper is to present the designing of mathematical model by formulas (1) of their application to the solution of selected optimization problems. The solution to the defined problem represented by a model often consists in finding an extreme of the criterion function, i.e. the point, eventually n-components of a vector in which the function attains its maximum or minimum. Such a vector represents the best variant of the problem under solution of the given set of variants. In this sense we speak about optimization and optimization methods. Thus, optimization in informatics means searching for "the best solution to the defined problem". In case of incomplete information about a composite system, eventually a regulated process, this refers to the system with incomplete information, therefore the methods of a new scientific branch – artificial intelligence – have to be used. Models of operational research are systems which are a simplified image of objective reality. They are of a mathematical character, i.e. they contain equations, inequalities, differential equations and differential-difference equations. Such modeling method belongs to mathematical modeling; mathematical models themselves, considering the form of uncertain variables occurrence, can belong to some of the following categories of models: deterministic, stochastic, strategic, adaptive and fuzzy. A criterion function an objective function with these models represents the extent of the evaluation of the achieved goal which was defined for the given system (Jadlovska et al (2005). The methods and the means of artificial intelligence include:

- Solution methods for problems with constraints
- Genetic algorithms
- Neural networks theory
- Expert systems
- Methods of chaos theory

Nowadays, based on Darwin's theory of evolution, evolutionary algorithms are being developed very fast. They are the essential instrument of informatics and modern numerical mathematics applied to the solution of complex optimization problems. (Hrubina&Jadlovská, 2002). When assessing a mathematical model, a real phenomenon is simplified, schematized and the scheme obtained is expressed in dependence on the phenomenon complexity by means of a selected mathematical apparatus. A model has to reflect all most important factors affecting the process, it has to provide a sufficiently true description of both quantitative and qualitative properties of the process that is being modeled. A mathematical description of the model structure according to the character of the process is a system of linear, non linear, differential or difference equations which reflect a mutual influence of different parameters. In the mathematical description of the equation of one type they do not exclude the occurrence of equations of another type. Mathematical modeling is not in contradiction to physical modeling, it is rather its replenishment. Physical modeling is not determined to analyze specific properties of a mathematical description, it is used to assess the objects adequacy based on the comparison of the values of some determining complexes in mathematical equations. With mathematical modeling, the process is under investigation. Accordingly, various parameters of a mathematical model that is modeled on a computer are changed. This enables to obtain information about various variants of the investigated process very fast. Within a reasonable time it is possible to realize optimum variants of a model which means to carry out a mathematical model optimization. Mathematical modeling is much cheaper than physical modeling regardless it expresses money costs or time costs

6. CONCLUSION

The advantages of the manufacturing programme investigation by means of the mathematical model lead to the assumptions of failure elimination that could occur with the experiments, e.g. products distribution. The model expressing the principal properties of the manufacturing programme, eventually its part, satisfies the basic criterion of a quality and applicability which is in accordance with a real situation in manufacturing. In the following stage of designing a general mathematical model of the process, a system of mathematical relations and equations is created. A simulation programme requires a selection of the method applied to the model equations solution, a design of a suitable algorithm of a solution and a programme. An important stage of the solution is the model verification, check-up tasks solution, analysis of their results as well as the suitability evaluation of their application to a given purpose. Based on the complete procedure, it is obvious that the design of products distribution scheduling is proposed in order to minimize the supply time and increase the profit of the firm.

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