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# On the Complex Problems of Operational Planning of Production at the Enterprise Level

*There are various acceptations as regards the concept on the efficient planning of production, in keeping with the subproblems contained in the respective concept.*

## 1. A WORKING DEFINITION OF THE OPERATIONAL PLANNING OF PRODUCTION

One of the most topical problems raised by the scientific organization and management of production at an enterprise level is that of the operational planning of production. This problem is tackled in various circumstances and at various levels by diverse specialists — from mathematicians, operations researchers and specialists in data proccessing to technologists, economists, engineers with various functions in enterprises, foremen and even team chiefs. The most characteristic aspect of this problem, however, is, in our opinion, the numerous characteristics simultaneonsly attributed to it, very often causing real confusion. Of course, under these conditions it is very difficult to formulate a rigorous definition of the problem, but, it is possible to outline a work definition which should comprise and eventually synthetize the various meanings which are given to it by theoreticians and practicians. Thus, in the following, we shall review in brief the most usual meanings in which the term of "operational planning of production" is used, to be able to try afterwards their systematization in a definition.

One of the most frequently used meanings when reference is made to the problem of the operational planning of production is the following: being given the production capacities of an enterprise (section) for a certain period, the quantities of finished articles demanded by various beneficiaries, the fabrication technologies concerning these products as well as the necessary data

about the possibilities of supply with raw and related materials, the optimum plan for the respective period should be determined, namely the best quantities of products from each assortment. Thus enunciated, the problem may be modelled as a problem of mathematical programming, the objective-function being possibly the maximization of the use of the production capacities, the maximization of the profit, the minimization of the cost price, etc., or possibly, the taking into consideration simultaneously of these optimizing criteria.

This way of presenting the problem has a pre-eminently static aspect, as it is considered that all the production capacities are free, at any moment, to be used for contributing to the manufacturing of a product which, in reality, occurs only with certain types of a productive product; in practice, there occur frequent superpositions, at the same moment, of several products which must be processed by the same production capacity, the staggering out in time of certain operations being necessary (the dynamic aspect). Thus "the optimum plan" which results from the "statical" model can practically never be achieved. Nevertheless, the method remains useful for giving general data on what may happen in the respective enterprise (section) in the considered period, especially, if the production capacities are corrected by multiplication by a subunitary correction coefficient which takes into consideration the superposition in time of the products on the same production capacity and, consequently, the necessity of shifting the processes.

A problem which is often associated by practicians with the operational planning of production, sometimes going so far as to identify it with the latter and which has also a static aspect, is that of establishing the necessary raw and related materials for a production plan known for a certain period of time. The reason why this problem, which naturally seems closer to the problem of supply than to that of the efficient planning of production, is associated with the latter, must be sought in the numerous difficulties in supply faced by those in charge of the production process; this causes them to grant greater attention to the supply problems which they consider as a key problem of production.

The establishment of the fabrication technology for a certain product, that is of the succession of operations, is, undoubtedly, a technological problem in the first place. This problem has still serious implications on the efficient planning of production by conditioning both the optimum plan in its static form and especially the spacing out of production in time. Besides these aspects, the problem of the establishment of the fabrication technology of various products has great affinities with the problem of the planning of production, when several ways of ordering operations are possible and the establishment of the optimum succession (technology) is pursued according to an optimity criterion. For this last problem, it is sometimes possible to use the algorithms for minimizing the Hamiltonian path of the theory of graphs and some adequate computer programmes.

A technological problem related to the above one is the classification of installations and their grouping on technological lines, consisting in the formation of classes of equipment called "technological lines", so that the number of "passes" of the objectives which are being processed from one class to another should be minimum.

This problem is pertaining rather to the activity for designing the location of installations in production workshops, but, as the parameters of the productive process are often changed or new instalations are purchased, the problem is often put as a preliminary operation of operational planning.

Another direction in which the notion of operational planning of production is used quite frequently is referring to a rather wide category of problems concerning the allocation of resources and operations on places of work or of the workers on places of work.

Some problems of particular allocation are those of assignment and loading for the solving of which instruments of mathematical programming and of the theory of graphs are used; however, they do not exhaust the great variety of the distribution problems.

A well known problem associated with a large or medium series production proceses is the dimensioning of the best lots for the manufacturing of products.

This side of the efficient programming of production, often tackled as a problem in itself, can be separated, in reality, only artificially, from the problem of scheduling, that is, establishing the timetable for the processing of components.

The problem of scheduling is, maybe, the most complex of all the aspects of the operational programming of production. A problem, pre-eminently dynamic and practically linked to all the other aspects of operational planning, it includes or implies a number of important subproblems, such as the staggering of the necessary resources (raw and related materials, funds, manpower, specialists, foremen, etc.) and its reverse, the staggering of the processing operations within the limit of the reserve of these resources known beforehand, aspects concerning the minimization of interoperation stocking costs, etc. are also present.

