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Lectures
on
Manpower Planning
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- a) Securing full employment;
- b) Maximum development of individual abilities and capacities as a basis for development of individual living standard and the entire welfare of personality;
- c) Maximum increase of national income by means of effective utilization of labour force.

During the transition period from capitalism into socialism the development of socio-economic structures of manpower is of paramount importance. Thus the target as a whole is not exclusively determined economically. Economical target takes a central place if political and social targets are to be fulfilled on an appropriate economical basis.

The economical targets for the development of labour force result from the fact that "the degree of skill of the existing population is the respective supposition for the whole productive activity, the main accumulation of wealth, the most important result of antecedent labour existing into the living labour itself"¹⁾. For industrially developed countries there are today

1) K. Marx, Theorien über den Mehrwert, Bd. 3, Berlin 1962, s. 193.

estimations that about $1/3$ of economic growth is due to the qualification of manpower.

The investments in education & training of labour force are steadily increasing. In the G.D.R. for example in 1965 the government invested in education and training the following rates for different manpower categories:

		Mark
for one un- or semi-skilled worker	:	about 11,000
for one skilled worker	:	" 18,800
for one technician	:	" 29,000
for one University -Graduate	:	" 53,500

When multiply these rates by the numbers of each of the given groups, the total investment for the labour force reaches about 131×10^9 Mark. The amount of fixed capital in the same year was about 400×10^9 Mark, showing that the proportion of fixed capital to investments in labour force was about 3 : 1.

It is typical for the socialist society that there is a conformity between individual interest in higher education and higher living standards and between the interest of society for continuously growing qualification of labour force.

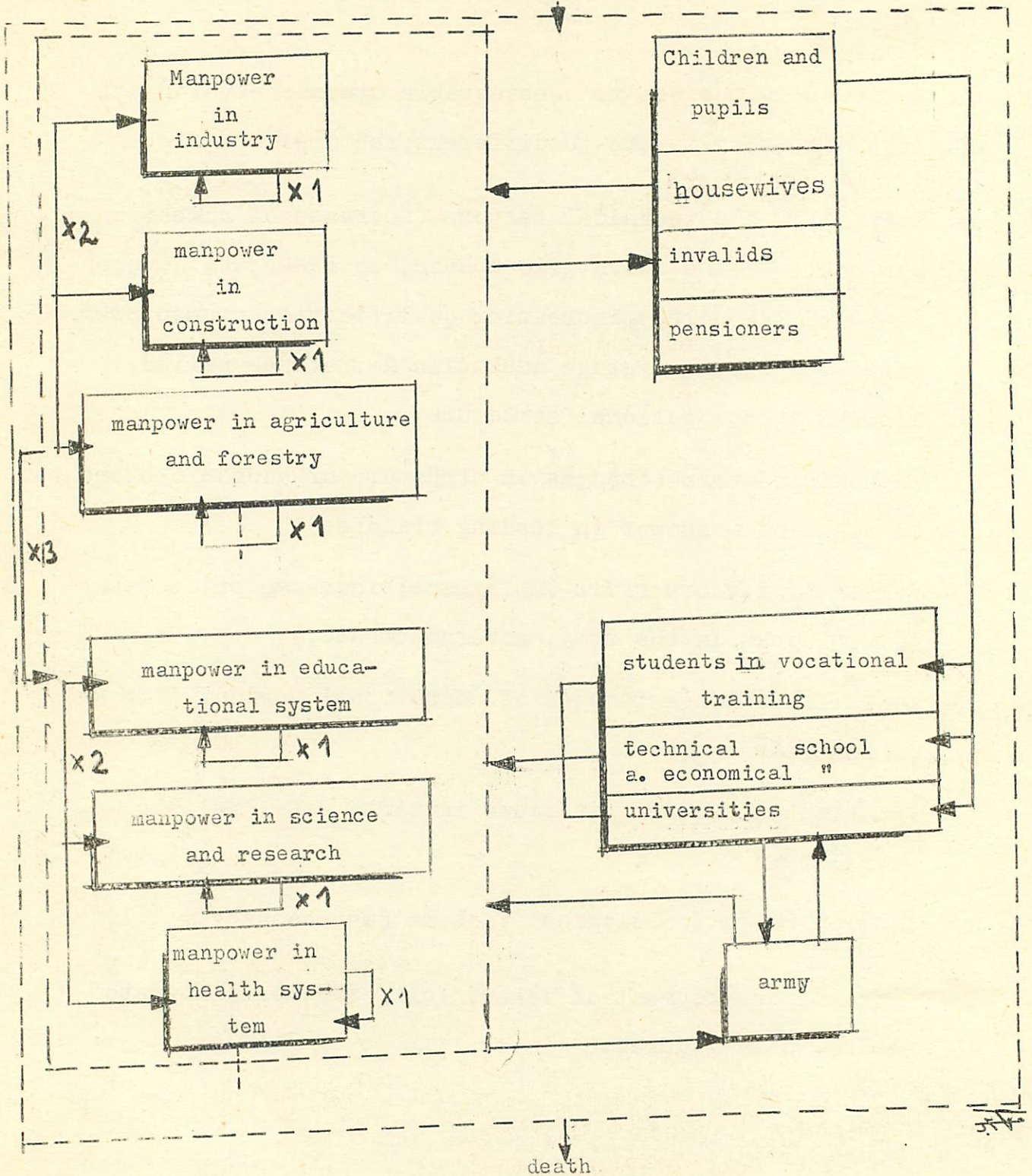
Labour force is subject to considerable dynamic development.

This dynamic trend is due to different factors:

- a) Scientific and technical factors (increase of number of employees in the scientific sphere, in research, development and technology, increasing qualification of manpower, extension of the average education & training period, changes in occupational structure;
- b) Economic factors (changes in structure of economic branches; increase of manpower in leading branches);
- c) Political factors (full employment; increase or decrease of employees in the army, government etc.)
- d) Social factors (extension of educational period; decrease of retiring age);
- e) Demographic factors (increase in birth rate, fall in mortality);
- f) Ideological & sociological factors (unnecessary mobility).

