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Planning of Production in Socialist Industry

Part III

Planning of Productive Capacity

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القاهرة

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3.2.1 Concepts of capacity[1)]

Generally speaking, planning of productive capacity comprises the determination of capacity and its utilization as well. It aims at revealing idle resources and at using them as effectively as possible.

For the time being, there are some differences, however, as to the space of time serving as basis of reference. While planning of available capacity is carried out mainly in connection with drafting long-term plans, utilization of capacity is calculated yearly. That is, it depends upon the fact whether the necessary quality of required data for exactly balancing productive capacity can be ensured. Otherwise, every calculation is going to be waste of time and money.

Hence, the more exactly we are able to estimate forthcoming demand all the better the conditions for prospective balances of productive capacities with the view to taking care of all the prerequisites for the future production. No matter, there are unpredictable factors effecting capacity and its utilization likewise. In spite of these factors or we may say because of them prospective planning of productive capacity must be given prominence. This so, because under conditions of both an increasing division of labour and mechanization and automation of production, the use of fixed assets determines decisively effectiveness of every factory and national economy as a whole.

In former times, it was usually determined by engineers and technicians. It was a principle inherited from the fact that capacity was considered to be a technological category influenced by, for example:

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1) This chapter is partly based on:
Dr. M. Engert: Investment Planning, part II, Memo No. 295 of the INP, Cairo, chapter 2.1

- technological parameter of the machines, expressed by turning speed, etc.,
- the number of horse-power of a diesel engine etc.

We were shown by practical experiences, however, that such a determination is a rather one-sided one. In many cases, the capacity calculated only with respect to technological date could easily be surpassed without any changes as to these technological data. This goes particularly for socialist competitions between single workers and working teams. From this it appears very obviously that capacity can't be a pure technological category only. It must rather be defineхd technologically and economically as well.

The definition used in the past underrated the creative faculties of workers in production process. It cannot be applied, therefore, under socialist conditions of production. In socialism, the worker, in close collaboration with engineers, technicians and economists, of course, becomes more and more the supervisor of production process. By considering this, in socialist economy the concept of productive capacity related to an enterprise is defined as follows:

The (productive) capacity is expressed by the maximum output of products or performances within a certain period with full utilization of all available means of production in accordance with the most rational way of production from the view of the national economy; it implies the application of progressive methods of work, techniques as well as of the most suitable forms of organization of the enterprise.

It can be seen that in planning, in the German Democratic Republic especially, capacity is interpreted as a maximum coefficient which can only be reached under most favourable conditions. That is why this capacity concept is used, above all, in prospective planning. Once we have calculated the capacity of a certain enterprise, it serves as a guideline for operative planning activities.

The mentioned concept of capacity, however, doesn't represent an utopic objective. It rather proceeds from the fact that capacity has to be calculated by taking into account those factors already known or applied somewhere in other parts of national economy, i.e., for example, in the most progressive enterprise of the same kind.

When calculating capacity, therefore, we have to consider such facts as:

1 - all available machines and equipment,

2 - maximum utilization of machines by considering the most appropriate system of work which differs from branch to branch according to the technological and economic conditions,

3 - the best results of work achieved already by workers of similar qualification and being employed under comparable conditions of production,

4 - the most effective technologies and forms of organization of the respective production process,

5 - that nomenclature of production which is supposed to meet the demand,

This approach reveals that every capacity has to be calculated, firstly, with thorough consideration of relevant economic and technological accomplishments inside and outside the enterprise given and, secondly, by using physical terms. Furthermore, capacity has to be regarded as the final goal which is to be reached by subsequent measures derived from the experiences of the most progressive enterprises.

After having outlined the general background, it renders necessary to explain the procedure for calculating productive capacity in more detail.

3.2.2 The procedure for calculating productive capacity

From what has been said it appears that capacity of every productive unit represents and aggregate figure reflecting influence of different factors. The same factors are determining decisively possible utilization of productive departments, factories, etc.. For making good use of them with the view to increasing effectiveness of every productive unit in national economy, it is necessary to analyse the single factors in more detail. The main points to be discussed are:

- the yardstick for expressing capacity,
- the registration of available machines and equipment,
- the determination of working time funds of machines and equipment,
- the optimum performances of workers,
- the influence of technology and organization of production,
- the role of the most important productive department,

There are some other factors, too, affecting capacity as seasonal supply with raw material, general changings of production program caused by new technological inventions, etc. representing more or less special cases or exceptions. Therefore, they are to be neglected.

The yardstick for expressing capacity

In general, productive capacity must be expressed in physcial terms, i.e. by means of certain products or performances. Only in doing so we are able exactly to balance capacity and demand. It can not be done by expressing capacity in a certain amount of working hours of workers and machines. In former times such a yardstick was partly used too. It was not successful, however, because of the fact that it could not be estimated whether a certain fund of working hours was suitable for manufacturing a certain kind or group of products.

Moreover, by using working hours as the basis of reference a possibly more extensive utilization for any production could be expressed. An exact definition of productive capacity also depends, however, upon the working time needed to produce a certain product, i.e., it depends also upon the intensive utilization of capacity. Thus, productivity capacity expressed in physical terms meets these requirement best by showing not only the effects of a higher extensive but also intensive utilization of productive forces available.

How can these basic ideas be materialized in practice?

In case of mass production there are no difficulties to determine that product serving as the yardstick for expressing capacity. If, however, there are a lot of different products to be produced in a certain factory, we will be forced either to express capacity according to the main products of the main productive departments or by means of so-called standard - types (conventional types). This standard type is expected to represent the main features of produced similar or related products, and it can be represented by a product really to be manufactured or an imaginary one. As far as there are too many differences between the single products , that means, regarding the kind of manufacturing and working time needed, coefficients should be used. The latter concerning, the following method is applied:

Type	number of products	$t_{prod.}$ in% of A	coefficient	capacity on basis of prod. A
A (standard-type)	1000	100	1,0	1000
B	500	110	1,1	550
C	1000	80	0,8	100
				2350

In the case in point, we have taken for granted that the structure of working hours, i.e., its composition is the same in general. The differences between them may be caused by different sizes of the products to be produced. Then, we are able to state that capacity of the productive unit in question is expressed by 2350 products of type A. If needed, the potentials are given to produce, for example:

of product B (910 + 500 + 727) = 2137 pieces and
of product C (1250 + 687.5 + 1000) = 2937.5 pieces

The method is rather simplified but it is showing the way of how to solve the problems generally. Similar methods have to be elaborated for other conditions of production, by considering the fact, however, that the expenditure for calculating productive capacity must be from the economic point of view in line with the efficiency of such a determination on basis of products . If not, the fund of working hours available must, at least temporarily, serve as basis of reference. We are able to do so as the developing and progressing specialization of enterprises and departments renders more easily to determine single products as a yardstick for calculating capacity. This shows, on the other hand, that we are forced by the very facts to choose that product or assortment of products as basis of reference representing not only the demand at present but also within the forth-coming period of planning.

If the production is expected to be changed, in principle, we are forced to calculate twice, i.e., on basis of the standard type at present and in the future.

