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SINGLE PRODUCTION ORDER VERSA PROJECT MANAGEMENT

Project management is characterised by necessity of an unique problem solution. In the same situation is SME wanted acceptance a single production order for the realisation. In that paper the possibility of the due-time single production order realisation and the sequence of processes needed for that realisation are considered. In order to solve that problem three-part meta rule was formulated.

1. INTRODUCTION

Strong competition on the market, fast information flow and emphasis placed upon customer needs realisation force a producer to increase the performance efficiency and prompt replaying on an inquiry. Small- and medium-batch enterprises (SMEs) having, in most cases, universal machine tools at their disposal, and connected with it high flexibility can take advantage of Make To Order (M-T-O) production realisation [1]. They can, after preliminary cost analysis and enterprise risk assessment, decide about an unique production order, which has very small or have no chances for repetition, acceptance for the realisation. Thus the spontaneous idea of analogy between that type of production order realisation and project realisation. Project is defined as any series of activities and tasks that: have a specific objective to be completed within certain specifications, have defined start and end dates, have funding limits and consume resources [2].

The approach based on project management, that is knowledge, skills, tools and techniques utilisation for archiving the given goal [4], can be successfully used to the single production order realisation.

Literature analysis says that common known are five phases of project management, also called project processes (fig.1).

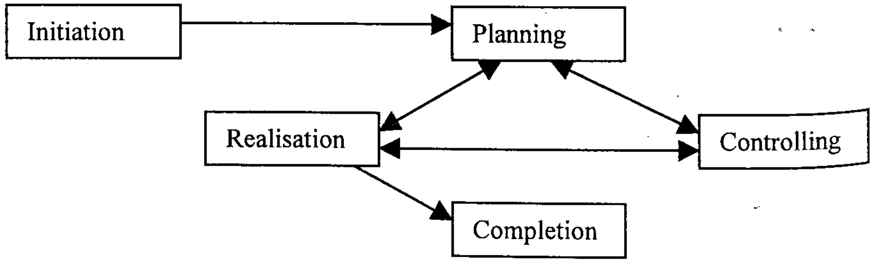

Fig 1. Relations between project processes. (according to [4])

The same processes take place in small and medium batch enterprises, which accepted untypical, single production order for the realisation.

1. Initiation- extending by the customer demand for the given type of product and placing the inquiry,
2. Planning – specifying by the producer whether the given production order can be accepted for the realisation, taking into consideration the system constraints (e.g. system and interoperation buffers capacity) and customer needs (e.g. due-time production order realisation),
3. Realisation – physical production order realisation in the production enterprise,
4. Controlling – validation of executive actions and progress estimation in terms of the time factor. (The cost factor is intentionally omitted, because it needs special, detailed analysis),
5. Completion – completion of previous phases and entire project. Moving the final goods to the shipping dock.

The next part of that paper applies to the planning phase. On one hand planning is the key stage of a project, because it is proved, that each hour used for planning gives 20 – 100 hours of profits during the next project phases. On other hand planning is also very important in terms of approach based on local dispatches rules proposed by us.

The single production order is characterised by relatively long time needed for staring-up and cease phases of production with relation to entire time necessary for that production order realisation. That characteristic is crucial for the producer and taking into consideration transitional phases in single production order planning process is elementary.

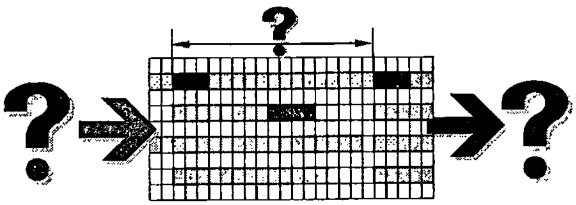

Fig. 2. Methodology of a single production order acceptance for the realisation

Proposed methodology of prompt production order realisation permits resignation from work- and time- absorptive analysis of possible variants of the new production order realisation and determination of sufficient conditions. Those sufficient conditions, when satisfied, answer the question, whether a production order can be realised in the given system. That methodology enables repetitive production flow planning (that type of production is considered, because of assembly processes) assuring compliance meeting of the desirable quantity and quality requirements. Methodology applies to steady state production flow, and also transitional phases: staring-up and cease, which are crucial to the single production order, i.e. the project (fig. 2).

2. PROBLEM FORMULATION

Given is SME, to which an inquiry arrives concerning the possibilities of the realisation of a single, unique production order including concurrent production of certain elements making a complex final good. The necessity of joining the elements during the assembly process determines small-batch production, which enables determination of repetition of certain sequence of production starting and in turn, operations on resources.