This dynamic development of labour force may be illustrated by the following figures:

Birth



- x 1 : mobility inside of a branch
- x 2 : mobility between branches
- x 3 : mobility between Regions.

Fig. (1)

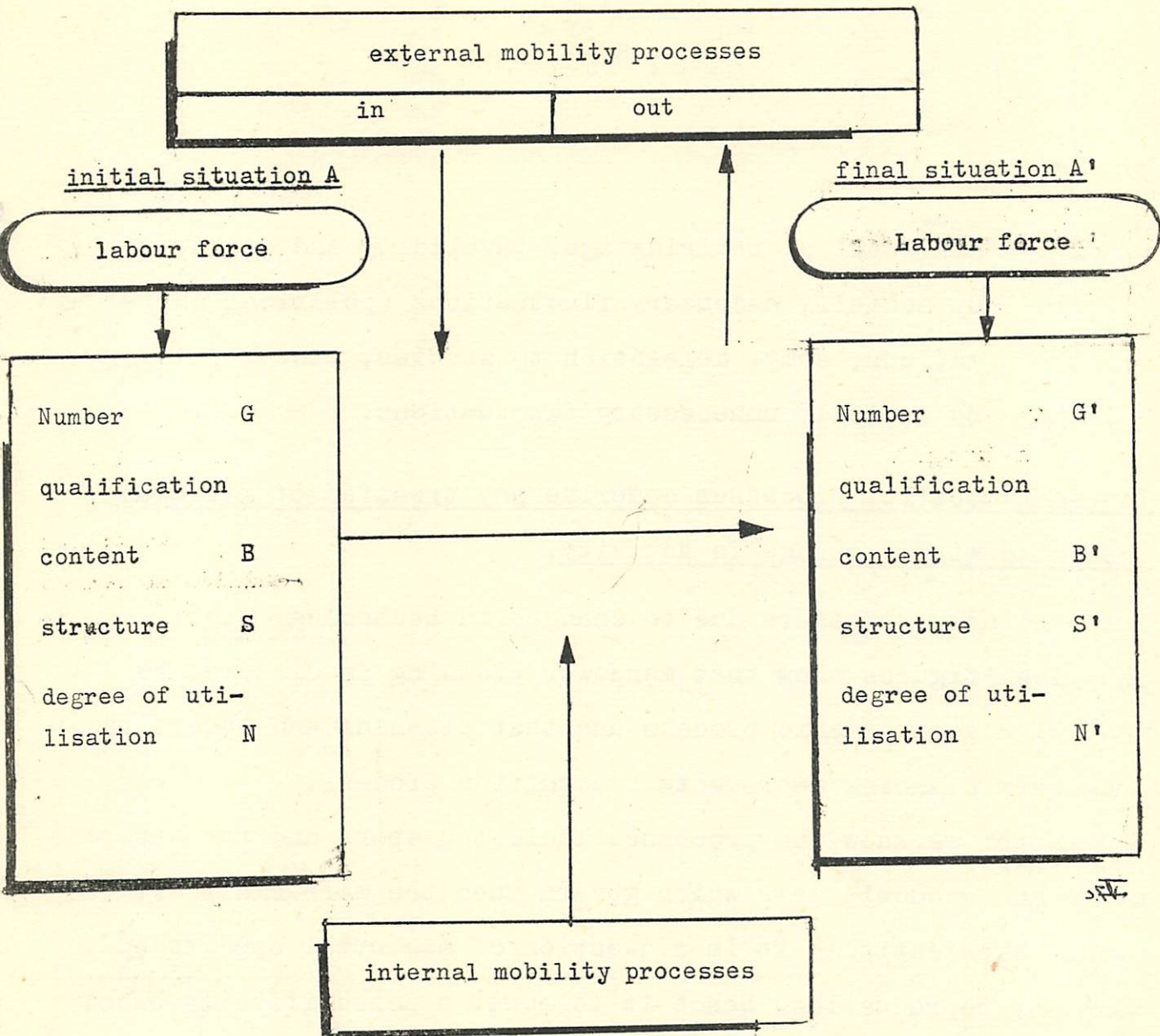


Fig. (2)

External mobility process represents the movement of labour force from and to economic activities

a) Entrants

i from the educational system (young skilled manpower, graduates from universities and technical schools);

ii from unemployed population.

b) Leavers:

- i - as^a result of retiring age, invalidity and death,
- ii- by socially necessary fluctuations (political obligations, army, delegation to studies, etc.);
- iii- by socially unnecessary fluctuations.

Internal mobility processes comprise any transfer of manpower connected with a change in activity.

This includes transfers due to changes in technology etc.

The given figures show that manpower planning is directed to control a very dynamic process and that planning and specially long term planning represents a cognition process.

The better we know the processes indicated above and the determinants and economic laws which govern them the more exact are the plans. Substantially it is a question of essential aspects of manpower reproduction. Hence it follows: a scientifically based planning theory is always based on a theory of manpower reproduction in the enterprise, Region and national economy. The manpower planning aimed at an optimum reproduction of manpower, the optimum criterion being derived from political, economical and social targets of the State.

The main objective of Manpower Planning is to find out an optimum solution considering all these factors. We must here mention that in a socialist country there are no conflicts between these different factors. Therefore it is always possible to achieve an optimum combination of these factors.

1.1.2. The strategic concept

The Government has elaborated for the realization of this target a strategic concept based on different forecasts. These forecasts include:

- population forecast;
- economic forecast;
- scientific forecast;
- manpower forecast;
- educational forecast.

In accordance with the long-term qualitative and quantitative development of labour force such forecasts are usually elaborated for a period of about 20 years.