The registration of available machines and equipment

When registering machines and equipment available, all of them are to be included regardless whether they are used in production at present. Stand-by machines or equipment that means those machines which cannot be used as single ones but only in connection with another plant, for example, a copying equipment for lathes or a part of a automatic line of machines, are to be neglected. The amount of stand-by capacity must be technologicall based. Excess of stand-by capacity of complete machines which can be used separately are consequently to be included in calculating capacity.

The classification system of machines and equipment represents the basis for registering the means of production available. This classificati however, has to be seen in connection with the requirements arising out of the production program. In other words, available machines etc. are to be registered according to main kinds of processing which must be carried through and which can be implemented by a certain type of machine.

To give an example:

To manufacture products requires a special group of turning processings. These processings can be implemented by a definite type of lathes. For balancing available capacity and requirement of capacity, the used classification of processings to be carried through and the classification of machines appropriate to implement them must be comparable.

The same holds true for the classification system of the worker. It must be set up in connection with the machines, equipment, etc. to be run so as to make sure that workers are employed in line with the demand brought about by the production program.

Additionally, the machines, etc. are to be registered according to their location, that means, by considering their distribution among the different productive departments. This so, because the balance of capacity is drafted by starting with comparing requirements and possibilities to meet them on basis of these departments which usually are specialized on certain products or processings.

Moreover, the means of production have to be analysed qualitatively because of the fact that a definite kind of processings may possibly be carried out by different machines. It depends, however, on their technical parameter and other conditions whether this processing can be implemented corresponding to the quality demanded for. Thus, the machines, equipment, etc. are merely registered by taking into account 3 or 4 groups representing the qualitative conditions. The conditions are marked as follows:

- top quality,
- good quality,
- average quality; i.e., excluding high quality of processings,
- unsufficient quality,

Finally, when registering the means of production all the machines newly to be invested in the forth-coming year or years (it depends upon the purpose of calculating capacity) or those to be broken up must be considered and included in planning as well.

The determination of working time funds of machines and equipment

When speaking about fund of working time we have in mind that number of working hours the available means of production can possibly be used in a certain planning period. This determination has to be seen in connection with socio-economic objectives of the country in question and technological conditions.

At first, the machines, etc. are used to the utmost in cases of urgent needs caused, for instance, by disproportions in national economy or by a stage of emergency, although this may lead to some negative results.

On the other hand, the working time of machines is determined by the technological process itself. It goes without saying that, for example, blast furnaces , certain equipments of chemical production, etc. must be operated continuously. Thus, the basis for calculating capacity is given by 24 hours production daily. A three shift - system is used, too, if there are certain disproportion between some technologically successive stages for producing a certain product to make sure that the following stages of production can be carried through, at least, by using capacity on an average. This goes, simultaneously, for so-called bottle-necks within enterprises which can be caused either by certain machines and equipment or by entire productive departments. In general, however,

- a three shift system for technological processes to be carried through continuously (24 hours daily),
- a two shift system for technological processes to be carried through discontinuously (15 hours daily)

are supposed to be the starting point for calculating capacity and its utilization.

Additionally, those enterprises marked by a discontinuous production process but being of extraordinary national economic importance - on account of different reasons as, e.g., to increase export - should be operating 21 hours daily and, at least, 302 working days per year.

Proceeding from these considerations the possible fund of working time has to be fixed in detail.

That means concerning the plants continuously to be operated, the fund of working time is formed by multiplying the number of days per year by a daily working time of 24 hours. This fund must be reduced by that time needed, if necessary, to implement planned capital or other rapairs which will bring about a standstill of the equipment under discussion. These interruptions, in turn, must be calculated by considering the most effective methods of repair possibly to be applied for that purpose. For avoiding unplanned interruptions and other brake-downs of machines, a system of preventing measures of repairs is to carry into effect so as to reduce the number of unavoidable interruptions and to shorten the repairing time to the utmost.

With regard to the enterprises marked by a discontinuous production process, the calculation of the working time fund looks as follows:

	number of days per year
-	free and holidays
=	working days per year

multiplied by the number of shifts per day and multiplied by the number of working hours per shift.

— Technologically-based stand-stills (in so far as they cannot be shifted outside of the normal daily working hours) caused by repairs, cleaning etc.

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fund of working time of machines expressed in working hours.

What has been mentioned concerning a planned system of preventive repairs for continuous production processes holds true for this kind of production, too. Furthermore, efforts should be undertaken so as to avoid all the interruptions during the normal daily workhours. You will find, therefore, that a main part of preventive repairs are carried out in the night-shift.

On the other hand, necessary repairs are to be planned in line with requirements of production program. As all the machines are not used to capacity during the whole year, those terms for repairing have to be fixed ensuring a continuous production process. In other words, that date and time of repair must be determined-in consistency with the physical wear and tear of machines, of course,-that will cause a minimum of economic losses.

Hence it follows that such calculations have to be carried out for the different kinds of machines operating within different departments. This so, because the qualitative conditions of every machine may be different ones, on the one hand, and their degree of utilization, too, on the other.

To implement these calculations demands for certain expenditures. They can be kept low by using well-prepared auxiliary means as

- plans of repairs based on the time the single and perishable components of machines (or groups of them) are used up and must be replaced (repairing interval).
- standards of working time for these continuously repeating repairs.

By means of these instruments, date and necessary time for repairs can easily be calculated by hand or, as far as accounting machines are available, by machines.

<u>The optimum performances of workers:</u>

As stressed earlier, productive capacity should be expressed in physical terms. The calculated working time fund of machines, however, shows only the amount of possibly available working hours being the basis for determining productive capacity. Capacity itself is determined by considering the number of products or units of industrial performances which can be produced in a certain unit of the working time fund. This quantity, in turn, depends decisively on the performances of the workers in question, i.e., their qualifications, experiences, attitude towards and intensity of work.

This isn't to say that quality of equipments and technical parameter of machines don't influence productive capacity at all. On the contrary. They represent practically the basis for all the further calculations, As experiences show, however, the actual degree of utilization or in other words, the number of products possibly to be produced depends merely on the attitude of operatżors. (Excluded are in these considerations completely automized machines). This can be proved very obviously by comparing the working results of similar machines within one enterprise or the single enterprises within one branch. By the way, thorough analyses of autstanding working results along with an exchange of experiences among workers represents an important factor for increasing labour productivity under socialist relations of production.

Since, as we have taken for granted, productive capacity is considered to play a stimulating role, progressive results of working people in operating machines have to serve as basis of reference for its calculation. In doing so, enterprises fallen behind the others are economicly forced to investigate experiences of progressive workers and to apply them to their own production.

Progressive results of working people are marked by such factors as, for instance :

- high qualification of workers according to the job to be carried out,
- normal intensity of labour,
- repeatedly reached best performances,
- most favourable working conditions practically applicable, however, everywhere, etc.

Thus, investigation of outstanding working results according to set quality standards is considered to lead to a whole program of new technical and organizational measures suitable to close the gap between productive capacity and reached level of its utilization. According to the mentioned problem, the program has to include measures as to the:

- qualification of workers;
- improvements of working conditions and technology,
- ideological education, that means, development of a new attitude toward work.

The latter is of extraordinary significance for developing countries starting with industrializing national economy and marked, therefore, by a real shortage of highly qualified workers. Ideological education must closely be connected with practical training of manpower, so as to develop such a attitude towards work in public enterprises appropriate to fulfil their economic objectives. This idea has been stressed by S. Mohieddin, premier of United Arab Republic , when urging the workers to do their duty towards their factories the way they do it towards their own family.[1)]

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1) S. Mohieddin: The Role of Worker, in: The Egyptian Gazette, November, 3, 1965, page 4.

