APPLICATION OF PATTERN RECOGNITION METHODS FOR IMPROVEMENT OF FLEXIBLE MANUFACTURING SYSTEMS' MANAGEMENT

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Developing countries emerging from command economies usually require dramatic, qualitative changes in commercial and industrial systems. This article presents one promising approach for doing so: the application of pattern recognition methods for improvement of flexible manufacturing systems' management in the former Soviet Socialist Republic of Armenia.

INTRODUCTION

For the past decade, the development of a market-oriented economy in the former Soviet Socialist Republic of Armenia has been experiencing substantial hardships. These hardships are a result of many factors, some Acts of God -- such as a devastating earthquake and few natural resources -- and others acts of Man: an economic blockade to the West, war to the East, cutting of rail lines to the North, and the collapse of major markets for human resources (such as highly educated but specialized engineers). Other causes, while not as drastic, are nevertheless important. High among these was the paucity of business, civics, and economics education. *

[Editor's note: Glendale, California based Junior Achievement Armenia has introduced just such education throughout elementary and secondary schools in Armenia along the lines of Junior Achievement of America's focus on supplementing U. S. public education in less advantaged areas through extra-curricular business and economics education sponsored and taught by volunteers from the local business community. In neither case are any government funds involved.]

In addition, an old and disabled system of management plagues Armenia as well as the other republics of the former USSR. Most of these have chosen the road of independent development from centrally planned to market oriented economies. This is intended to achieve a commercial and industrial intensification not seen since World War II. Thus it is not surprising that most of these countries have found that this transition period demands drastic and qualitative changes in their economies, both from a macro-economic and a micro-economic perspective. As for the latter, it is proposed that comprehensive industrial intensification can be achieved *via* implementation of new technologies, technical improvements, re-equipment, and introduction of new methods of production management.

The central reason for this is that most enterprises are characterized by decreasing growth rates. This is related to the low level of specialized workplaces and production areas capable of accommodating required machine tools in a relatively short time period. Introduction of new management methods requires resolution of the above-mentioned problems. In this respect, a range of measures is considered that would improve utilization of manufacturing capacity of enterprises. The new forms of production organization should facilitate more effective use of equipment capacity and introduction of new technologies.

EFFECTIVE PRODUCTION SYSTEMS MANAGEMENT

There is no question that more effective management of production systems is needed. But many of the problems related to design of an effective production systems' management remain unsolved. In particular, existing methods of production

objects' classification do not permit practice of optimal classification of manufactured objects, especially for flexible industrial systems (Technological Classificator, 1974; Ward, 1963). This study considers the problem of optimal classification of production objects for implementation in workplace of the flexible industry.

Despite the high level of theoretical development there are a number of unsolved tasks in the classification of production objects (Zagoruyko., 1972).. Widely known methods and approaches are not applicable to the optimal classification of production objects that would take into consideration the current requirements of Flexible Manufacturing Systems (FMS) management. This is why a scientifically grounded organization of the grouped processing gives a large economic effect for a number of FMS management indicators:

- Increased productivity of processing;
- Technical preparation of production, and mastering of new production, is faster;
- Design and mastering of special machine tools is simpler and less costly.

NEW CLASSIFICATION OF FLEXIBLE PRODUCTION OBJECTS

This study presents a new method for classification of flexible production objects (such as parts, units, accessories, components, or details.) This method is

an application of the modernized algorithm of automatic classification considered in the theory of pattern recognition (Classification and Cluster, 1980; Obenchain, 1977; Ward, 1963; Rozonoer, 1970). The problem is division of the adaptive samples into definite taxonomies (Kaklushina, Dovzhenko, and Degtyrev, 1976). This problem is solved with the help of given solution rules in such a way that the number of taxonomies is minimal subject to the constraint that it is sufficient to describe objects with given precision and reliability.

The object classification is equivalent to division of a certain set of multidimensional objects into classes. It is based on the fact that there is an isolated group of points in the space of indicators that corresponds to each class. Since the preliminary setting of standards is not feasible, the identification of similarities and differences is done by division of the set of objects into an endogenous number of unknown classes.

Euclidean distance φ can be taken as a measure of closeness between the objects under consideration. However, a wide range of its values (from 0 to ∞) makes the following analysis very difficult. Therefore. The function of potentials is used to solve the problem

$$\varphi = \frac{1}{1 + \alpha D_{ij}^2},$$

that varies from 1 to 0.

In order to group objects into classes it is necessary to have a minimal dispersion of indicators within the class and maximal differences between average values of the classes. There are many ways of presenting the optimal conditions of object classification. In this article the method of potentials is used and the problem is solved with the help of the algorithm of objective classification (Ward, 1963; Rozonoer, 1970; Kaklushina, Dovzhenko, and Degtyrev, 1976).

The sought criterion is presented in the following form:

$$I = I_1 - I_2 \to \max,$$

where I_1 is the "average self – potential" of given classification and I_2 is the value characterizing the proximity between classes. The value of "average self – potential" for given classification is determined as follows

$$I_1 = \frac{1}{k} \sum \Phi(A_i, A_i),$$

where k is the number of classes in the classification and $\Phi(A_i, A_i)$ is the "class average potential" characterizing the object's measure of proximity within the class.

The value of I_2 is determined as follows

$$I_2 = \frac{2}{k(k-1)} \sum_{i=1}^{k-1} \sum_{j=i+1}^{k} \Phi(A_i, A_j),$$

where $\Phi(A_1, A_i)$ is a measure of proximity between the classes.

A classification is chosen for which I achieves a maximum. The more compact the classes are the larger is I_1, and the further they are the smaller is I_2. Therefore, the choice of classification (composed of several different objects of the same combination), for which criterion I assumes the greatest value, is objectively optimal. The problems of selection of distinguishing properties that characterize the objects of classification are considered, as well as the specifics of manufacturing process. The applied method gives an opportunity to find the optimal classification of production objects.

The obtained results for the classification of production objects allow a uniform loading of equipment. This in turn leads to an increase in the coefficient of equipment use per unit of time, and to manage production more efficiently. The results of the model prove that the proposed approached could be applied effectively to increase intensification of production and development of efficient management. This method has advantage over other methods because it can easily implemented on different levels of management.

SUMMARY

This article presents a promising approach to enable developing countries emerging from command economies to intensify the results from industrial intensification. The application of pattern recognition methods for improvement of flexible manufacturing systems management may be just the approach needed to

effect the dramatic, qualitative changes in commercial and industrial systems desired in the former Soviet Socialist Republic of Armenia.

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