SYSTEM OF FLEXIBLE COMPANY PLANNING

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Abstract

The success in production sphere lies in the art of the "right product" production, in right quantities, in right time, in good quality and for the price which is acceptable for the customer. The ability of the company to react flexible to the requirements of the market is one of its competitive advantages. If such a company has the capacities already planned it is often necessary to change the plans and partially re-organize the production because of a new order or the necessity to finish one product before another. First it is necessary to take into account the capacity of the company in the dependence of machine number, the number of workers and the number of working shifts in production process. On the other side it is necessary to make decisions based on costs. It is expectable that the company will react flexible to the requirements of customers and adapt the production. At the same time the company has to change its production plan not only according to these requirements but also according to economical difficulty minimization. One of the main tasks of the flexible planning is the detection of wrong decisions in the process of production plan creation. The production plan process has to be variable enough, however the variability must not negatively influence the product quality, reliability, supply rate and accuracy or final price. The flexible planning offers a company the freedom in best production process selection according to highest profit.

Keywords: System, planning, flexibility, optimization, production

1. INTRODUCTION

In current market conditions production, the manufacturing enterprises have to adapt to frequently changing requirements of customers causing problems in the area of production planning. Internal information systems (IS) are often unable to predict flexibly the accurate need and capacity of personnel, technology, resources, areas and other factors in the case of operational and technical conditions. The companies are forced to respond rapidly to the changes under pressure from strong competition. There is in particular, the so-called product flexibility. It is not expected that the product portfolio is changed completely but its diversification is made. These requirements are best fulfilled by flexible production systems where high input costs are balanced by the possibility to simply and quickly change the production according to market requirements.

When evaluating the production effectivity an important factor except profit is also the return of investment. While profit increases with higher investments, the return of investments increases only until certain value of investments. From certain point, the return of investment decreases. When taking into account the flexibility, enterprises with flexible production lines appeared to be most suitable. Nowadays it is required that production systems are not only flexible but also agile. That means they have also the ability to predict changing requirements except product flexibility.

In production enterprise, it is necessary to dispose with planning tool which takes into account these changes and offers outputs showing future behavior of production system. Various analysis and studies are often made in the background of planning system with results entering into recalculating algorithm. The task of the user is to enter input parameters (e.g. production plan, production dose etc.) and the results are the required outputs.

Often demands on planning tool (one of the IS modules in company) are made to completely fulfill only custom-made solution, but this is often hardly to be paid by customer. It is not an easy task when creating such planning tools because the solution has to be flexible enough to implement current customer requirements.

2. SOLUTION ACCORDING TO PRODUCTION TYPE

The requirement for maximal flexibility of IS is especially typical for production enterprises because their production processes belong to the most complicated. The problem should be treated according to various production types, to the repetitiveness of production (custom, piece, serial and mass production), because the IS often has to cover many of these production types in one company at the same type. This all depends on product success on the market or on product type and characteristics. E.g. in an production enterprise with wide final product portfolio assembled from e.g. from 80 % of same semi-products, the final products can be produced on demand and the production of common semi-products can be a serial production. Thus the processes in individual production division can be different in the same company.

Planning tools used in IS should thus be able to plan or control different production types in the framework of one implementation and they should be able to distinguish differences in processes which are characteristic for them. If we take a look on customer requirement fulfillment according to the time needed for product and its structure supply (**Fig. 1**), we can determine which processes have to be included into supply time for individual production type and which processes are key ones for that production type or their solution requires specific requirements that are not required by other production types.