Because production order is single and its size is known the question arrives: *Is the due-time production order realisation possible and which sequence of processes realised in steady state and in starting-up and cease phases make that realisation possible?*

The essence of the proposed methodology boils down to the integration of the production flow planning and control. It means that simultaneously the management of SME makes planning decision and creates the procedure of distract production flow control, taking into consideration transitional phases, which ensures production realisation.

In order to solve that problem, meta rule, consisting of three parts, was formulated:

META RULE {[starting-up rule], [dispatching rule], [cease rule]}

The meta rule is the combination of the dispatching rule, the starting-up rule and the cease rule.

$$R_i^M = \left\{R_i^R, R_i, R_i^W\right\} \qquad (1)$$

where:

R_i^R – starting-up rule allocated to i-th resource,

R_i – local dispatching rule allocated to the i-th resource,

R_i^W – cease rule allocated to i-th resource.

The beginning of analysis is local dispatching rule determination. The procedures of control for starting-up and cease phases are defined on the bases of control procedures for the steady state.

3. LOCAL DISPATCHING RULES

In the repetitive production, period T_c is determined by a sequence of the accesses of the operations on the shared resources, according to the dispatching rule.

Local dispatching rule (LDR) $R_i(p_{i1}, p_{i2}, \ldots, p_{io_i})$ determines the number and the sequence of processes executed on the i-th resource [3], where:

R_i – dispatching rule allocated on the i-th resource,

$p_{i1}, p_{i2}, \ldots, p_{io_i}$ – process number executed on the shared resource M_i

$i \in \{1,2,\ldots,m\}$, m - number of resources,

o_i – number of operations executed on the shared resource M_i, according to the rule R_i.

Realisation of LDR guarantees at least one execution of each process, which route crosses the resource. For the guarantee cyclic behaviour of the system, the conditions of starvation-free and deadlock-free system operation must be satisfied. First, local dispatching rules must be allocated to each common resource, second, the balance condition that assures that the number of processes entering the system is equal to the number of processes leaving the system should be satisfied [5]. The conditions of qualitative system functioning determine the subset of permissible process realisations. Basing on this subset, the satisfaction problem was formulated.

A dispatching rule is executed repetitively and it guarantees steady-state behaviour of the system. The most important is that the functioning dispatching rule should cause the self-synchronisation of the system according to the expected cyclical behaviour and bring the entire production to the end without the deadlock appearances.

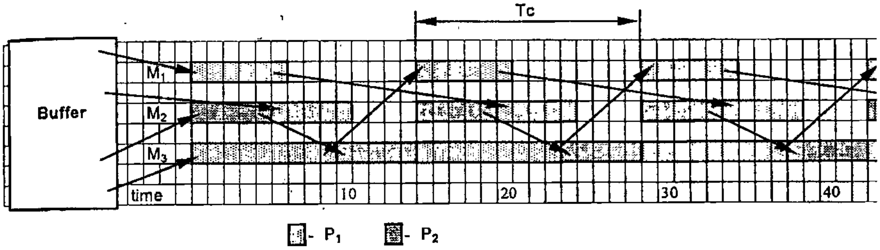

Fig.3. Concurrent processes realisation

However the arbitrary allocation of the dispatching rules to resources may cause a deadlock. In order to prevent that situation, it is necessary manually fill-up the additional number of elements into the interoperation buffer or build a method of allocation of rules, that assure interoperation buffer filling-up, before starting production in steady state. These rules are called staring-up rules. Analogously, it is necessary deleting additional number of elements, allocated during the starting-up phase from the interoperation buffers, after completion of production in steady state That process is realised by cease rules.

4. TRANSITIONAL PHASES

Realisation of a single, unique production order in SME caring out concurrent, repetitive production needs special concentration on the transitional phases. That is connected with relatively long time of starting-up and cease phases with relation to entire time needed for production order realisation. The transitional rules are determined on the bases of known rules for steady-state behaviour of the system.

4.1. Starting- up rule

Determined starting – up rules must guarantee deadlock-free behaviour of the system and synchronisation of the system according to the desirable steady state. The method is presented in the algorithm shown in the figure 4.