From this it appears, furthermore, that these analyses of outstanding working results should be carried out by engineers, economists and workers as well supported by representatives of trade unions.[1] They have to put pressure on reponsible managers and other outhorities so as to prepare and implement all the necessary measures enabling workers of the productive department or factory in question to reach these progressive results, too.

It should be noted that there are some differences when automizing production processes. In this case, technical parameter are coming into the foreground. Nevertheless, influence of productive workers on the amount of productive capacity is not eliminated. It can be expressed by such factors as

- using of more productive tools and mechanism,
- shortening the time needed to prepare machines for manufacturing a new component, etc.

affecting productive capacity likewise.

Influence of technology and organization of production process:

It goes without saying that progressive performances of working people are mainly determined by their ability to apply modern technologies to their work. These new technologies can only become fully effective, however, if their implementation is closely connected with a highly rationalized organization of production process as a whole. That's to say, when calculating productive capacity we have to proceed from those technologies and forms of organization being the most progressive ones, on the one hand, applicable in practice without additional state investments, in general, on the other. Only in doing so, enterprises are orientated in which direction their already used technique is to be developed. That's also true concerning organization of production process. This, in turn, includes such problems as

1) c.f. ibidem

- organization of a rationalized and continuous flow of materials,
- organization of a highly effective system of materials handling,
- drafting of such a system of short-term production planning suitable to avoid delays in loading machines, etc.

That means, all those preconditions have to be considered making sure the most effective utilization of funds of working time of workers and machines available. As, moreover, these mentioned factors are influencing outcome of production very decisively, the most progressive methods applicable under existing or forthcoming conditions and to be realized without state investments have to be used as basis of reference for calculating productive capacity.

It has been mentioned, that necessary improvements are expected to be implemented without additional state investments. This doesn't mean to exclude all alternatives in calculating capacity implementation of them demands for financial means at all. Every improvement needs , more or less, financial and other material means so as to be materialized. Since, however, most of these improvements will lead to savings sufficient enough to cover necessary outlays, they should be financed out of the funds of enterprises or credits granted by the state bank respectively. Hence, we have to proceed from such a modern level of technology and organization of production process to be realized by the enterprises themselves, no matter, whether they are already existing at present.

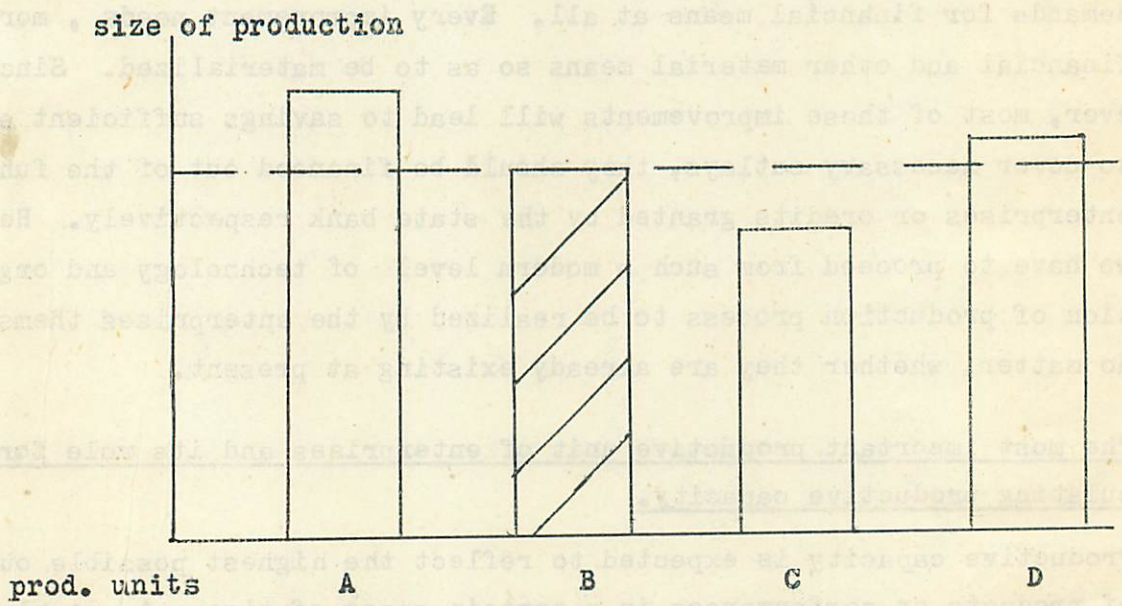
<u>The most important productive unit of enterprises and its role for calculating productive capacity.</u>

Productive capacity is expected to reflect the highest possible output of products or performances in a certain space of time. As nearly all the enterprises are composed of various productive units with different capacities that productive unit has to be chosen as basis of reference being the most significant one for producing the main products of the enterprise in question. This productive unit is characterized by such factors as, for example:

- it must be needed for implementing main production process
- its role so as to give the product its typical peculiarities, e.g., mechanical departments in engineering enterprises,
- the concentration of most important machines and equipments for main production process,
- its share in the fund of fixed capital of the enterprise.

Hence it follows that in this case we distinguish ourselves generally from those criteria formulated by bourgeois economists. They are using the bottleneck of enterprises as basis of reference for calculating productive capacity.

Why does this not apply to factories under socialist relations of production?



B = most important productive unit

C = bottleneck

First of all, bottlenecks don't reflect an objectively existing necessity since enterprises, under socialist relations of production, are layed out by considering a high degree of specialization upon one or a limited number of similar or related products. Furthermore, there are no reasons at all hampering to overcome such disproportions which may possibly arise out of necessary alternations as to the production program. In drafting capacity of productive units for new enterprises on the basis of an all-round investigation of demand and the basis trends of science and technology, bottlenecks can mostly be avoided from the very beginning.

Moreover, when using that productive unit marked by the highest dapacity as basis of reference some problems may arise. Firstly, it has to be analysed why there are such differences over against other productive units. In many cases you will find that changings in the production program took place demanding for a new structure of capacity within the enterprise. Secondly, on the other hand, it renders possible that capacity of this productive unit was expected to be used not only for the main production process but also for auxiliary production like repairings, etc.

What-ever the reasons may be, as far as this productive unit doesn't represent the most significant stage of main production process it cannot serve as a starting point for calculating productive capacity. This so, because

- it must be investigated, at first, whether such a general increase of capacity is in line with national economic needs, if so,
- it is not quite clear, whether this increase of capacity can be reached more effectively by new investments than by expanding an already existing factory, for example,
- under unchanged conditions of production such a calculated capacity will not at all stimulate the efforts of working people to reach this aim since it is practically impossible.

After all, when calculating productive capacity on the basis of the bottleneck this would not reveal the actual possibilities of the enterprises to increase production. There would be a disguised capacity to be made fully effective by small investments only. Also in such a case, calculated capacity would not play any mobilizing role. Thus, as a matter of fact, productive capacity has to be and is calculated proceeding from that of the most important productive unit. In doing so,

- bottlenecks will be revealed overcoming them is expected to lead to a higher degree of utilizing productive capacities of factories,
- proportions and disproportions in enterprises and branches will be disclosed. Their investigation forms a very important precondition for entire investment policy.
- working people can materially be interested in reaching extraordinarily high working results in these bottlenecks and in developing innovation suggestions aiming at overcoming them as well.