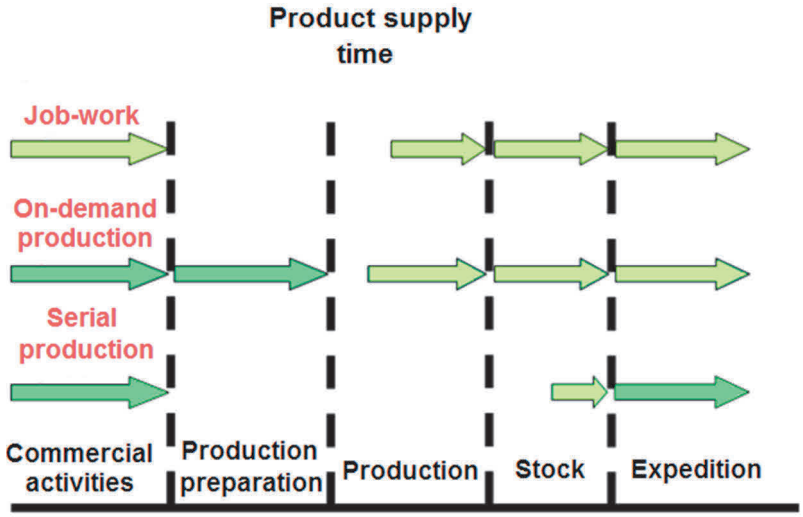

Fig. 1 Differences in product supply time structure for various production types

Individual phases of the main production process should be supported by adequate workflow which ensures partial task assigning in the production process to individual responsible staff with the possibility to check the time plan fulfillment.

The workflow is appropriate to use e.g. in on-demand production where commercial and pre-production phases are tightly connected and they can have significant influence on supply time shortening or on the success of the producer in tenders he attends. The planning tool of IS can directly influence the supply time and increase the number of proposals that the company is able to process. As seen on figure above, darker colors denote supply time phases that require solution in other types of production which are not used so widely.

An important part of the flexible planning system is the deployment of open and closed production system combination in which it is possible to interfere even during ongoing production plans. A recommended standard for closed production system is a minimum of one day, i.e. 24 hours. Production system planning with recommended standard of solution works according to equation 1 + x + y, where the variables denote three different level of planning views:

- plan in the production process with one day period (recommended planning standard),

- production plan for individual production shifts x,
- sales plan y.

The basic shortage of the order planning for production is the absence of rules, according to which the incoming orders should be judged. This leads to errors in operational decisions and planning. Order judgment should be driven by strict rules:

- economical assessment of order,
- technical-technological assessment of order,
- material balance of order,
- capacity balance of order.

There are preparations which influence the whole effective and flexible planning process prior to planning. The registered orders have to be evaluated technologically and technically. If the required product has already been produced, the technological production procedure is already created. The technological procedure of production determines the sequence of production operations, operation times of product operations, the amount and type of material used, aggregate and device parameter settings, qualitative and quantitative data for particular product. The information if the product can be produced is assessed by the technical-technological assessment of the order or product. The effectiveness of the particular product production is assessed by the economical assessment of the order. For effective economical judgment it is necessary to have cost calculations prepared for particular products. The calculations should include production cost division on fixed and variable costs.

Capacity assessment of order ensures and determines the time and volume fulfillment of sale contracts, co-ordinates the production process according to optimal exploitation of production, transport and stock capacities. During order classification and including into plan periods (month, week), we have to classify the ordered product in advance into production segments which precede the last final segment in production process, so that the supply time is fulfilled.

By order replacement between planning periods, the capacity requirements can be adjusted, so that:

- the supply time is fulfilled,
- the capacity in planning periods is not exceeded,
- the link between particular production segments is kept,
- production cycle is kept.

2.1. Planning possibilities

In practice the prices paid by customers are the subject to contracts between partners and thus price for one customer is usually different from the one paid by another customer to the same producer. Many factors form this price, among others the most important are e.g. the amount of ordered products. If these parameters are fixed and known in advance, it is possible estimate the behavior of partners.

In some production areas it is necessary to choose appropriate production type. E.g. the so called production from stock in mostly not rentable because all the over production is unsalable. Therefore it is necessary to choose such production system that the greatest part of customers is satisfied with no loss created in over-production. For such systems it is appropriate to divide contracts on fixed and flexible orders with both side advantages for producer and customer. Fixed orders create about 60 % of overall production capacity of the producer. The remaining 40 % is left for flexible requirements of customers. These flexible contracts are made in very short time periods, sometimes during few hour time spans.