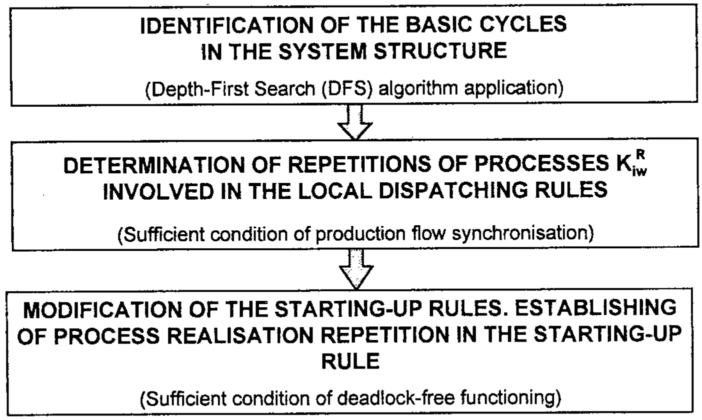

Fig.4. The method of starting-up rules determination

The presented method consists of the following stages:

Stage 1. Identification of the basic cycles in the system structure.

For the given local despatching rules, matrixes of the processes MP_j and matrixes of the system structure Ms resources between which production routes create basic cycles are determined. A basic cycle in the system of concurrent production processes is created by the set of production routes crossing limited number of resources, in such a way that starting from any resource and moving along the production routes or their parts, in accordance with the direction of their flows, it is possible to return to the resource we started from, not crossing the same route more than once.

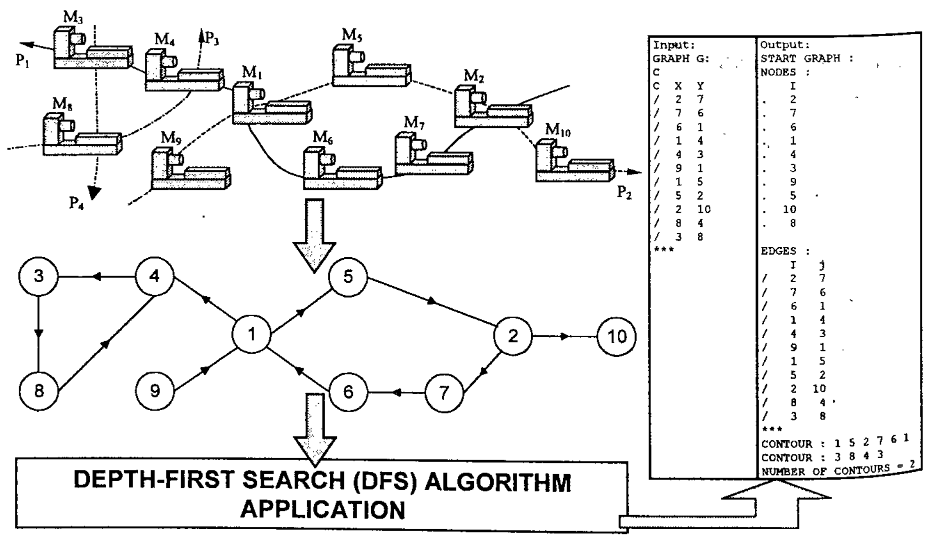

Fig.5. The cycles identification in the system structure

In the systems with a closed structure in which basic cycles take place, a cycle of mutual expectations may occur. If at the same time the rest of the necessary conditions are satisfied arises a deadlock in the system. Searching of the basic cycles is realised using Depth- First Search (DFS) algorithm (fig.5) adopted from Graph Theory. The result of that stage is list of resources belonging to the basic cycles. If the list is empty (lack of the cycles) modification of the sequence of processes in the LDR is useless.

Stage 2. Determination of repetitions of processes involved in the local despatching rules.

For the given LDR are determined repetitions of occurring of each process in starting-up rule, which guarantee preliminary filling-up of interoperation buffers. In each interoperation buffer there should be a number of intermediate products sufficient for to at lest one cycle of steady-state realisation. The determination of repetitions of processes is realised according to the algorithm presented in [3]. During that stage are defined staring-up rules, which satisfy the sufficient condition of production flow synchronisation. That condition takes into consideration additional buffer capacity used to preliminary filling–up of interoperation buffers, which enables production flow synchronisation of the system according to expected steady state.

Stage 3. Modification of the starting-up rules. Establishing of process realisation repetition in the starting – up rule (fig.6). For the resources belonging to the basic cycles in the system structure, determined in the first stage, the requirements concerning the allocation of the process to resources are ordered. That activity protects the system against the condition of mutual expectation satisfying, which guarantees that the system will function without deadlocks.