During the elaboration of the strategic concept the Government starts from the fact that the existing scientific and technical revolution needs objective changes in the structure, quality & efficiency of productive forces, in the present time. Clearly,

this is valid also and above all for the most important productive force, i.e. the labour force. In this connection it means:

Educational effects, structural effects and utilisation effects.

In determining the strategy of the GDR, it is aimed to maximise the qualification development and its optimal utilization as the situation of full employment is reached and secured.

The most important strategic targets have been determined on the VII. Congress of the Party. They include:

- a) general compulsory education in the polytechnical secondary school with 10 classes;
- b) general vocational training for all juvenales as far as they will not attend Universities or High institutes;
- c) increase of efficiency of high education;
- d) 25 per cent of each birth cohort attend university or high institute in full-time courses (inclusively correspondence courses it would mean about 30 per cent);
- e) the inventory of graduates from universities and high institutes will be increased in the period

1965-1980 by 2,5 time, the inventory of scientists and engineers by 3,5 time;

- f) this means that about 7-8 per cent of the national income is spent for educational targets.

By this strategic concept the general trend for labour force is given.

1.1.3. Contents of Manpower Planning

The Manpower Planning has 2 main steps:

- a) to precise the targets of the strategic concept;
- b) to elaborate a suitable program to fulfil the targets.

Planning means to work out different alternatives inside the target area and also includes decision on the optimum alternative by means of selected optimum criteria.

Therefore, manpower planning includes:

- a) determination of the average inventory and its structure;
- b) determination of demand divided in structural elements;
- c) determination of the turnover rate (entrancers, transfers, qualification from one step to the next etc.).

The planning task consists of determining the target area and to set up the program for transforming the given initial situation into the aimed one. Therefore, the planning always includes the following parts:

- a) determination of target area (= which situation is to be reached) and the possible optimal alternative,
- b) analysis of the initial situation (== where we are now);
- c) work out of transformation program (which measures are necessary to arrive from the initial situation to the target area).

The most difficult task is to determine the target area¹⁾. The basis for this are the above mentioned forecasts.

1.1.4. Unity of Planning and its Realisation by the Government organs.

The realization of plan requires the state control.

The state authorities (from enterprise to the State Commission)

1) under the target area we have to understand the limits within which all possible alternatives can be fulfilled.

use a system of economical and noneconomical measures for this purpose. Manpower planning contains a number of specific aspects arising from the particular position of the human being in the social production and reproduction processes. Everyone in society has the right to choose the kind of education, and his work place within the framework of the social opportunities. In these circumstances it is impossible to forecast and master fully the effects of all the factors influencing the development of labour force in advance. Therefore in this branch of planning the actual development everytime will correspond with the planned one only approximately. This difference between both will be minimum the more effective the ~~state~~ measures stimulate the reaching of planned situation.

The most important state control measures are to be classified as follows:

- a) economical measures: wage system, income policy etc.
- b) socio-economical measures: housing, cultural and social utilities: etc.
- c) administrative measures: limitations for particular specialisations in vocational and technical schools and universities,
- d) educational measures: education and training according to demand, improvement of educational efficiency etc.

- e) ideological measures: vocational consultations for pupils of attraction of the required manpower to the most important projects.
- f) sociological measures: improvement of the working atmosphere, etc.
- g) demographic measures: influence of the population growth.

The plan is to realise the best if the individual, groups and society as a whole coincide with each other as far as possible. This must be reached by the mentioned system of control measures. In doing so the individual interests can be realized only in the framework of socially fixed limits.

1.2. Methodological Fundamentals

1.2.1. Manpower structure and its Representation

Manpower of the national economy, sector or enterprise always appears in particular structures. They reflect:

- a) the different aspects of division of labour;
- b) the socio-economic conditions;
- c) the demographic conditions.

Such structures are:

- i - the sectoral structure indicating the distribution of manpower among economic sectors and branches;
- ii- the structure indicating the distribution of manpower among the departments of research/development, management, production etc.;

- iii- the qualification structure indicating the distribution of manpower among qualification levels and occupational groups;
- iv- the socio-economic structure indicating the distribution of manpower among the different social classes and groups;
- v- the regional structure indicating the distribution among regions;
- vi- the age and sex structure indicating the distribution by age groups and sex.

There are other structures such as the so called manpower group structure (for example Direct workers: indirect workers, in production). Formally any given manpower structure can be represented as follows:

The distribution of manpower according to one criterion gives a structural vector.

$$Z_Q = \begin{pmatrix} A_1 \\ a_2 \\ \cdot \\ \cdot \\ \cdot \\ A_n \end{pmatrix}$$

This vector would be the simple qualification structure vector where the different A represent the qualification groups. The structure according to two criteria gives a structural matrix.

For example; Qualification-branch-matrix.

<div style="display: flex; align-items: center; justify-content: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Qualification</div> <div style="text-align: center;">branch</div> </div>		Agriculture	Industry	Σ
High Education	Scientists					
	Engineers					
	...					
	Σ					
Technical Education	Commerce					
	Textile					
	...					
	Σ					
	...					
	...					
	...					
	Σ					

Qualification -Branch-Matrix.

The above mentioned explanation shows the possibility of combining the different structures of manpower. The more combinations we can get, the higher is the possibility of distributing the available manpower (e.g. Qualification -Branch - Region - Matrix). In this case the number of possibilities is 3. Then the Freedom degree (F) of each vector is 2. Generally we have $(n-1) \geq F \geq 0$, where n represents the number of structures.

For purposes of practical planning as a rule a system of manpower matrices with a limited number of criteria is sufficient. The most important matrices are the following:

- a) the qualification -branch-matrix
- b) the qualification - activity - matrix
- c) the qualification - Region - matrix

Manpower classification is the main tool to obtain an efficient system of matrices which enable us to analyse and plan Manpower. For this purpose there must be a set of catalogues for the different kinds of classifications (e.g. in the GDR there are catalogues for occupational structure, qualification structure, etc. for each economical branch).

