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The requirements and possibilities balance method used for production planning in the manufacturing assembly systems

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Abstract

The subject matter of that paper is to plan the method of concurrent multi-assortment rhythmic production realised in manufacturing assembly enterprises. The outworked method putting an emphasis on effective utilisation of system resources taking into consideration the synchronising role of its bottlenecks. The process of the making of the planning decision flows simultaneously with the procedures generating process of the distributed control of the resources work in the system. Comparing with the hitherto researches the originality of the requirements and possibilities balance method (RPBM) is the described production type enabling tasks realisation in the exclusive-like mode and also in the rendezvous-like mode, which is characteristic for assembly processes.

Keywords: Production planning; Manufacturing assembly system; Adding decision method

1. Introduction

Surrounding reality is actually characterised by very fast rate of the progressive changes. That stuff, which was modern, original and unknown yesterday, is the generally used standard today and will be obsolete and squeeze out by another, better, faster or user-friendlier solution tomorrow. The sudden development of technique, technology, automation and computer science has caused the removal of the time and spatial barriers contributing to the progressive process of globalisation.

The present-day customer being able to compare easily a purchase offer made to her/him with the competing firms propositions, is very demanding and her/his needs and preferences are subject to continual modifications what in the obvious way determines the activity of enterprises. The production strategies of the contemporary enterprises have been essentially changed by their customer oriented activity, the fast reaction to demand changes and requirements of the marketing strategies.

Recently another strong tendency in industry to produce complicate products in variant forms, differing from each other with single elements or whole sub-assemblies is observed. Manufacturing assembly enterprises produces that kind of products. In the manufacturing assembly systems (Fig. 1) manufacturing processes at manufacturing resources (i.e. machine tools) and assembly processes at assembly resources (i.e. robots, manipulators) are realised. Assembly processes can represent different percent of total production processes realised in the plant, dependent on industrial trade and the kind of the final products [1]. However, many producers deal only with assembly what can be observed in promptly developing branches of industry such as car, audio-video and computer ones. Elements for assembly are often bought by competing firms at the same suppliers, that is why rate, costs and quality of assembly decide about competitiveness of a given enterprise.

An interest of the issues of the production organisation in the manufacturing assembly systems working in changeable environment results from those premises.

2. Research problem

In relationships between customers and producers natural discrepancy of interests takes place. On the one hand a customer wants to buy cheep and fast diversified high-quality

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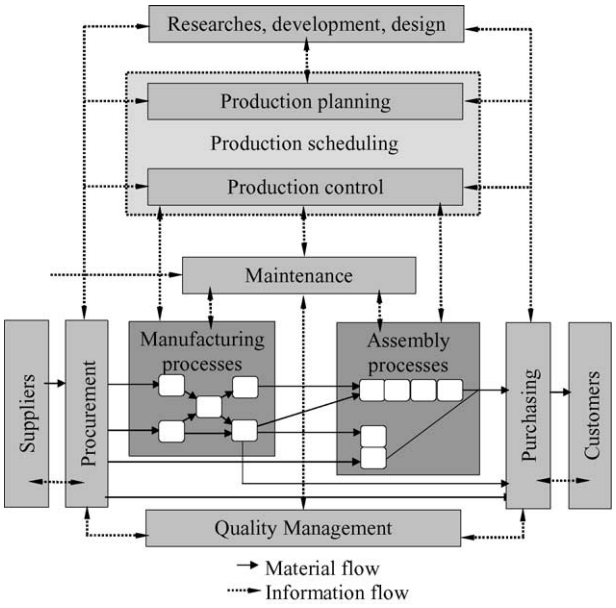

Fig. 1. Manufacturing assembly system (adopted from [2]).

products. On the other hand assurance of higher quality of goods means higher costs as well as a higher price of products for a producer. Similarly, prompter or multi-assortment production means needs of buying the modern equipment or overtime work. It, of course, also increases costs and price of products [3]. The practical solution of that conflict boils down to find a consensus which is a point in which both customer and producer are sufficient satisfied for making business together. The research problem boiling down to specify whether the producer with limited possibilities can meet customer's requirements results from those premises (Fig. 2). In particular the following question appears: Can customer requirements be fulfilled in a given production system determined by its constraints?

The considered problem belongs to the group of decision problems expecting the clear-cut answer: yes or no. That problem belongs also to the class of NP-hard and is characterised by a proved very high level of complication and combinatorial explosion of the solutions [4]. Search of the optimal and quasi-optimal solutions because of the occurred difficulties, such as time- and capital-consuming have been given up in favour of find the solution that is included in the set of permissible solutions. Finding the permissible solution is equal to solution of the satisfaction task. The requirements and possibilities balance method (RPBM) boils down to the checking of the sequence of the sufficient conditions.

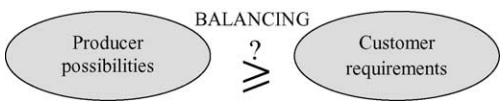

Fig. 2. Producer possibilities versus customer requirements.

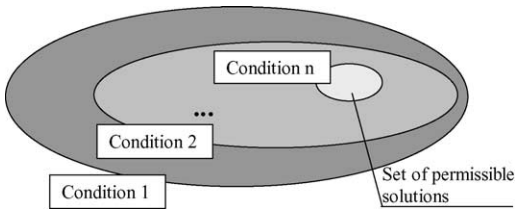

Fig. 3. Space of permissible solutions.

The two variants of the producer activity are considered:

- the acceptation for the realisation a set of production orders into the empty system,
- the acceptation for the realisation a single production order into the system in which some production orders are already realised, under condition that realisation time of the earlier accepted production orders cannot be changed.

The main aim of the producer is determination whether a given set of production order/a single production order can be realised in the system according to the quantitative requirements, such as: the number of the final products, the realisation term, the efficiency of resources utilisation. However, that activity has to be preceded by checking whether production flow in the system is possible. Thus, qualitative acceptable production flow in the system has to be guaranteed at the beginning. That production flow has to be characterised by the deadlock-free and the starvation-free system behaviour [5].

It follows that all sufficient conditions can be divided into the qualitative and quantitative ones. Each condition limits the sufficient conditions set (Fig. 3). The first solution, which meets the conjunction of all checked sufficient conditions, is deemed as the permissible solution and is a basis of the production plans and the procedures controlling the resources work in the system.

3. Production flow in the system

Because of necessity of taking into consideration on the one hand constraints connected with producer possibilities and on the other hand costumer requirements as well as demands the two-part model of multi-assortment production flow has been formulated (Fig. 4). The production flow model consists of the system model and the production order model concerning producer and customer requirements. It has been assumed that production realised in the system is concurrent, multi-assortment and rhythmic. Regarding to the rhythmic behaviour of the system, an algebraic specification of the system parameters is possible.

The considered *A* system is in steady state, meaning that the earlier accepted production orders are realised in a certain rhythm, also a starting up phase and a cease phase have been omitted. The system works for small- and medium-batch multi-assortment production needs and the set of assortments