Sometimes it can happen that the most important productive unit represents, at the same time, the bottleneck of the enterprise in question. In such a case that productive unit is considered to determine productive capacity being of similar or rather similar significance. This, so as to be able to uncover reserves within the other departments.

Hence it follows, to determine the most important productive unit of enterprises demands for a very thorough analysis. Moreover, for getting comparable results in a certain branch, for instance, the calculations must be led by superior state authorities, for example, the organizations of industrial enterprises. That's to say, these organisations are expected to inform enterprises which are the most important stages of respective production process as to the branch and from the national economic point of view. In this way, the actual national economic bottlenecks are revealed. To overcome these bottlenecks forms a main objective of investment planning.

3.2.3. Methodical running off for calculating productive capacity.

Needless to say that according to the very different conditions of production process within the various branches of industry, there is no absolutely uniform methodical running off for calculating productive capacity. But, although some pecularities may occur, practical application of every calculation has to proceed from the above-mentioned basic principles. Observance of them must be ensured by a high level of qualification of those charged with implementing these tasks, on the one hand, and by respective instructions of superior authorities, on the other. These instructions include, for instance, that calculations should be carried out by considering the following steps:

1. Calculation of partial capacities, i.e., of the capacity of the various productive units within a factory. This comprises, in turn:
   a- calculation of working time funds of machines and equipment,
   b- determination of progressive performances of workers,
   c- determination of partial capacity of the respective department expressed by its main product
2. transformation of these calculations based on the different main partial products of the single stages of production process in order to use the mains product of the enterprise as basis of reference,
3. calculation of productive capacity by considering the most important productive unit.
4. characterizing the internal disproportions and formulating of those measures suitable to eliminate or, at least, to weaken them.

From this it appears that the calculation of productive capacity itself- and the difficulties connected with it-depends mainly on such factors as

- specialization of production program and
- alterations in production program.

Regarding the latter, sometimes it renders necessary to use a so-called "indifferent product" as basis of reference. This product needs not to be an actually produced one but it must be marked by the main features of those products manufactured in the enterprise at present.

To give an example:

If there are different kinds of webs produced in a weaving factory such a web can be used as basis of reference which is characterized by the average breadth, the average number of wefts per centimentre, etc.[1)]

For illustrating now the methodial running off of calculating productive capacity we would like to give a practical example, too.[2)]

Productive capacity is to be calculated for a factory producing a special kind of cement. The factory itself is composed of the following productive units.

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1) c.f. page 6

2) c.f. Oekonomik der sozialistischen Industrie (economy of socialist industry) textbook, Berlin 1961, page 404.

productive units	most important machines	final product	working time
quarry	excavator	unrefined limestone	two shifts
preparation of raw materials	mills	milled limestone	three shifts
kiln dpartment	converting furnaces	clinker	three shifts
milling of cement	cement mills	milled cement	three shifts

Now we have to continue in calculating working time fund of the single productive units:

1) Concerning the quarry

Working time fund of excavator amounts to 365 days per year minus that time needed for capital repairs and other technically conditioned standstills of the machines, i.e., approximately 15 days per year. Thus, working time fund comprises 350 days multiplied by 16 hours (daily working time) equals 5600 hours per year.

Progressive performances of working people in operating such an excavator have been estimated to reach a level of 37.5 metric tons per hour.

Therefore, partial capacity of the quarry amounts to 5600 x 37.5 = 2100 000 tons unrefined limestone

2) Concerning the preparation of raw materials

There are two mills for preparing raw material. Working time fund is calculated as follows:

365 days per year
− 41 days for repairing and other standstills

324 days x 24 x 2 = 15 552 hours

Progressive performances of working people = 11.574 tons per hour, that means,

15 552 x 11.574 = 180 000 tons milled limestone

represents the partial capacity of this productive unit.

3) Kiln department for burning limestone and other raw materials

There are two converting furnaces (or rotary furnaces). Working time fund is reckoned:

365 days per year

\- 65 days for repairing and other standstills

300 days x 24 x 2 = 14 400 hours

Progressive performances of working people operating these equipment = 9.38 tons per hour, that means,

14 400 x 9.38 = 135 000 tons clinker

4) Concerning cement mill

There are two cement mills used for milling clinker. Their working time fund amounts to

365 days per year

\- 25 days for repairing and other technically conditioned standstills

340 days x 24 x 2 = 16 320 hours.

Progressive performances of working people related to the quality of cement needed = 10.11 tons per hour. Thus, partial capacity is

16 320 x 10.11 = 165 000 tons cement.

Now, the partial capacities of the single productive units must be related to the final production, in this case,
to the production of cement marked by a certain quality. This has to be done by considering the necessary quantities of the different raw materials needed to produce, e.g., 100 tons of cement

out of 100 tons unre-fined limestone can be produced		necessary input of raw material for 100 tons of cement	
milled limestone	93 tons	unre-fined limestone	140 tons
clinker	64 tons	milled limestone	130 tons
cement	71 tons	clinker	90 tons

Thus, partial capacities of the single productive units related to the final product amount to:

1) quarry

$$\frac{2\,100\,000 \text{ tons unre-fined limestone} \times 100}{140} = \underline{\underline{150\,000 \text{ tons of cement}}}$$

2) preparation of raw materials

$$\frac{180\,000 \text{ tons milled limestone} \times 100}{130} = \underline{138\,500 \text{ tons of cement}}$$

3) kiln department for burning limestone

$$\frac{135\,000 \text{ tons clinker} \times 100}{90} = \underline{\underline{150\,000 \text{ tons of cement}}}$$

4) cement mill

$$\frac{165\,000 \text{ tons cement} \times 100}{100} = \underline{\underline{165\,000 \text{ tons of cement}}}$$

After having finished calculation of capacity of productive units, productive capacity of the enterprise has to be determined on the basis of that capacity of the most important productive unit. As the kiln department is considered to carry through the most important stage of production process its capacity serves as basis of reference. In the case in point its capacity amounts to 150 000 tons related to the final product. Thus, productive capacity of the enterprise in question amounts to 150 000 tons of cement.

Proceeding from the calculated productive capacity on the basis of that of the most important productive unit, we have to estimate now the existing proportions or disproportions respectively. In our case, there is a bottleneck concerning the preparation of necessary raw materials. This bottleneck is mainly due to the standstills of the mills for exchanging easily perishable components. Thus, efforts have to be made so as to increase time of useful life of these components, on the one hand, and to shorten the time for necessary repairs, on the other. Only in doing so, the other productive units can be run to capacity.

Furthermore, if there are some objective limits, cement mills have partly to be used for preparing raw materials.

3.2.4. Utilization of productive capacity

Like calculation of productive capacity, calculation and planning of its possible utilization is also affected by the socio-economic conditions given. This so, because utilization of capacity depends upon an exact and comprehensive investigation of demand for over a long period. This demand, however, cannot be foreseen by the single capitalist factories because of the strong and economic competition on the home and foreign markets. For being able to react on suddenly arising demand, high standby capacities are widespread in capitalist factories. Thus, you will find that idle capacities-except for armament production - are typical for capitalist relations of production.