1.2.2. Manpower Inventory and Manpower Demand

The start point of planning is to find out the average inventory of manpower. The inventory B is to be changed

from situation 0 into situation n.

$$B_o \longrightarrow B_n$$

As inventory we mean the totality of manpower or a given structural element. If $B_o = B_n$, then the number of leavers are to be replaced only during the period n.

This will be represented by the replacement need S.

(More exactly S is the component for inventory maintenance!)

If

$$B_n > B_o$$

we have to add both S and the change need W (component due to change).

Then

$$Q = W + S$$

where Q is the total number of enterances (demand).

$$B_n < B_o$$

two cases are to be distinguished:

1. case: $0 < Q < S$ There are enterances smaller than S.
2. case: $Q < 0$ There are no enterances of labour force but transfers.

(This situation is typical for example for coal miners and the lower qualification groups)

For the calculation of the inventory maintenance component (S) have:

$$S_i = B_i \cdot S_z = \text{replacement need in year } i$$

where $S_z = \text{replacement rate}$

For the period of n years it is valid that:

$$S_n = \sum_{i=1}^n (B_i \cdot S_z)$$

For the calculation of the component of inventory change (W) it is valid that:

$$W_n = B_n - B_0$$

$$W_i = B_i - B_{i-1}$$

$$W_n = \sum_{i=1}^n B_i - B_{i-1}$$

If the average growth rate W_z is given

$$W_z = \sqrt[n]{\frac{B_n}{B_0}} - 1$$

Then

$$W_n = \sum_{i=1}^n (B_{i-1} \cdot W_z)$$

If the calculation of the components of inventory change and maintenance relates to a labour force matrix we have the following relations:

Gives the matrix A the labour force inventory and its structure in the basis year t_0 and the matrix C the inventory in the plan year t_1 then

$$A + B = C$$

where B is the matrix of change (extension or diminution) of the number of manpower in the respective structural elements. It is

$$a_{ik} + b_{ik} = C_{ik}$$

where a_{ik} , b_{ik} & C_{ik} represent the elements of the matrices A, B and C respectively.

then
$$b_{ik} = k'_{ik} \cdot a_{ik}$$

and
$$c_{ik} = a_{ik} (1 + k'_{ik}).$$

k'_{ik} is the coefficient of inventory change. If $k'_{ik} > 0$, k'_{ik} is the Demand coefficient of extension. The total demand G is composed of the inventory change B and the replacement need D

Then
$$G = B + D$$

$$g_{ik} = b_{ik} + d_{ik}$$

If k''_{ik} is the coefficient of replacement need then

$$\begin{aligned}g_{ik} &= k'_{ik} \cdot a_{ik} + k''_{ik} \cdot a_{ik} \\&= a_{ik} (k'_{ik} + k''_{ik}) \\k_{ik} &= k'_{ik} + k''_{ik}\end{aligned}$$

and
$$g_{ik} = k_{ik} \cdot a_{ik}$$

If i is the index of the rows and k that of the columns then

$$a_i = \sum_{k=1}^n a_{ik}$$

where a_i is for example the number of manpower of an occupational group

and
$$g_i = \sum_{k=1}^n k_{ik} \cdot a_{ik}$$

where g_i is the demand on this manpower category.

1.2.3. The Analysis of the Initial Situation

The target of manpower planning is to use manpower with maximum efficiency for the national economy. For the fulfillment of this task important clues can be derived from the analysis of the initial situation. The most important is to derive from analysing the initial situation conclusions for an optimum planning. First of all important questions during the analysis are as follows is the existing labour force used efficiently,

what hinders a higher efficiency, how to overcome the reasons? Components of these questions are:

a) Is the existing qualification used efficiently? Is it possible to use manpower of high qualification more by better organisation or by a better division of labour (such as by an appropriate number of auxiliaries)?

b) Fit the existing occupational structure with the activity? The analysis should contain also the analysis of errors arising from previous plans; this gives conclusions for the new planning technique.

The methods used for analysis must be based according to its purpose. There are different appropriate methods in this case:

- a) structural analysis as cross-sectional analysis, trend analysis and structural comparisons (such as and occupational activity structures)
- b) factor analysis: correlation and regression analysis
- c) work studies to find out the efficiency of the existing qualification.

On the national level international comparisons are important.

1.2.4. Planning Methods

In theory and practice different planning methods are developed and used at present for the planning of inventory of different manpower categories.

In the following we shall give a short summary of the most important manpower planning methods:

a) Norm Method

The norms are considered as an important planning tool in all fields of planning. In case of manpower planning norms are used often and they are the basis of planning the number of production workers in enterprises. Norms are used for planning other occupational groups and on higher planning levels (sectoral, National). In the last case norms can only be used for planning when they reflect the relations between manpower inventory & the influencing factors. Therefore norms must be based on accurate analysis of these factors. The simple norms relates manpower inventory to only one influencing factor (e.g. Engineers/ fixed capital). Such norms can be simply calculated but they are used only when the effect of the other factors can be neglected. The majority of norms is based normally on 2 or 3 factors. The introduction of the effects of more factors has shown that no better results can be achieved. Such

norms are worked out by means of correlation & regression analysis. They are not reflecting the average level but they reflect a higher level.

Specially are such norms applicable for manpower planning in the nonmaterial sectors. For example in the educational system the number of teachers can be determined in relation with the following factors:

1. Number of pupils;
2. Capacity norm per teacher (e.g. the number of working hours / week, etc.);
3. Number of lessons per week;
4. Number of pupils per class.

