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FACTORS INFLUENCING BATCH SIZE

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ABSTRACT:
Presented article is focused on batch sizing. Batch size issues at a formal level have tended to be treated as a trade-off analysis or optimization between set-up or ordering costs, storage and holding costs, and stock out costs. By focusing on the critical few batches that determine the behavior of the whole process we can often make substantial improvement to the process with no detriment to the system as a whole. Batching issues have a profound influence on the characteristics of any process and substantial gains can be made by properly understanding the dynamics involved.
KEYWORDS:
batch size, attributes, machine cycle.

1. INTRODUCTION

It is important to improve setup time so that you can successfully reduce batch size. There are several factors influencing batch size. Those have opposite-acting influence very often. Decreasing batch causes:

- increase of work productivity and rate of technological operation,
- simplification of operative production management,
- decrease of fixed costs.

On the other hand the increase of batch size causes:

- extension of average manufacturing throughput time,
- decrease of production tolerance to changes and failures.

2. BASIC ATTRIBUTES INFLUENCING MAXIMUM UTILIZATION OF PRODUCTION CAPACITY

Production process is a system of production, transfer, manipulation and storage operations, participating in production in a certain production segment. If a part of it is done predominantly by means of one machine or in one workplace, we talk about technological operations. Connections among production operations are characterized by basic attributes influencing the maximum utilization of production capacity, namely balance, parallelism, rhythm and continuity [2].

2.1 Balance

If one technological workplace is a set of production factors influencing each other, then balance is a relative continuity of different activities of workplaces with different capacity among all the factors of transformation process. Balance is not constant from the long-time-period point of view because it is connected with changes of production technologies and product proportion. Relation is: ratio of machinery equipment, which means the machine production plan to the required number of products in required time. Balance prevents bottleneck occurrence, which avoids full utilization of production possibilities [1].

2.2 Parallelism

Parallelism in production process means a parallel execution of the same or different technological operations. It is based on division of labour, but it cannot be used everywhere and in the same way. It depends on the character of production process.

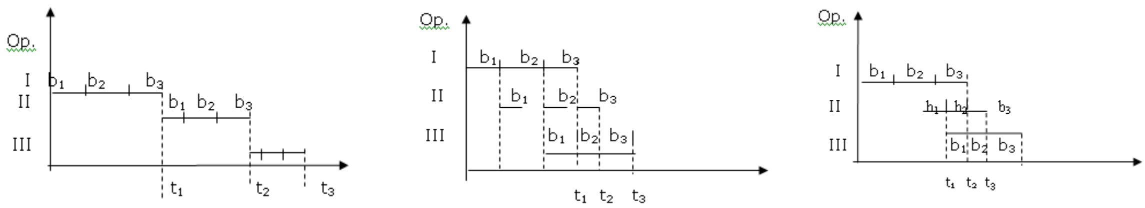

Figure 1. Basic types of production process from parallel point of view

$$T_{seq.}=n\times\sum_{k=1}^{n}t_i \quad (1); \quad T_{par.}=\sum_{k=1}^{n}t_i+(b-1)\times t_{max} \quad (2); \quad t_{com.}=n\times\sum_{k=1}^{n}t_i-(b-1)\times t_{shorter} \quad (3)$$

Legend: t_{max} - operation with the longest production time
$t_{shorter}$ – shorter time of consecutive operations
n - manipulation batches

In one workplace parallel processing of several components or parallel processing of several components by several tools shows the parallelism or, together with main activities also subsidiary operations are being executed. The length of production cycle depends on parallelism, which means that the higher the parallelism, the shorter the production cycle is [3]. The main difference between the sequential and the parallel production processes is shown in figure 2 (under simplified conditions). Machine failures are used by the parallel run of technological operations and the combined way gives the production process without idle time. If we compare times of both operation cycles, then $T_{par}<T_{com}$. We are talking about an efficient idle time.

2.3 Machine Cycle

Machine cycle shows the way in which the batches are coming to particular realization. It describes regularity and balance of operation process. Machine cycle M_c is direct proportional to the length of production period P and indirect proportional to the quantity of production Q.

$$M_c=\frac{P}{Q}\left[\frac{hr}{pcs}\right] \quad (4)$$

Degree of machine cycle is the rate of production produced in a longer period of time. The special production has a high machine cycle while the machine cycle of the universal production is low [4].

2.4 Continuity

Continuity tries to minimize idle times among technological operations from three points of view:

- treatment of objects within operation process,
- activity of operation instruments (efficiency),
- activity of labour.

Continuity ratio R_c is time of production cycle T to production operation P_o:

$$R_c=\frac{T}{P_o} \quad (5)$$

We are also interested in non-continuity ratio R_n:

$$R_n=\frac{T-P_o}{P_o}=\frac{T}{P_o}-1 \quad (6)$$

3. OPTIMAL SIZE OF PRODUCTION BATCH

There are several methods for determination of optimal batch size. Among the basic ones: capacity approach, cost approach, standard frequency of batches approach, method of static batches.