Furthermore, as mentioned earlier, productive capacity is mainly calculated in capitalist enterprises on the basis of technical paramenters. Its utilization, however, is merely determined by economic considerations. Prominence is given to such criteria as cost and profits. Although some bourgeois economists are using the lowest cost per unit as basis of reference that cannot be, in practice, the last criterion since, finally, the amount of profit plays the decisive role in capitalists' activity. This is also expressed by W. Calveram when saying that:

> The really optimum zone of employement is lying round the point of the highest total profit.[1)]

In a planned national economy, conditions are given to utilize productive capacity, by an large, to full extent. This so, because

- new investments and enlargements of already existing enterprises are based on long-run investigations of trends of science and technique and demand: for the different sectors of national economy,
- national economic plans are based on these investigations of demand by considering productive capacities available,
- finally, the increase of living standard is regarded to be the last criterion for any production and not the volume of profit. That's to say, necessary returns of socialist industry have no end in themselves but they are serving nothing else but implementing this mentioned national economic objective.

From this is appears that utilization of existing capacities has to play a decisive role in socialist economy as their highest possible employment enables us to increase economic growth without being in need of additional investments. This goes for developing countries, especially, because of the shortage of financial means for new investments. President Nasser is quite right when saying:[2)]

1) Translated form German:
Die eigentlich optimale Beschaeftigungszone liegt aber..um den Punkt des hoechsten Gesamtbetrages,
Calveram, W. Industriebetriebslehre, in: Die Handelshochule, Wiesbaden, page 77.

2) c.f. Nasser discusses essential functions of ASU, in: The Egyptian Gazette, 21-5-1965, page 6.

If there is a factory operated one shift only and we build another factory (that means, for the same production, th.a.) this comes under the term of "extragance". Every factory must be operated in round the clock shifts, i.e. a full 24 hours.

Although the European socialist countries have succeeded in operating factories in two or three shifts - this depends on the technical and technological conditions of production and manpower available - there are still a lot of deficiencies limiting the already existing possibilities to increase living standard.

These obstacles are mainly due to a not yet sufficient quality of planning and managing national economy, in general, and branches and enterprises, in particular. That means, machines and equipments in factories are not used to capacity because of such deficiencies in the organization of production process as, for instance:

- insufficient preparation of the production of new goods,
- insufficient supervision and control of current production,
- still existing disproportions within and between productive units because of general changing in the production program, on the one hand, and of the age of the enterprise, on the other.

These obstacles of using productive capacity have to be disclosed very thoroughly and diminished or even put aside in the shortest time possible. This, in turn is going to be reached by means of technical and organizational measures being a main instrument for incresing economic efficiency of enterprises.[1)]

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1) c.f. Planning of Technical Progress, forthcoming Memorandum of the Institute of National Planning, Cairo.

After all, what are the main categories needed to express different degrees of utilizing productive capacity and how are they characterized?

The first category or concept to be considered is called:

Actual capacity, or better, actual utilization of capacity. It shows the already reached level of utilizing capacity. It is used, above all, for analysing the effects of measures which were taken so as to narrow the gap between productive capacity itself and its utilization for production. We have to calculate, therefore,

$$\frac{\text{actual capacity} \times 100}{\text{productive capacity}} = \text{rate of utilization}$$

When comparing this rate of successive years the coefficient must be, in general, an increasing one.

For example : 1962 : $\frac{84 \times 100}{120} = 70\%$

1963 : $\frac{96 \times 100}{120}$ 80%

1963 : $\frac{102 \times 100}{120}$ 85% etc.

For drafting the annual plans another concept is applied:

Possible utilization of capacity (or possible capacity).[1] This concept expresses the total output which can possibly be attained in the forthcoming plan-year. This implies, in turn, all possibilities the enterprise in question will dispose of at that time. Hence, we have to take into consideration the differences as against those factors used for calculating productive capacity itself. That means, for calculating possible capacity we cannot proceed from the best results but from:

1) Although this concepts ins't an exact one it is very often used in practice.

1) those results of work to be reached by most of the workers with average skillness;
2) such a utilization of the working time fund of machines and equipment which can really be reached next year;
3) that level of utilizing available techniques by means of those technologies applicable under the conditions of the following year;
4) the effects of existing bottlenecks in machinery on output (as far as these effect can-not be removed by other measures).

The factors concerning "all available machines" and the "nomenclature of production" used for determining productive capacity are valid, too, regarding the calculation of possible capacity.

The results of calculating possible capacity should be compared with the amount of productive capacity and actual capacity as well for analysing how we succeeded in utilizing the potentials given.

If there are any factors negatively affecting the utilization of possible capacity which are not under control of the enterprise in question another concept, the concept of

planned utilization of capacity (planned capacity) is used.

Generally, it equals possible capacity with except of such factors as, for example,

- difficulties arising out of peakhours in supply with electric power.
- changings in the nomenclature of production which must be produced but doesn't correspond to the productive funds available,
- shortage of transport capacities which may cause-sometimes-irregular raw material supply, etc.

These factors have to be estimated as thoroughly as possible so as to avoid their hampering influences or to keep them at a very low level.

For analytical purposes, now we are able to compare:

$$\frac{\text{possible capacity} \times 100}{\text{productive capacity}} = \text{rate of utilization}$$

$$\frac{\text{planned capacity} \times 100}{\text{possible capacity}} = \text{rate of utilization}$$

By means of these formulas it can be revealed whether we were able to close the gap between the calculated productive capacity and its utilization on the one hand, and the gap between possible and planned utilization of productive capacity, on the other. The latter is the most important figure in planning. This so, because planning of utilization of capacity is by no means some activity far from economic and technological reality. It should be compulsory, therefore, for all nationally-owned or public enterprises to calculate the utilization of planned capacity and to submit respective figures to superior authorities within the framework of plan-proposals.

3.3 Planning of production by means of mathematical methods and by considering different conditions given.

After dealing with all the qualitative problems to be taken into consideration when planning of production and productive capacity is under discussion, we would like to show now what kind of quantitative determination is possible on the basis of the above-mentioned ideas. And that must be stressed once again, mathematical methods can only successfully be applied when the necessary precondition are qualitatively defined very thoroughly. Without having accomplished these stages of prepration mathematical methods are useless, that's to say, they don't represent actually existing proportions, conditions, etc. Thus, they cannot be used by top-management for scientifically-based decision-making.

1. Example:

There are two products to be produced in a forthcoming period. Their production requires three kinds of material which are available in limited quantities only. The gross production of the factory shall be as high as possible. Hence, we have to plan such a composition of two products promissing a high gross production by considering:

a) the limited supply with material,

b) the different prices of the two products.

Conditions:

1. price of product x_1 = 6
   price of product x_2 = 9

2. material number 1 is needed
   3 units for one product x_1
   2 units for one product x_2

   material number 3 is needed
   5 units for one product x_1
   6 units for one product x_2

   material number 3 is needed
   1 units for one product x_1
   3 units for one product x_2

3. material available
   number 1 = 33 units
   number 2 = 66 units
   number 3 = 24 units

4. gross production is expected to be a maximum.