Similarly norms can be worked out in the health services sector, scientific institutions, banks etc. The time span in which the norms are considered to be applicable depends upon how long we can assure that the influencing factors are unvariable. Generally the time span is from 5 to 7 years.

b) Trend-Extrapolation-Method

This method depends upon the registration of the behaviour of a certain phenomenon during a certain period (base period) and the projection of this behaviour in the future. By applying this method appears a number of problems which

must be taken into consideration. Here we shall give only 2 of such problems:

- 1) the conditions in the plan period must be nearly the same as those in the basis period. This must be always controlled.
- 2) the plan period should be always shorter than the basis one. Here appears the problem of lack of such sufficient trends for the basis period.

Therefore, this method can be used effectively for short-term planning. It can be used not only for the projection of absolute numbers but also for relative numbers.

In some cases the trend - extrapolation leads to unreal results and therefore we have to use another method to achieve real results.

C) Qualified Estimation Method

The application of this method leads in many cases to useful results. Estimations are always possible when the other methods are not applicable. Estimation for manpower planning are used in many countries. Recently in the USSR a method was developed which exceeds the present experience in this field. It is a combination of the Delphi-method, which is based on consulting a group of experts in the concerned field and the PERT - Method (Program Evaluation & Review Technique). This method is suitable specially for

long-term planning and forecasts. In the following we shall give the main steps which to be followed by manpower planning:

- 1) A sufficient number of experts is to be consulted. They must have the theoretical and practical abilities in the concerned field (e.g. Manpower planning, education, etc.) All the necessary informations about these experts must be well known.
- 2) They will be consulted about a certain event and the possible occurrence time and the necessary activities leading to this event.
- 3) Their answers are to be collected and the probability of the accurate occurrence time of the event and the necessity of activities are to be calculated.
- 4) The most probable occurrence times and activities are to be brought in a network.
- 5) The activities will lead to new events nearer to the basis year. For these new events the whole process must be repeated until we reach the basis year.

Example:

1. In the field of manpower planning on the national level 100 experts are grouped.
2. They are consulted about the following questions:

- a) when it is possible to double the number of engineers?
- b) Which conditions are to be fulfilled?

3) The answers were as follows:

	<u>year</u>	<u>No. of Experts</u>	<u>Probability</u>
a)	1975	10	0.10
	1980	15	0.15
	1985	70	0.70
	1990	5	0.05

	<u>No. of Experts</u>	<u>Prob.</u>
b) Building new hostels	90	0.90
" " laboratories	85	0.85
Increasing the no. of the staff	95	0.95
" " " " students	100	1.00

4. From these results we can get the following basis network.

1985



activity

1980



1979 hostels

Labora-
tories
1979

Staff
1979

Students in
Secondary
School

1977 Start of
building the
hostels

Ealabbish-
ment
1978
of Lab.

Preparation
1974
of the staff

Assitants
1969

Students in
4 preparatory
Schools

Basis	Year
1940	1941
1942	1943
1944	1945
1946	1947
1948	1949
1950	1951
1952	1953
1954	1955
1956	1957
1958	1959
1960	1961
1962	1963
1964	1965
1966	1967
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2168	2169
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2200	2201
2202	2203
2204	2205
2206	2207
2208	2209
2210	2211
2212	2213
2214	2215
2216	2217
2218	2219
2220	2221
2222	2223
2224	2225
2226	2227
2228	2229
2230	2231
2232	2233
2234	2235
2236	2237
2238	2239
2240	

This network is only a simple illustration of this method.

d) International Comparisons:

International comparisons are used often for manpower forecasts and long-term planning, specially for high qualified manpower. The advantages of this method are:

- 1) to recognize the regularity of manpower development;
- 2) to supply planner with the necessary informations.

They are useful for both theoretical and practical purposes.

But we have to consider the following limitations:

- 1) The specific demographic, economic, social and other conditions must be considered for each country; therefore it is better to compare between countries with nearly similar conditions;
- 2) The educational systems are not the same in the different countries. The highest grade of comparison exists for the high educational graduates;
- 3) There are great differences in the statistical systems of the various countries.

We must here mention that this method is to be used only as a tool to precise and check the results of our plans.

e) Mathematical Models

Mathematical models are used nowadays as a planning tool but only from the theoretical point of view. They will be the most important practical planning tools in the future. By the preparation of manpower plans it is very important to combine different methods. We have to apply such methods which can realise the required results with minimum effort. It is always possible to obtain such results by simple methods. The more the results for the practice obtained from the theories, the more useful are these theories.

1.3. Development of Theory and practice of manpower

Planning in the GDR

Today, after 20 years of successful political and economical development, the GDR disposes of a developed planning theory and of extensive experiences in the Planning practice being an integrated part of the national economic planning system. It is concentrated always on 3 levels: the enterprise, the Region and the national economy as a whole respectively on the different sectors and branches.

Considerable changes were taking place in the GDR's manpower potential as a result of planned processes; which one represented by the following tables:

	1952	1956
Total	100	100
Public sector total	53,6	84,1
- State sector	50,0	64,8
- Co-operative sector	3,6	19,3
semi-state sector	-	5,3
Private sector	46,4	10,6

Table 1: Manpower according to property status of enterprises

	1955	1964	1980
Total	100	100	100
with university qualification	1,6	2,6	6-7
Technicians and manpower with special qualification	2,8	4,8	11-12
Skilled workers	25,6	45,6	62-70
Semi or un-skilled workers	70,0	47,0	13-19

Table 2: Qualification structure of manpower in the public sector

	1952	1966
Total	100	100
Industry	29,4	35,8
Construction	5,8	5,7
Manufacturing craftsmen	7,0	5,2
Agriculture, forestry	22,9	15,9
Transport	5,5	5,4
Post and communication - system	1,6	1,8
Trade	10,7	11,5
Sectors outside material production (health-system finance..)	13,8	17,4

Table 3: Manpower structure according to sectors

The great structural changes are reflecting the radical socio-economical changes but also the economic scientific and technical development.

