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STATE OF EQUILIBRIUM AND TECHNOLOGICAL PRINSIPES CONTROL OF DISCRETE MANUFACTURING SYSTEM

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Abstract : The cutting conditions of basic working regimes (minimum machining cost, maximum productivity, maximum profit and minimum tools requirements) can be calculated in advance. When a break- down occurs , it is possible to calculate in real time adaptive conditions eliminating losses from the break-down and finally to restore the balance of the manufacturing system Presented mathematical model by means of variations in cutting conditions, makes it possible to keep the manufacturing configuration in balance, both from the production capacity and production plan point of view.

Key words : adaptive control, break down, optimalization, cutting conditions ,stable working regimes, manufacturing system, production plan and production capacity.

1. INTRODUCTION

Adaptive control in the latter sense is understood as such control of the manufacturing process that secures the permanent balance between the production capacity and production requirements. Production in machinery industry is of a stochastic character and a control in a more narrow sense of the word means to determine the way and means of production in accordance with the time plan of the products` launch and to regulate the actual behavior of the manufacturing process in such a way that the deviations from the plan are minimal .

During creating and managing the technology of the cutting process are already used exact approaches, models and methods of solution. At disposal is extensive mathematical mechanism, for calculating and optimising of technological parameters and processes, for choosing machines, tools, fixtures, manufacturing compositions, transport and manipulation components, etc. witch provides very good results by using exist database of the input parameters. In this programming system are completed and

systematized science-technical outputs, methods, mathematical models and programme products, witches were made for subject: Technology of the adaptive control process[1-8].

The usage of this model in real practice requires existence of technological and economical data in database. Mainly are needed the statistic models for calculations of economical parameters as cost of minimum work of the tool machine and the instrument during one lifetime. It is definitely profitable to make investment into design of own database.
These information are the main conditions for optimization of the cutting operations sequence and calculations of the influence of modification in technological and economical parameters, particularly costs and machining productivity. In the development of technological database the vital role can do universities, where are experiences and experimental environment.

2. THEORETICAL RESOURCES AND PRINCIPLES OF AN ADAPTIVE CONTROL OF THE AUTOMATED MANUFACTURING CONFIGURATION

For the given manufacturing configuration and the time plan of the products` launch we choose the objective (criterion) function. According to the objective function used, we can define the following *stable working regimes* of the manufacturing configuration:

WR 1 - working regimes of minimum machining costs
WR 2 - working regimes of maximum machining productivity
WR 3 - working regimes of minimum tools requirements
WR 4 - working regimes of maximum profit.

In formulating the original task of the control we choose one of the mentioned regimes. As the *basic working regime* is regarded the first one, under which the parameters are optimized from the point of view of the machining costs. The choice of the objective will depend on the relation between production capacity, which is at disposal in the given time period and is necessary to meet the requirements on production:

MC. If the production capacity and requirements to production are in balance, the optimum criterion *can* be the minimum costs of machining.

MP. Let's consider the situation when the disposable production capacity and the one necessary to meet the planned tasks are not in balance and we have an insufficient production capacity. In this case the criterion for the choice of optimum conditions of machining will be the maximum productivity.

CMT. If the existing production capacity and the capacity necessary to meet the planned tasks are not in balance and we have the surplus capacity, the criterion for the choice of the optimum conditions is minimum costs on machining tools.

The planned flow of the production process can be disturbed by break-downs. As a break-down is regarded every deviation of the conditions of production from the conditions expected in forming the plan. A break-down of a machine, control system, deficiencies in the tools equipment, etc. result in the temporary decline of the production capacity. Operational changes in the planned quantity of products` launch are evident as well. In some cases the shortcomings can be removed by decreasing the cutting speed, but this measure can influence the tools wear and tear. If the break-down results in decreasing productivity of the machine equipment (e.g. decreasing the planned quantity of products, shifting some part of operations to other machines, etc.) the balance is secured by lower cutting conditions. The outlined situations points at the needs to create a model of an adaptive control of a manufacturing cell or of a larger manufacturing configuration respectively. The model of an adaptive control enables to develop the new operational plan corresponding to the momentary conditions of production. While to form the original plan usually several days are at disposal, new plan for the changed conditions of production can practically be at disposal immediately after the break-down occurs. Working or cutting conditions, restoring the balance between production capacity and requirements to production, were called adaptive working and cutting conditions respectively.

Working conditions of stable regimes can by calculated in advance. If a break-down occurs, we can calculate the adaptive working conditions in real time. The latter eliminates losses due to the break-down and as a final result restore the balanced status of the manufacturing system.Above, the theoretical starting points of an adaptive control of a discrete production in machinery industry were outlined.

The analysis performed points at the extraordinary complexity of an adaptive control of the discrete machinery production. The time factor of the break-down duration and the time necessary (or time that is at disposal) to develop the new operational plan, corresponding to momentary conditions of production, are important. Practical solution of the problem requires the maximal acceleration of developing the second best solution.
Mathematical calculation of an adaptive cutting speed provides the program for cases of one-tool machining. The search of a more general program for further operation structures (values for multi-tool machining) is the subject of present research activity.

The mathematical model of an adaptive control of the manufacturing configuration, developed at the Department of Manufacturing Systems, Faculty of Mechanical Engineering, Bratislava, enables to immediately remove the impact of the break-down occurred and to restore the original working regime of the manufacturing configuration, to restore the balanced status.

3. CONCLUSIONS

Practical implementation of the adaptive control model of the discrete machinery production requires to have at disposal a data bank of data on technological properties of the machined and cutted materials (mainly regarding the durability) and economic parameters (costs of tools during one period of durability and costs of one minute working of the manufacturing equipment) for the production considered.

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