CAPACITY APPROACH figures out the minimum batch as:

$$b_s=\frac{t_{pe}}{\alpha\times t_i} \quad (7)$$

α – coefficient ensuring that t_{pe} will not exceed the so-called maximum acceptable rate. It is chosen for a certain components group with the same production conditions.

Coefficient is in the interval ⟨0.02; 0.12⟩ and for example:
- for big and complicated components – α = 0.04
- middle-size components – α = 0.05
- small components – α = 0.08
- automated production – α = 0.10

COST APPROACH - also called optimization approach as it solves compromise between fixed cost dispraise for one piece and increase of batch size. On the contrary, with increase of fixed costs, total costs and capital fixture increase.

$$b_s = \sqrt{\frac{2 \times C_{pe} \times Q_p}{C_i \times C_s \times t}} \qquad (8)$$

C_{PE} – costs of preparation and finishing,
Q_p – planed production quantity in pieces or kilograms,
C_j – costs of one item in SKK,
C_s – storage costs.
t – period of the year depends on Q (for year period t=1)

STANDARD FREQUENCY OF BATCHES APPROACH – batch is corrected for standard year frequency following the calendar rhythm of the planning of production set.

METHOD OF STATIC BATCHES divides produced items and components to value-significant and non-significant. Value non-significant products are mass-produced and their batch size is stable and constant in time. Value significant products are produced in smaller quantity and a predefined batch is corrected by allowance (which is predefined too), what approximate batch quantity to real planned need for a period. The result of the method is a basic batch as an interval from minimum to maximum batch quantity, which should not be exceeded [3].

4. BATCH SIZE FROM MODERN APPROACHES POINT OF VIEW

Material Requirements Planning (MRP I) – is concerned primarily with the scheduling of activities and the management of inventories [6]. It is particularly useful where there is a need to produce components, items or sub-assemblies which themselves are later used in the production of a final product. MRP was developed step by step and every step is hierarchical distant to previous one by taking out of lacks [8].
- 1st degree - the Master Production Schedule is based on known or forecast demand for a specified future period, e.g. the forecasting period. The schedule shows how much of each end item is wanted and when the items are wanted. It is in effect the delivery of the “due date” schedule for each product expressed in terms of both quantity and timing. The period over which this demand expressed will depend on the type of product concerned and the capacity planning procedures used by the organization.
- 2nd degree – Detailed Scheduling and Loading – is particular schedule of production tasks for individual workplaces with a time advance of one day up to one decade.
- 3rd degree – Economic Order Quantity – optimal batch depends only on total costs. Stationary frequent production with constant times and costs for rebuilt of production equipment is assumed.
- 4th degree - Sequencing – the determination of the best order for processing a known set of jobs through a given set of facilities in order, for example, to minimize total throughput time, minimize queuing, minimize facility idle time etc.
- 5th degree – MRP I – a technique by which known customer demand requirements are “exploded” to produce “gross” parts, components or activity requirements. These “gross” requirements are compared with available inventories to produce ”net” requirements, which are then scheduled within available capacity limitations. MRP is for scheduling and also for inventory management and capacity management.
- 6th degree – MRP II – Manufacturing Resource Planning – represents an extension of the features of the MRP system to support many other manufacturing functions. The most

important functions of MRP II are: Master Production Scheduling (MPS), Rough Cut Capacity Planning (RCCP), Capacity Requirement Planning (CRP), Production Activity Control (PAC).

- 7th degree – Optimized Production Technology (OPT) – is the focus on "bottleneck" operations.

OPT rules are [5]:

- balance flow, not capacity,
- the level of utilization of a non-bottleneck is not determined by its own potential but by some other constraint in the system,
- activation and utilization of a resource are non-synonymous,
- an hour lost at a bottleneck in an hour lost for the total system,
- as hour saved at a non-bottleneck is a mirage,
- bottleneck govern both throughput and inventories,
- the transfer batch may not, and often should not, be equal to the process batch,
- the process batch should be variable, not fixed,
- schedules should be established by looking at all of the constraints simultaneously. Lead times are the result of a schedule and cannot be predetermined.

5. CONCLUSION

Production process is a system of production, transfer, manipulation and storage operations, participating in production in a certain production segment. If a part of it is done predominantly by means of one machine or in one workplace, we talk about technological operations. The optimal batch size is the quantity of products set to production and taken from production at the same time, with minimum cost and maximum usage of machines capacity. This needs cooperative approach to technological workplaces and perfect knowledge of them. Article deals with all attributes of batch sizing and talking about effectiveness of production process.

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