The technological aspects of the operational planning of production are very closely linked with the problems of standardizing the execution periods of the various operations or of the specific consumptions of raw and related materials as well as of calculating the production capacities. The first of them are, in essence, problems, of the study of labour and they can be approached with modern means and in close connection with the ergonomic aspects which take into account the inter-action between worker and the working conditions.

Although usually considered as distinct problems both as regards object and method, because of their importance in the effective implementation of the production planning, we can unhesitatingly classify among these problems the psycho-sociological difficulties of the production process. No matter how improved the methods for modelling the planning of production and no matter how rigorous their implementation, the efficiency of the results which are obtained depends, to an ever greater extent, on the mass of human aspects which we term, in brief, psycho-sociological ones, rather than people who are planning and managing production are willing to admit usually. That is why, we consider it necessary to include them among those which have to be taken into account when reviewing the problem of the planning of production and its entire scope.

An aspect of main importance for the profound understanding of the problem of production planning is the inter-connection between it and the

other key problems of production at an enterprise level. It is noticed even from the above brief review that some aspects of the problem of the planning of production are placed on border with other problems, such as those of supply, or technological problems, sometimes real superpositions occuring (for instance, in the case of the determination of the necessary raw and related materials). If we examine the relations existing between the planning of production and the other important problems of the enterprise, we shall notice other similar superpositions and, in any case, relations with problems will appear, such as those concerning the relations with the suppliers and the home and foreign market, transport, wages problems, repairs, quality control, investments, administrative-management problems. The problem of production planning cannot be separated from its content and, consequently, its inter-connection with the other key problems should be taken into consideration in its definition and especially in its analysis.

Let us now try to formulate the work definition we referred to at the beginning of the article.

The operational planning of production represents a series of considerations concerning the theoretical and especially practical solution of the problems pertaining to the establishment, implementotion control and updating of the optimum production plan for very short periods, at an enterprise, section and team level, taking into consideration the technological aspects, the aspects concerning the necessary and available resources, and the ergonomic and psycho-sociological ones.

The approach to the complex of problems inherent the planning of production is affected by the number of available specialists and by the time limits for the carrying out the entire action. Most often, the limits imposed on these two main resources of the analysis team obliges to selecting only some of the multiple aspects of the problem and to their differentiated study.

## 2. CLASSIFYING THE TYPES OF PROBLEMS OF OPERATIONAL PLANNING

The taking into consideration of the above-mentioned aspects as being specific to the complex problem of production planning engenders a multitude of possible types of particular problems which have to be systematized and classified. In the following, we shall outline a methodology for the operations of systematizing and classifying the types of production planning problems.

The basic idea of the methodology is to define elementary types of problems, from the stand point of each of the aspects enumerated in section 1 and then to combine the elementary types into complex types (the respective aspects represent criteria for establishing the elementary types).

To facilitate the presentation, we introduce the following remarks:

— The criterion of elaborating the optimum plan (for short periods) **P**;

— The criterion of establishing the necessary raw and related materials: **N**;

— Technological criteria: **T**;

— The criterion of allocation: **A**;

— The criterion concerning the calculation of lots: **L**;
— The criterion of scheduling: **S**;
— Ergonomic criteria (including standardization too): **E**;
— Psycho-sociological criteria: **Ps**;

As has already been shown, the elementary types will be established from the standpoint of each of these criteria. A proposition diagram in this direction could be the following:

— *According to criterion* **P**:

• Type $P_1$: the production plan is established beforehand, thus no problems of optimizing its structure appear practically; such situations are characteristic of the units tackling the problem of the operational planning of production after the state plan is approved of by the competent bodies and the plan provisions are detailed at an assortment level, leaving no possibility of decision on this problem, at a unit level.

• Type $P_2$: possibilities occur for optimizing the structure of the plan, either because the problem is tackled in the period of elaboration of the plan proposals or due to the situation in which although the plan is already approved of, it allows certain local decisions concerning the describing of the assortments in detail.

— *According to criterion* **N**:

• Type $N_1$: production processes with less than 200 necessary raw and related materials.

• Type $N_2$: production processes with 200—2000 necessary raw and related materials.

• Type $N_3$: production processes with over 2000 necesary raw and related materials.

— *According to criterion* **T**:

• Type $T_1$: complex production processes in continuous flow (in the chemical, iron and steel industries, etc.).

• Type $T_2$: complex production processes with a repetitive character and organization on technological lines.

• Type $T_3$: complex production processes with a repetitive character to which the group technology may be applied.

• Type $T_4$: complex production processes with a predominant character of unique products (examples: building-assemblage), research-development over-haulrepair activities).

• Type $T_5$: production processes with a technology of reduced complexity.

— *According to criterion* **A**:

• Type $A_1$: production processes in which no distribution problems occur.

• Type $A_2$: production processes in which distribution problems occur.

— *According to criterion* **L**:

• Type $L_1$: production processes in which the problem of the calculation of lots does not occur (generally, small serial processes).