5. $x_1 \geqq 0; \; x_2 \geqq 0$

Solution:[1)]

At first, we have to develop a simplex-tableau which looks like the following

$$T_1 = \begin{array}{cccccc} x_1 & x_2 & y_1 & y_2 & y_3 & b \end{array}$$

$$T_1 = \begin{pmatrix} 3 & 2 & 1 & 0 & 0 & 33 \\ 5 & 6 & 0 & 1 & 0 & 66 \\ 1 & 3 & 0 & 0 & 1 & \underline{24} \\ -6 & -9 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Now, we have to start with calculating by forming the **Standard-Matrix S** completed by inserting the necessary materials for one unit of product. Since we are intending to reach a maximum of gross production, we have to start with product x_2 marked by a higher price.

$$S = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$R_1 = \begin{array}{c} \begin{array}{cccc} y_1 & y_2 & x_2 & z \end{array} \\ \begin{pmatrix} 1 & 0 & 2 & 0 \\ 0 & 1 & 6 & 0 \\ 0 & 0 & 3 & 0 \\ 0 & 0 & -9 & 1 \end{pmatrix} \end{array}$$

1) As to the following explanations we have taken for granted that the features of linear programming are known. If not, Memo No. 600: Lecture Note on Matrices, should be studied.

After forming R_1 this matrix must be inverted so as to be able to multiply it by our first matrix. This inversion is to be carried out according to the method developed by the mathematician Fatscher. In doing so, we are able to shorten the procedure as no formation of the single algebraic components renders necessary.

Regarding this method, we have to proceed from that element serving as starting point in our calculation. This was the third line of T_1 as there was the smallest number of products x_2 that could be produced out of the available materials. Now, this figure 3 serves as starting point again. According to the method of Fatscher, the respective matrix R_1 has to be inverted by

1. forming the reciprocal value of this element, in our case of 3 that means $\frac{1}{3}$;
2. dividing all the other elements of this column by this elements and changing the signs.

Thus, the inverted matrix R_1 looks like the following:

$$R_1^{-1} = \begin{pmatrix} 1 & 0 & \frac{2}{3} & 0 \\ 0 & 1 & -2 & 0 \\ 0 & 0 & \frac{1}{3} & 0 \\ 0 & 0 & 3 & 1 \end{pmatrix}$$

That's to say, up till now we have exchanged the dependent and independent variables as follows.

dependent	independent
y_1 y_2 y_3	x_1 x_2
y_1 y_2 x_2	x_1 y_3

Moreover, R_1^{-1} has to be multiplied by T_1, that means:

$$\begin{pmatrix} 1 & 0 & -\frac{2}{3} & 0 \\ 0 & 1 & -2 & 0 \\ 0 & 0 & \frac{1}{3} & 0 \\ 0 & 0 & 3 & 1 \end{pmatrix} \times \begin{pmatrix} 3 & 2 & 1 & 0 & 0 & 33 \\ 5 & 6 & 0 & 1 & 0 & 66 \\ 1 & 3 & 0 & 0 & 1 & 24 \\ -6 & -9 & 0 & 0 & 0 & 0 \end{pmatrix} =$$

$$= \begin{pmatrix} \frac{7}{3} & 0 & 1 & 0 & -\frac{2}{3} & 17 \\ 3 & 0 & 0 & 1 & -2 & 18 \\ \frac{1}{3} & 1 & 0 & 0 & \frac{1}{3} & 8 \\ -3 & 0 & 0 & 0 & 3 & 72 \end{pmatrix} = T_2$$

So, we have calculated a possible volume of gross production which is based on a maximum production of x_2 out of that material that represents the bottleneck for increasing production. Since, however, there is still a negative element in the last line of our matrix, the result of our calculation can be improved. This is done in like manner as in the first step of our calculation but by using the product x_1 and the limited amount of material still available. In our case, the second line of the matrix T_2 is concerned. The columns y_2 ~~and y_1~~ and x_1 have to be exchanged.

dependent variables	independent variables
y_1 y_2 x_2	x_1 y_3
y_1 x_1 x_2	y_2 y_3

$$R_2 = \begin{pmatrix} 1 & \frac{7}{3} & 0 & 0 \\ 0 & 3 & 0 & 0 \\ 0 & \frac{1}{3} & 1 & 0 \\ 0 & -3 & 0 & 1 \end{pmatrix} \quad \text{then } R_2^{-1} = \begin{pmatrix} 1 & -\frac{7}{9} & 0 & 0 \\ 0 & \frac{1}{3} & 0 & 0 \\ 0 & -\frac{1}{9} & 1 & 0 \\ 0 & 1 & 0 & 1 \end{pmatrix}$$

$$R_2^{-1} \times T_2 = \begin{pmatrix} 1 & -\frac{7}{9} & 0 & 0 \\ 0 & \frac{1}{3} & 0 & 0 \\ 0 & -\frac{1}{9} & 1 & 0 \\ 0 & 1 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} \frac{7}{3} & 0 & 1 & 0 & -\frac{2}{3} & 17 \\ 3 & 0 & 0 & 1 & -2 & 18 \\ \frac{1}{3} & 1 & 0 & 0 & \frac{1}{3} & 8 \\ -3 & 0 & 0 & 0 & 3 & 72 \end{pmatrix} = T_3$$

$$T_3 = \begin{array}{c} \begin{array}{cccccc} x_1 & x_2 & y_1 & y_2 & y_3 & b \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & \frac{7}{9} & \frac{8}{9} & 3 \\ 1 & 0 & 0 & \frac{1}{3} & -\frac{2}{3} & 6 \\ 0 & 1 & 0 & -\frac{1}{9} & -\frac{2}{3} & 6 \\ 0 & 0 & 0 & 1 & 1 & 90 \end{pmatrix} \end{array}$$

Now, there are no negative elements in our last line, that means, the result represents the maximum solution. As, furthermore, only the dependent variables represent a certain value, we are able to state:

A maximum gross production amounting to 90 will be reached when using materials available for producing

6 units of product x_1

6 units of product x_2

Then, 3 units of material 1 will be remaining. (c.f. the connecting lines inserted into the last matrix of our calculation)

Finally, the result of our calculation is to be proved.

Starting point:

$$\begin{aligned} 3\ x_1 + 2\ x_2 &\leqq 33 \\ 5\ x_1 + 6\ x_2 &\leqq 66 \\ 1\ x_1 + 3\ x_2 &\leqq 24 \\ 6\ x_1 + 9\ x_2 &\rightarrow \max \end{aligned}$$

Applied to our example:

$$3 \times 6 + 2 \times 6 + 3 = 33$$
$$5 \times 6 + 6 \times 6 \quad --- = 66$$
$$1 \times 6 + 3 \times 6 \quad --- = 24$$
$$6 \times 6 + 9 \times 6 \quad --- = 90$$

No matter, the figures which have been used in our example are very simple ones. In any case, when similar conditions are given the procedure will always be same. Sometimes it renders necessary to carry out some steps more or to use calculating machines. This doesn't affect, however, the general procedure.

2. Example[1]

There are 4 products to be produced. The prices are

$$x_1 = 40$$
$$x_2 = 80$$
$$x_3 = 20$$
$$x_4 = 15$$

The task is set to plan a maximum commodity production by observing the following conditions:

a) There are 3 productive departments for producing the mentioned products. The necessary working time for each product and within each department is shown by the following table.