Parallel to the economic development, changes in manpower planning took place. Whereas in the beginning the quantitative aspect and the year planning were predominant due to a great extensive growth of the socialized sector, a long term and great change of the qualitative aspect of manpower is occurring due to the techno-scientific revolution. Therefore today forecasts and long-term planning of manpower with the qualitative aspect are the central points.

2. Forecasting and Long-term Planning of Manpower on the National level

2.1. The Analysis and Forecast of the Development of the National Total Manpower (NTM)

Today nobody disposes of a mathematical model rendering possible sufficiently exact forecasts of NTM. Therefore at present there are attempts to find out the tendencies of the structural development and regularities by an analytical system. Then to use them for forecasting the future development. So it is possible to elaborate sufficiently founded forecasts as a basis for long term decisions for economic and educational policy. The forecasts in the GDR (and in other socialist countries) are based on careful analysis of the trends of volume and structure of NTM and make for this purpose use of different methods and ways using frequently the international comparison as additional and checking measure.

2.1.1. The volume of the National Total Manpower

Initial point for the determination of the volume of NTM is the demographic analysis and population development forecast. The calculations of the future development are based on the specific age and sex structure of the GDR, the low birth rates (About 1.2

per cent per year) and the high mortality rates due to the specific population structure in the GDR.

The following table shows this trend:

	1970		1975		1980	
	thousand persons	per cent	thousand persons	per cent	thousand persons	per cent
Total population	17,200	100	17,380	100	17,620	100
from which:						
Children	3,950	23	3,970	23	4,000	23
Pension age	3,400	20	3,410	20	3,080	17
Working age	9,850	57	10,000	57	10,540	60

Table (4)

The following table gives the change in these population groups divided by sex in the period 1970 - 80 in (1000)

	female	male	total
Total population	+ 40	+ 380	+ 420
from which:			
Children	+ 25	+ 25	+ 50
Pension age	- 230	- 90	- 320
Working age	+ 245	+445	+ 690

Table (5)

The population in the working age will increase by about 7 per cent during these 10 years.

Between the population in the working age (PWA) and the national total manpower (NTM) there are the following relations:

$$NTM = PWA \cdot g + PE = PWA_m \cdot g_m + PWA_f \cdot g_f + PE$$

NTM = national total manpower

PWA = population in working age

PWA_m = " (male)

PWA_f = " (female)

g = general employment rate = NTM/PWA

g_m = " (male)

g_f = " (female)

PE = Number of pensioners employed

$$g_m = 1 - (k_1 + k_2 + k_3)$$

$$g_f = 1 - (k_2 + k_3 + k_4 + k_5)$$

k_1 = coefficient for military service ¹⁾

k_2 = " education and training.

k_3 = " invalidity

k_4 = " release due to pregnancy

k_5 = " other reasons.

¹⁾ Number of members of the army , etc.
Male population in the working age.

For the forecasting purposes the estimation of the following factors is important:

- a) development of employment rate for women (k_5)
- b) development of employment of pensioners (PE)
- c) development of number of persons in education and training (k_2)

- The increase in employment rate (k_5) for women is influenced by different factors. These include :

- a) the increase in qualification level. According to sociological studies women with a trade or profession have more desire to work (in 1980 nearly all women aged till 50 years will have a trade or profession);
- b) the preparation of new places of employment for women in lower industrially developed regions. The employment rate in several regions is about 10 per cent lower than in other regions;
- c) the quantitative and qualitative improvements of education and care of children of the working women in nurseries, kindergartens and day nurseries.

There are other factors working against the increase in employment rate of women (extension of release of mothers before and after birth, increase in family income etc.).

The trends in the employment of pensioners is not easy to estimate. It is to consider that the average life expectancy is rising

indicating an increase in employment. Studies on the state of health show that about 80 per cent of pensioners (in the first 5 years after reaching pension age) are able to work in appropriate working places.

The number of students can be determined relatively exactly from the forecast of the qualification structure and the targets of educational policy. In the GDR, in the following years, the number of pupils in the classes 9 to 12, and students in vocational and professional schools and universities will increase considerably:

- a) an increase in employment rate of women (k_5)
- b) a decline in employment rate of pensioners (PE)
- c) an increase in the number of pupils and students in working age and an extension of the average educational period.

It follows, that the national manpower will grow slower than the population in the working age.

2.1.2. The Regional Structure

The development at the volume of the national total manpower is directly connected with its regional development since the population reproduction takes place in the regions.

Due to the different demographic situation in the different regions,

also the population development will have different trends. Among the 15 regions of the GDR for Example 10 will have in the 1970-1980 period an increase in population, the region Dresden will remain constant while in the regions Leipzig, Karl-Marx-Stadt and Berlin will decline. This gives a different development in the number of manpower taking into consideration the different development of employment rate.

For example:	1980 : 1970	Rostock	120 per cent
		Dresden	102 per cent
		Berlin	99 per cent

These calculations do not take into consideration the future migrations.

In comparing the regional manpower development with agglomerations there is apparently a strong development in the lower developed areas and insufficient development in the agglomerations.

Conclusions:

- a) allocation of production in lower developed regions
- b) Advancement of migration into the agglomerations.