• Type $L_2$: production processes in which the problem of the calculation of lots occurs (medium and large serial processes).

— *According to criterion* **S**:

• Type $S_1$: production processes in which the (rigid) technological succession and the character of the process do not raise problems of scheduling.

• Type $S_2$: production processes at which no problems occur in scheduling as regards the ensurance of the necessary resources as a result of which the programming in time of activities is made by observing the logical and technological restrictions, with estimations of medium length (the most characteristic example for this type are the processes of a unique product type modelled with network-time diagrams, thus, without taking into consideration limitations concerning resources).
• Type $S_3$: production processes in which scheduling is affected by limitations concerning some resources (examples: a) processes of a unique product type modelled with network-digrams and by taking into consideration the available resources; b) big serial repetitive processes, such as those in the processing sections in the machine-building industry).

— *According to criterion* **E**:

• Type $E_1$: processes with ergonometric problems and problems of reduced complexity standardization.
• Type $E_2$: processes with ergonometric problems and problems of medium complexity standardization.
• Type $E_3$: processes with ergonometric problems of considerable complexity.

— *According to criterion* **Ps**:

• Type $Ps_1$: processes with simple psycho-sociological problems.
• Type Ps: processes with complex psycho-sociological problems.

On the basis of the above elementary types, one can define $2 \times 3 \times 4 \times 2 \times 2 \times 3 \times 3 \times 2 = 1728$ types of problems of operational planning of production which may characterize a big diversity of cases which can be met with in practice. Thus, many problems of operational planning at the level of the processing sections in the machine industry will be of the complex type $P_2N_3T_2R_2L_2S_3E_2Ps_1$; problems of the type $P_2N_3T_4R_2L_1S_2E_2Ps_2$ will often occur in the investment and building activity; in the processes with a continuous character in the iron and steel industry and chemistry we shall find problems of the type $P_1N_1T_1R_2S_1E_2Ps_1$, etc.

We mention that the types proposed above have an orientative character aiming at illustrating the methodological idea of classifying the types of problems concerning the operational planning of production. A definitively and rigorously scientific typology would, indisputably, require a deeper analysis.

## 3. STAGES IN THE EFFICIENT SOLVING OF PROBLEMS CONCERNING THE OPERATIONAL PLANNING OF PRODUCTION

The problem of the operational planning of production is most often tackled fragmentarily both by theoreticians and practicians. As a rule, theoreticians adopt this way of approach as a result of the difficulty of modelling the problem in its entire complexity and, consequently, they divide it into "subproblems" of the type of those presented in the first part of the study. Practicians are constrained to a fragmentary approach, on the one hand, for lack of the complex models and, on the other hand, out of the necessity to cope with the solicitations to which they are subjected by practice.

In our opinion, a general solution to the problem of the operational planning of production implies the following stages:

a. The establishment of the definitive types of elementary problems (of the kind of those orientatively indicated in section 2, of course, as a result of a detailed analysis, based on many concrete cases).

b. The determination of the models corresponding to the type problems, either by adapting some well known models from the literature of speciality or by approaching new models.

c. The solution of the computational aspects of the problem by working out a system of computer programs for finding aggregate models and testing them on real cases the utilization of existing program decks by integrating them into the system is not excluded.

d. The informatic solvind of the problem by working out a system of computer programmes for found aggregate models and their testing on real cases; the utilization of existent programme decks by integrating them into the system is not excluded.

e. The informational-decisional solution of concrete problems for the efficient planning of production.

This last point which is equivalent to the implementation of the system of models and programmes implies the previous informational-decisional analysis of each separate case, for adapting the system to the single product-reality of each enterprise.

Indisputably, a typological systematization, eventually a typification of the informational-decisional aspects occuring in the enterprise would mean a considerable facilitation of work for implementing the system of models and programmes concerning the problem of the operational planning of production by eliminating or shortening the stage of analysis which, asitis well known, is very laborious. This, however, is a problem which although is closely linked to that of the operational planning of production, is at least equally complex and difficult.

## REFERENCES

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## A PROPOS DES PROBLEMES COMPLEXES CONCERNANT LA PROGRAMMATION EFFICACE DE LA PRODUCTION

Dans la première partie de l'ouvrage on présente une définition de travail de la programmation efficace de la production.

La deuxième partie contient la proposition d'une classification des divers types de problèmes intéressant la programmation de la production. Finalement, il est établi, en esquisse, un plan d'étude en perspective portant sur le complexe des problèmes relevant de la programmation efficace de la production.

# О КОМПЛЕКСНЫХ ВОПРОСАХ ОПЕРАТИВНОГО ПРОГРАММИРОВАНИЯ ПРОИЗВОДСТВА

В первой части настоящей статьи приводится рабочее определение оперативного программирования производства. Во второй части статьи предлагается классификация типов задач программирования производства.

В заключение намечается программа работ по перспективному изучению комплекса вопросов, которые вместе взятые представляют собой оперативное программирование производства.