1) Based on: Die Bedeutung des Variantenvergleichs, (The importance of comparing variants) in: Die Rechentechnik, No. 1/1965.

dep.	hours per product				Fund of
	x_1	x_2	x_3	x_4	working hours
I	2	4	1	10	$\leq$ 1000
II	1	2	4	2	$\geq$ 800
III	6	0	10	4	$\leq$ 1600
	9	6	15	16	

That is to say, productive capacity of I and III is limited and cannot be surpassed while capacity of II must be surpassed.

Moreover, x_2 is only in need of working time of department I and II. Then it is finished.

b) It is compulsorily prescribed by superior authorities to produce

$$x_1 = 100 \text{ units}$$
$$x_4 \leq 80 \text{ units}$$

c) Supply with electric power is limited to 800 kwh. Demand for electricity amounts to

$$x_1 = 0$$
$$x_2 = 1 \text{ kwh}$$
$$x_3 = 4 \text{ kwh}$$
$$x_4 = 2 \text{ kwh}$$

Way of solution

According to the objective,

$$40 x_1 + 80 x_2 + 20 x_3 + 15 x_4 \longrightarrow \max,$$

i.e., they are expected to be a maximum.

If so, the following equations must be considered.

$$
\begin{aligned}
&1)\quad 4\,x_2 + x_3 + 10\,x_4 + x_5 = 800\\
&2)\quad 2\,x_2 + 4\,x_3 + 2\,x_4 - x_6 = 700\\
&3)\quad 10\,x_3 + 4\,x_4 + x_7 = 1000\\
&4)\quad x_4 + x_8 = 80\\
&5)\quad x_2 + 4\,x_3 + 2\,x_4 + x_9 = 800
\end{aligned}
$$

Now, we have to solve the equations according to the asked x_2 ; x_3 ; x_7; x_8; x_9; ($x_1 = 100$) (simplified manner of representation)

from 1) $4\,x_2 = 800 - x_3 - 10\,x_4 - x_5$

$$\underline{x_2 = 200 - 0.25\,x_3 - 2.5\,x_4 - 0.25\,x_5}$$

from 2) $2\,(200 - 0.25\,x_3 - 2.5\,x_4 - 0.25\,x_5) + 4\,x_3 + 2\,x_4 - x_6 = 700$

$$
\begin{aligned}
400 - 0.5\,x_3 - 5\,x_4 - 0.5\,x_5 + 4\,x_3 + 2\,x_4 - x_6 &= 700\\
3.5\,x_3 - 3\,x_4 - 0.5\,x_5 - x_6 &= 300\\
- 3\,x_4 - 0.5\,x_5 - x_6 - 300 &= -3.5\,x_3
\end{aligned}
$$

$$\underline{x_3 = 85.714 + 0.857\,x_4 + 0.143\,x_5 + 0.286\,x_6}$$

from 4) $\underline{x_8 = 80 - x_4}$

from 3)

$$
\begin{aligned}
10\,x_3 + 4\,x_4 + x_7 &= 1000\\
857.14 + 8.57\,x_4 + 1.43\,x_5 + 2.86\,x_6 + 4\,x_4 + x_7 &= 1000\\
12.57\,x_4 + 1.43\,x_5 + 2.86\,x_6 + x_7 &= 142.86
\end{aligned}
$$

$$\underline{x_7 = 142.86 - 12.57\,x_4 - 1.43\,x_5 - 2.86\,x_6}$$

from 1 by inserting calculated x_3

$$x_2 = 200 - 0,25\,x_3 - 2,5\,x_4 - 0,25\,x_5$$

$$x_2 = 200 - 0,25\,(85,714 + 0,857\,x_4 + 0.143\,x_5 + 0,286\,x_6) - 2,5\,x_4 - 0,25\,x_5$$

$$x_2 = 200 - 21.428 - 0.214\ x_4 - 0.036\ x_5 - 0.0715\ x_6 - 2.5\ x_4 - 0.25\ x_5$$

$$\underline{x_2 = 178{,}572 - 2{,}714\ x_4 - 0.286\ x_5 - 0.0715\ x_6}$$

from 5.)

$$x_2 + 4\ x_3 + 2\ x_4 + x_9 = \qquad = 800$$

$$x_9 = 800 - 178{,}572 + 2.714\ x_4 + 0.286\ x_5 + 0{,}0715\ x_6 -$$
$$- 4\ (85{,}714 + 0.857\ x_4 + 0{,}143\ x_5 + 0{,}286\ x_6) - 2\ x_4$$

$$x_9 = 621{,}428 + 2.714\ x_4 + 0{,}286\ x_5 + 0{,}0715\ x_6 -$$
$$- 342.856 - 3{,}428\ x_4 - 0{,}572\ x_5 - 1.144\ x_6 - 2\ x_4$$

$$\underline{x_9 = 278{,}572 - 2{,}714\ x_4 - 0{,}286\ x_5 - 1.0725\ x_6}$$

Now, Z or

$40\ x_1 + 80\ x_2 + 20\ x_3 + 15\ x_4$ should be max.

$$Z = 4000 + 80\ (178{,}572 - 2{,}714\ x_4 - 0.286\ x_5 - 0{,}0715\ x_6) +$$
$$+ 20\ (85{,}714 + 0{,}857\ x_4 + 0{,}143\ x_5 + 0{,}286\ x_6) + 15\ x_4$$

$$Z = 4000 + 14285{,}76 - 217{,}12\ x_4 - 22{,}88\ x_5 - 5{,}72\ x_6$$
$$+ 1714{,}28 + 17{,}14\ x_4 + 2{,}86\ x_5 + 5{,}72\ x_6 + 15\ x_4$$

$$\underline{\underline{Z = 20\ 000.04 - 184{,}98\ x_4 - 20{,}02\ x_5}}$$

From this it appears that - by observing mentioned conditions - maximum commodity production amounts to 20 000.

Now, we have to single out those quantities of x_2; x_3; x_4; (x_1 was given = 100 units) enabling us to reach that commodity production. This has to be done by analysing calculated equations.

Since production of x_1 was fixed and amounts to

$$100 \times 40 = 4000$$

production of x_2 has to comprise 200 units.

Thus, maximum commodity production will be attained when producing

$$x_1 = 100 \text{ units} \quad (100 \times 40 = 4000)$$
$$x_2 = 200 \text{ units} \quad (200 \times 80 = 16\,000).$$

On the other hand, when producing

$$x_1 = 100 \text{ units} \quad (100 \times 40 = 4000)$$
$$x_2 = 178 \text{ units} \quad (178 \times 80 = 14240)$$
$$x_3 = 85 \text{ units} \quad (85 \times 20 \quad 1\,700)$$

the maximum commodity production will not be reached.

Furthermore, although other variants may be possible, this shall be enough so as to show how to solve the problems under discussion in general.

In the preceding calculations, commodity production was to be maximized. On conditions that productive capacity should be utilized best, we have to proceed from the different working hours to produce one unit of the planned products. According to that the aiming function is formulated:

$$9\, x_1 + 6\, x_2 + 15\, x_3 + 16\, x_4 \longrightarrow \max$$

The other conditions are remaining unchanged.