For getting information about migration an analysis of the previous trends is necessary. This gives the following phenomena:

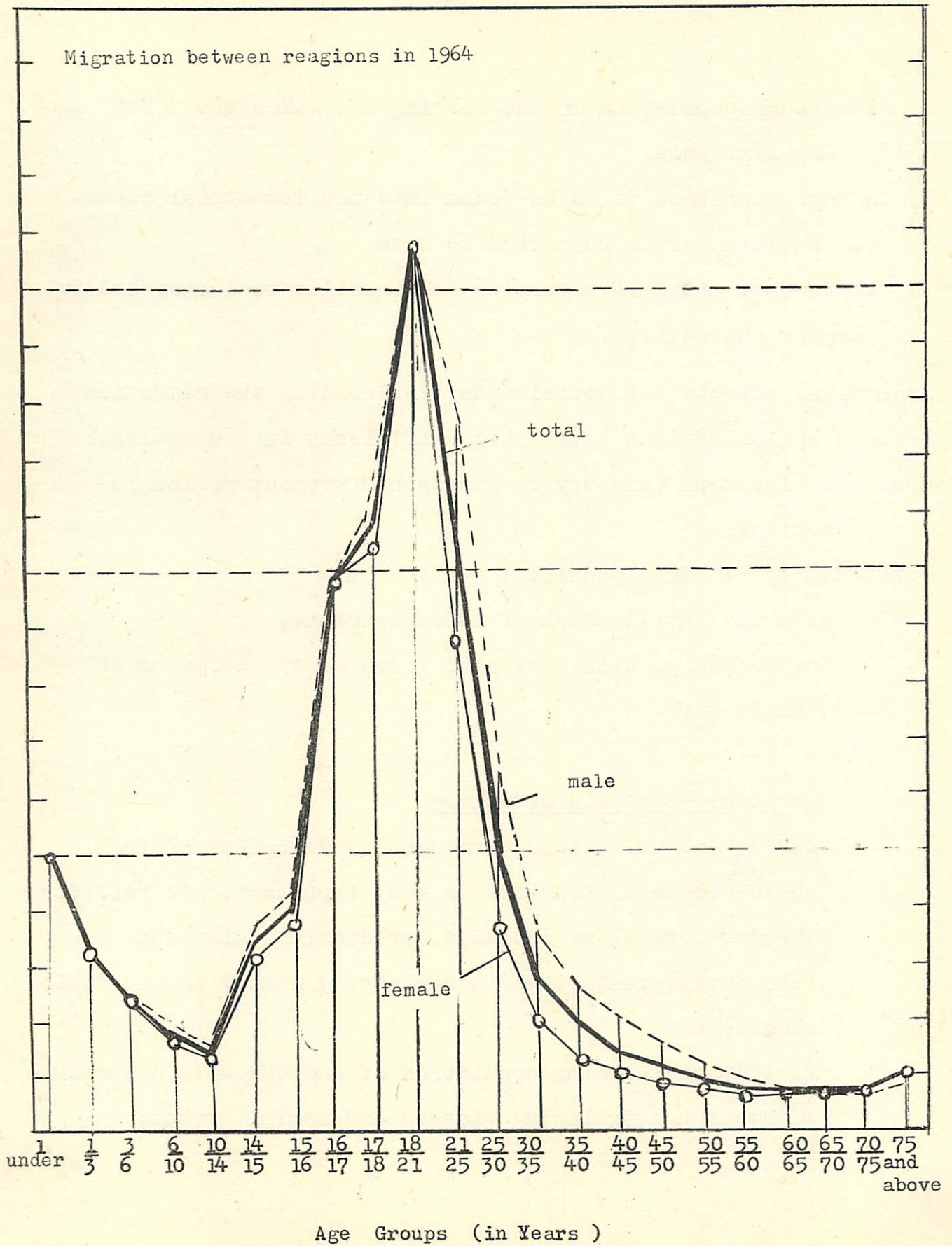


Fig. (3)

- a) The young population in the working age takes the first place.

See next page

- b) A high migration is to be found into new industrial plants and built-up areas connected to them.
- c) There is a trend of migration from smaller to larger and to largest communities.

Economical aspects are decisive for influencing the migration because agglomerations have a high efficiency in the national economy. A modern industry is impossible without regional concentrations.

Particularly it makes possible:

- a) an effective utilisation of infrastructure,
- b) a more effective utilisation of fixed assets by means of more shift work.

2.1.3. The Socio-Economic Structure

- During the transition period the development of the socio-economic structure is very important. It reflects the development of socialist production relations. This development stage is reflecting itself in the following data.

In 1966 the working population of the GDR were distributed among the following classes and social groups:

Working class	76.6	per cent
Farmers at co-operatives	10.9	"
Craftsmen at co-operatives	1.8	"
Professionals	6.6	"
Private craftsmen	2.3	"
Retailers (private)	0.8	"
Others	0.9	"

Table (6)

With further development firstly the number of private enterprises will decline gradually and this of semi-state enterprises but also co-operatives of craftsmen will grow up so that the number of persons employed in socialist sector will further increase. This development will be accompanied by important changes within the classes and social groups.

2.1.4. The Sectoral Structure

'In the early 1950s Fourastie¹⁾ succeeded in proving that the growing industrial development of a country is connected with a typical trend of the allocation of manpower on the sectors.

- I. agriculture and forestry
- II. industry
- III. services (all sectors ~~outside~~ outside I + II)