For better understanding we can give an example. Let us assume a production system of XY company, which consists of four individual production devices. The production capacity is stated in **Table 1** for every device and the production price of one piece of product on that particular device. The overall production capacity of the company equals to the sum of all production capacities of individual devices. Four customers have

contracts with the producer on fixed orders and daily contracts are made beyond fixed orders. Amounts in pieces are denoted in **Table 2** for fixed and flexible orders as well as the price that customers will pay for the products.

Table 1 Overview of production capacities and production costs of particular devices

Production device	Production capacity [pcs/hour]	Unit price [€]
1	100	3
2	120	2
3	80	2
4	100	2

Table 2 Overview of fixed orders, flexible orders and unit prices of products

Customer	Fixed orders [pcs]	Unit price [€]	Flexible orders		
			1st. day	2nd. day	3rd. day
1	800	3	400	300	400
2	400	3,5	400	300	400
3	400	4	300	300	400
4	600	3	200	300	400

As the summary daily requirement of customers exceeds the capacity possibilities of the producer, he can use various alternatives to satisfy the customers:

- the producer accepts the orders in the sequence as they arrived and after the production capacity is full, no other orders are accepted,
- the producer accepts the orders according to their values, and rejects orders with lower values that exceed his production capacity,
- the producer accepts all orders but he reduces them (he does not want to lose any customer form long time point of view),
- it is also possible to consider a combination of alternatives.

These solutions and results are depicted on **Fig. 2**. Progressively results of mentioned alternatives are shown where the last alternative is the combination of the second and third alternative (the order with highest value is accepted and all the other orders are reduced in order to fit into production capacity of the enterprise).

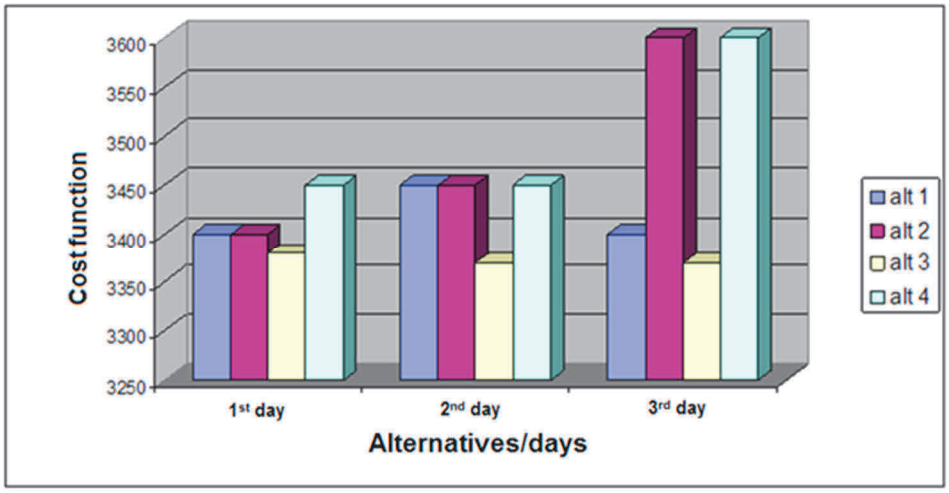

Fig. 2 Final alternative analysis of order reception during three days

Another example with flexible planning is the planning in the enterprise with aluminum alloy production. In the proposed company a preliminary production planning precedes the production plan creation with 1 day period. Preliminary planning ensures preliminary production distribution in time according to production capacities and required delivery times. Production plan depicted on **Fig. 3** denotes an open production system with the possibility of changes and pre-planning in consideration of unexpected new orders in the system or customer requirement changes. Thus the planning flexibility increases. The order which is necessary to plan is shifted to required segment on the time axis. The planner decides if the selected date is in accordance with required delivery time and production capacity. The selected order occupies the time span according to required amount to produce and to standard melting time with full furnace capacity. In the case of fixed planning of production an order is selected from preliminary planned production and it is planned for production according to the required amount, i.e. the production is divided into meltages. A recipe is selected and it is adjusted if needed. Necessary material types are added gradually with accurate amount during recipe creation for melting. After recipe completion, the input materials are divided for particular furnaces.