Now, it must be checked whether the calculated quantity of products for a maximum commodity production is at the same time suitable for attaining a high degree of utilizing capacity. This has to be carried out by inserting the already calculated values into the newly formulated aiming function.

$$Z = 900 + 6\,(178.572 - 2.714\, x_4 - 0.286\, x_5 - 0.0715\, x_6) +$$
$$+ 15\,(85.714 + 0.875\, x_4 + 0.143\, x_5 + 0.286\, x_6) + 16\, x_4$$

$$Z = 900 + 1\,071.432 - 16.284\, x_4 - 1.716\, x_5 - 0.429\, x_6 +$$
$$+ 1285.71 + 12.855\, x_4 + 2.145\, x_5 + 4.290\, x_6 + 16\, x_4$$

$$Z = 3\,257.142 + 12.571\, x_4 + 0.429\, x_5 + 3.816\, x_6$$

As there are still positive elements, Z doesn't represent an optimum, or in other words, there are still idle capacities. For using this capacity, a certain number of x_3 should be produced. Thus, x_3 must be calculated newly. At first, the following steps are necessary. (simplified) from 3.) $10\,x_3 + 4\,x_4 + x_7 = 1000$

$$857.14 + 8.57\,x_4 + 1.43\,x_5 + 2.85\,x_6 + 4\,x_4 + x_7 = 1000$$
$$12.57\,x_4 + 1.43\,x_5 + 2.85\,x_6 + x_7 = 142.86$$
$$2.85\,x_6 = 142.86 - 12.57\,x_4 - 1.43\,x_5 - x_7$$
$$\underline{x_6 = 50.12 - 4.41\,x_4 - 0.502\,x_5 - 0.351\,x_7}$$

from 1.)

$$x_2 = 178.572 - 2.714\,x_4 - 0.266\,x_5 - 0.071\,(50.12 - 4.41\,x_4 - 0.502\,x_5 - 0.351\,x_7)$$
$$x_2 = 178.572 - 2.714\,x_4 - 0.286\,x_5 - 3.559 + 0.313\,x_4 + 0.036\,x_5 + 0.025\,x_7$$
$$x_2 = \underline{175.013 - 2.401\,x_4 - 0.250\,x_5 + 0.025\,x_7}$$

from 2)

$$x_3 = 85.714 + 0.875\,x_4 + 0.143\,x_5 + 0.286\,(50.12 - 4.41\,x_4 - 0.502\,x_5 - 0.351\,x_7)$$
$$x_3 = 85.714 + 0.875\,x_4 + 0.143\,x_5 + 14.284 - 1.257\,x_4 - 0.143\,x_5 - 0.1\,x_7$$
$$\underline{x_3 = 99.998 - 0.400\,x_4 - 0.1\,x_7}$$

from 5)

$$x_9 = 800 - x_2 - 4\,x_3 - 2\,x_4$$
$$x_9 = 800 - 175.013 + 2.401\,x_4 + 0.250\,x_5 - 0.025\,x_7 - 4\,(100 - 0.4\,x_4 - 0.1\,x_7) - 2\,x_4$$
$$x_9 = 400 - 175.013 + 0.401\,x_4 + 1.6\,x_4 + 0.25\,x_5 + 0.375\,x_7$$
$$x_9 = \underline{224.987 + 2.001\,x_4 + 0.25\,x_5 + 0.375\,x_7}$$

$$Z = 9\,x_1 + 6\,x_2 + 15\,x_3 + 16\,x_4 \longrightarrow \max$$

$$Z = 900 + 6\,(175.013 - 2.401\,x_4 - 0.250\,x_5 + 0.025\,x_7) +$$
$$+ 15\,(100 - 0.4\,x_4 - 0.1\,x_7) + 16\,x_4$$

$$Z = 900 + 1050.078 - 14.406\,x_4 - 1.50\,x_5 + 0.15\,x_7 + 1500 -$$
$$- 6.0\,x_4 - 1.5\,x_7 + 16\,x_4$$

$$Z = \underline{\underline{3450.078 - 4.406\,x_4 - 1.5\,x_5 - 1.35\,x_7}}$$

Hence, productive capacity will be utilized best when producing

x_1	=	100 units	(100 x 9 = 900)
x_2	=	175 units	(175 x 6 = 1050)
x_3	=	100 units	(100 x 15 = 1500)

To sum up, although the figures and conditions of the example have been chosen arbitrarily, the manifold correlations, dependences and possible variants became obvious without being able, however to go into all the details. This must be the contents of special studies.

Moreover, so useful mathematical methods may be, it depends finally upon the national economic objectives, upon the investigation of demand, upon the supply with raw materials, etc. which composition of the production program according to the possible variants is chosen.

Afterwards, this selected program has to be balanced and brought in line with the other ingredients of the comprehensive plan of factories, organizations of industrial enterprises as well as such other institutions of national economy as the state bank, etc. As these problems are already dealt with in the memorandum No. 552 of the Institute of National Planning, they are to be neglected in here. Therefore, the main forms for planning of production are only added. This is intended to show which forms can be used for making sure a uniform manner of representation at the different levels of national economy.

PRODUCTION PLAN

general declarations			column[1]
factory:	county:		
place:	factory No:		
telefon:	property:		
street:	superior org.		
	sector:		

description of balanzing position:	balancing position No:

balancing organ:	place	date

signature

	unit of descr;	qual. column	punch card	prec. year	plan year	quarter of plan year I	II	III	IV
total production	1.unit								
	2.unit								
industrial commodity production	1.unit								
	2 unit								
	idp.[2]								
stock of finished goods, 1.1.	1.unit								
	2.unit								
	idp.								
stock of finished goods, 31.12.	1.unit								
	2.unit								
	idp.								
production for population	1.unit								
	2.unit								
	idp.								
export	1.unit								
	2.unit								
	idp.								
	ep.[3]								

1)For inserting column No of punch-cards
2) industrial delivery price
3) enterprise price

PRODUCTION PLAN

factory	punch card	precedi year	plan year	quarter of plan year I	II	III	IV
gross production f.p.[1]				—	—	—	—
± stock changings of interm. goods p.c.[2]				—	—	—	—
non-industrial commodity prod. idp.[3]				—	—	—	—
out of it: construct. and project.perf.idp.				—			—
industrial commodity production idp.							
sales idp.							
production for population idp.							
export idp.							

general declarations			column
factory: place: telefon: street:	county: factory No: property: superior organ : sector:		

1) fixed price
2) prime cost
3) industrial delivery price

place ______________ date ____________

____
signature

4. Concluding remarks

It has been authors' intention to outline the very comprehensive tasks of production planning in socialist industry with special reference to the planning of public and industrial enterprises.

We are well aware of the fact that there are a lot of other problems worth while discussing in this connection. Nevertheless, they couldn't be dealt with in these memos for avoiding a splitting into too many details depriving the reader of the opportunity to study and to understand the general ideas of production planning in socialist industry.

Thus, after having understood the whole background of production planning it will be much easier but also be necessary to study such special questions as

- different methods for investigating demand for certain products,
- the application of mathematical methods for investigating demand, balancing of productive capacities etc.

and to combine them properly with the general system of planning of public enterprises. This goes especially for the studies of those methods being applied to capitalist factories. Only when being conscious of the differences in planning, experiences and methods of capitalist enterprises and economists can be used for the benefit of public and industrial enterprises in the UAR.

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