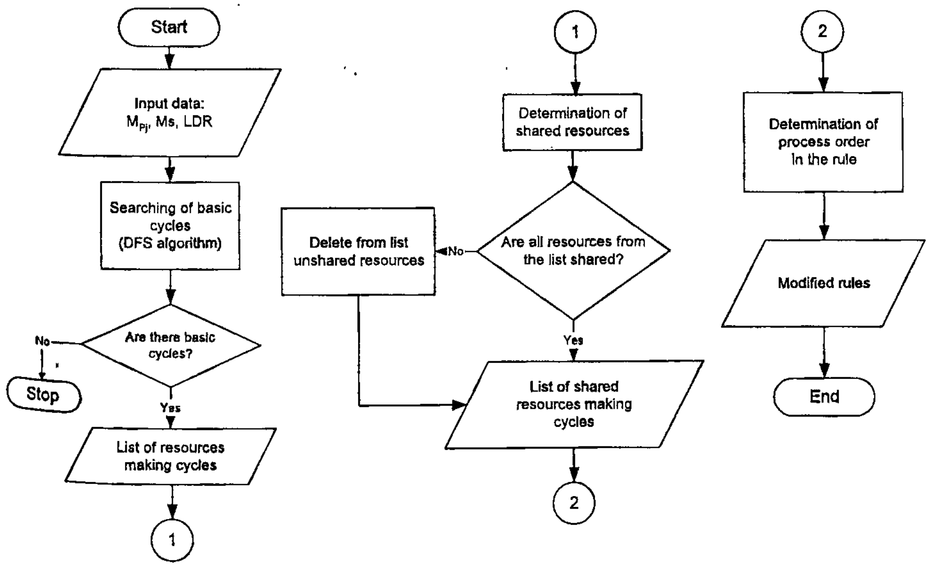

Fig.6. Establishing of process realisation repetition in the starting – up rule.

4.2. Cease rule

The starting-up rule realises preliminary filling-up of interoperation buffers, which permits the disclosing of a bottleneck in the system and the synchronisation of the system according to the expected steady-state. The proposed approach causes additional number of intermediate product allocation in the system. Because of that, after the realisation of the expected number of cycle of local despatching rules required to entire lot realisation, it is necessary to conclude the production trough deleting additional number of intermediate products from the interoperation buffers.

The method of cease rules determination is realised, like starting-up rule, in three stages (fig.7).

Stage 1. Identification of the basic cycles in the system structure.

Stage 2. Determination of repetitions of processes involved in LDR in the cease rule.

Stage 3. Modification of the cease rules. Establishing of process realisation repetition in the cease rule.

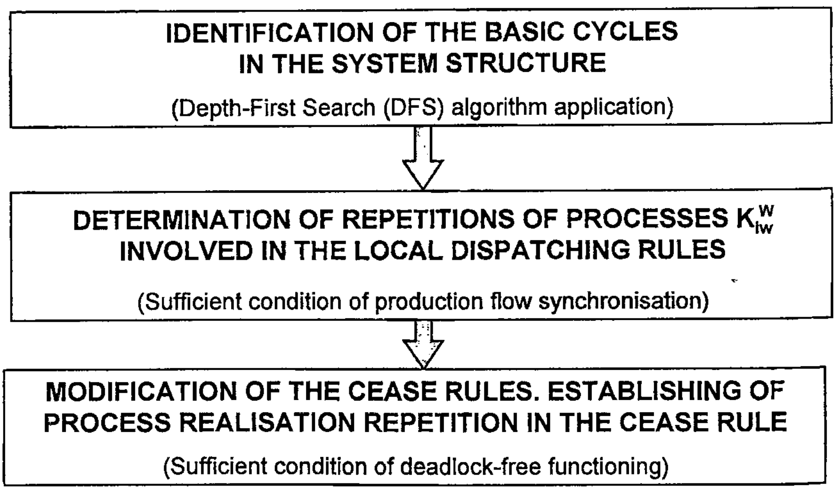

Fig.7. The method of cease rules determination

To carry out that process it is necessary to realise a number of operations allowing to delete from the interoperation buffers one element of the given process, for the resources present in the production route before the operation realised on one resource.

5. CONCLUSIONS

The basic characteristic of a project is its uniqueness. A single production order carried out by SME, which realises concurrent repetitive production is also characterised by that feature. Because of that, five project processes: initiation, planning, realisation, controlling and completion occur also during the implementation of a single production order. From among those processes, the planning stage plays an important role. The correct implementation of that process allows to economise on time and, in turn, on financial resources.

The proposed methodology boils down to the verification of sufficient conditions, the satisfaction of which enables the determination whether the given production order can be realised in the given time period. The stages of production planning and control are integrated.

The answer the question: Is the due-time production order realisation possible and which sequence of processes realised in steady state and in starting-up and cease phases make that realisation possible? is possible thanks to the implementation of the meta rule. The meta rule consist of: local dispatching rule and also the starting-up and cease rules, the later two types of rules being especially important to the realisation of a single production order. The implementation of that idea is advantageous for both, the customer and the producer. The former receives a prompt replay to his enquiry, the latter is able to minimise the risks connected with the single production order realisation.

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