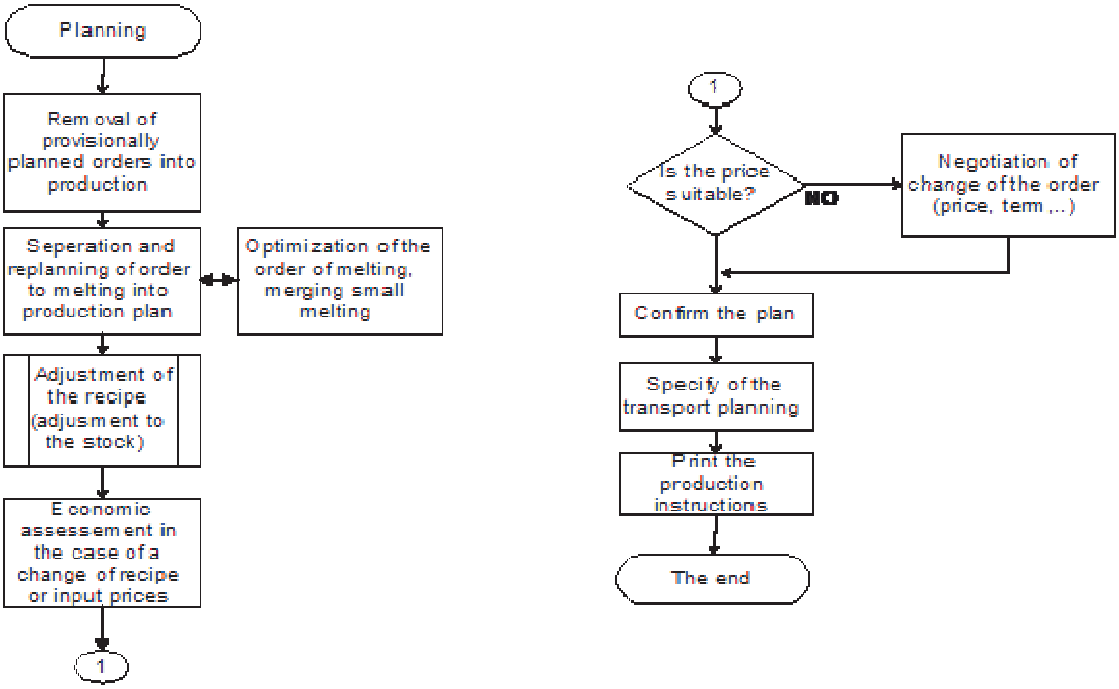

Fig. 3 Planning process algorithm of aluminum alloy production

If the company wants to be flexible in production planning, it has to know how to ensure:

- high productivity at small product doses,
- the flexibility of produced components or assembled units according to customer requirements,
- varied production portfolio with instant innovations,
- reduction of stock size and materials on stock,
- time and power exploitation of devices,
- product quality increasing,
- quick solutions of problems that arise,
- short and accurate delivery times.

3. CONCLUSION

Nowadays, if a production enterprise wants to make the „optimal“ production plan, an appropriate software support is required. The reason is the time difficulty and dynamic changes resulting from production character or the input material supply system. A production plan stated in advance with optimization elements can appear

as the most wanted parameter during production from productivity increasing point of view, i.e. the lowest production costs. It is necessary to gain appropriate overview over production task distribution on the devices (in time) and the impact of such new decisions on overall production effectiveness. The result of effective planning of production is not only the determination of input material, raw material and energy need but also the determination of production capacity of personnel sources. It is necessary to ensure the customer order process planning for production segments and consequently the order flow has to be coordinated so that the order is satisfied in optimal relations. Due to changing conditions and the need to adapt to market demands, flexibility deserves a high attention.

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