(1) A French expert

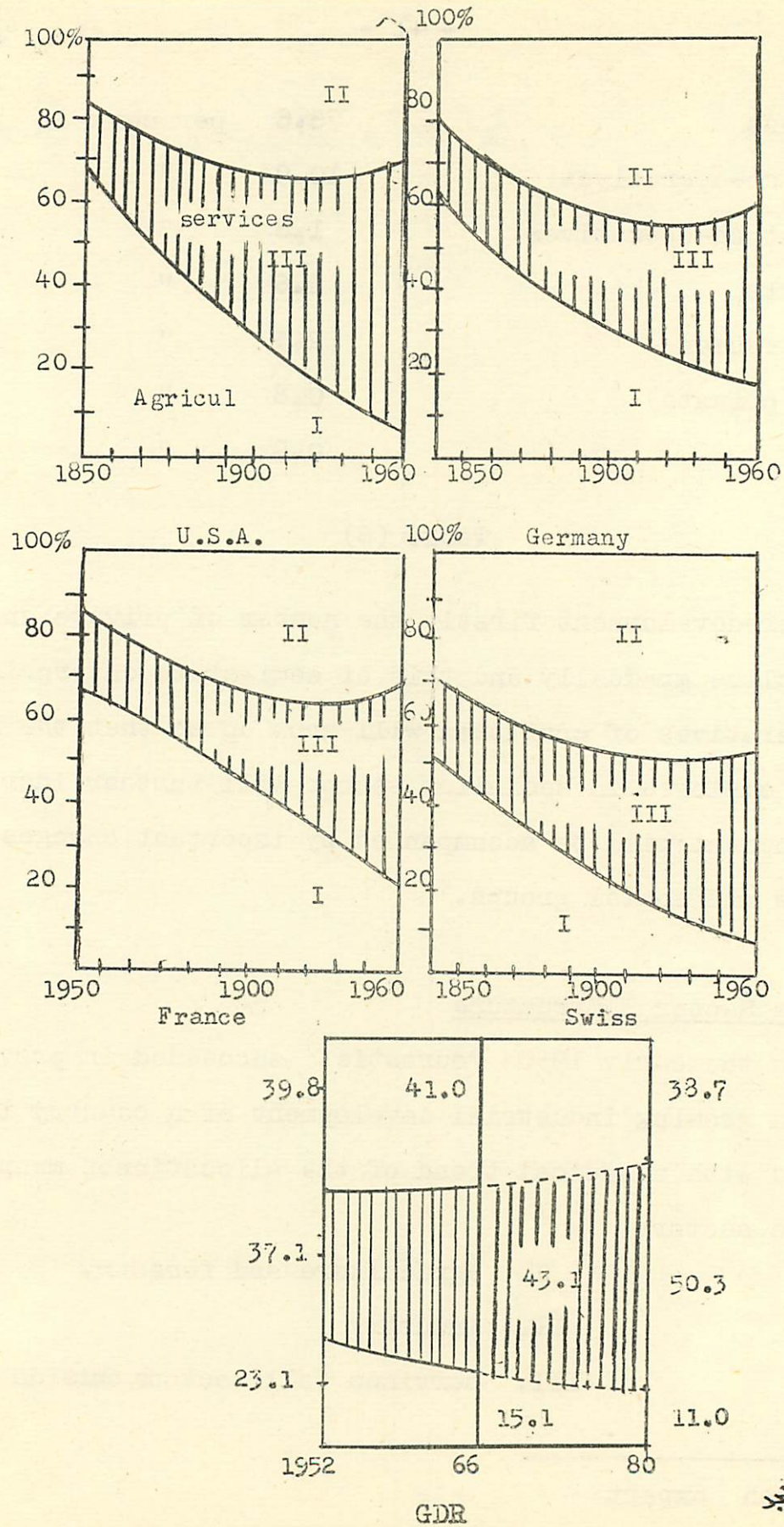


Fig. (4)

This classification gives initial points for the general estimation of the trend according to global sectors. For practical planning and international comparisons however it is necessary to have a further classification. The classification used in the most socialist countries is as follows:

a- manpower in the material production

Agriculture and forestry

Industry

Construction

Transport Communication

Trade

b- Manpower in branches outside the material production

Health sports

Education/arts/

Science/Research

Finances/credits/insurance

Administration

Others

- For many of this sectors there is a comparison of structural development of manpower from 1955 to 1964/65.

See Table on the next page

	Agriculture & Forestry		Industry		Construction		Transport & Comm.		Trade		Education/Culture & Social Sector	
	1	2	1	2	1	2	1	2	1	2	1	2
U.S.A.	12.2	6.2	29.8	27.6	6.2	6.4	7.0	4.8	18.5	23.0	22.1	27.7
Sweden	20.4	13.8	32.9	36.0	7.9	9.1	8.1	7.5	13.0	13.5	17.0	19.8
Japan	38.9	24.3	19.5	25.1	4.4	6.5	4.7	6.4	17.4	20.1	13.8	13.2
England	4.6	3.5	45.4	40.6	6.5	7.2	7.7	6.9	12.2	14.2	23.5	27.6
West Germany	16.9	11.6	39.2	41.6	8.2	8.1	5.6	5.8	13.7	14.2	16.1	18.6
G D R	22.4	16.0	39.8	40.0	5.5	5.0	6.9	6.0	10.9	11.0	14.5	18.0
Italy	33.9	25.4	27.3	30.0	8.3	10.8	4.0	5.2	12.7	14.1	13.8	14.5
CSSR	34.1	21.8	32.6	38.2	6.8	8.0	3.4	3.7	8.0	8.5	14.9	19.4
Hungary	54.5	32.1	19.4	31.0	1.9	5.9	4.0	6.3	5.3	7.5	14.9	17.2
UDSSR	43.0	34.0	31.0	34.0	-	-	6.0	8.0	5.0	6.0	15.0	18.0
Poland	56.6	47.1	18.8	23.3	4.2	5.7	3.8	4.8	5.2	5.3	11.6	13.8
Rumania	69.7	56.7	13.1	19.2	4.3	6.3	2.5	3.3	3.3	4.0	6.8	10.0

1 = 1955

2 = 1964/65.

Table (7)

This trend over 10 years shows:

- a) The percentage of employers working in agriculture decreased in all countries.
- b) The percentage of manpower in industry were growing in all countries excluding USA and UK. Several countries show nearly constant trends. It is to conclude that the turning point will be reached (GDR, West Germany)
- c) The percentage of manpower in construction is growing in most countries excluding GDR, Western Germany)
- d) The percentage of manpower in transport and communication is growing in most countries.
- e) The percentage of manpower in trade, in the educational system and in health is growing in all countries (excluding Japan). But it is to see that an employment rate in the trade in capitalist countries is too high which is not aimed at by socialist countries.

- According to the existing forecasts it is not estimated that this general trend continues in all sectors in the GDR. It is rather to suppose the following development:

= agriculture and forestry:	decrease of relative number of manpower
= industry	: decrease of relative number of manpower

= construction	:	increase of	relative number of manpower	
= transport/communication	:	decrease	"	"
= trade	:	"	"	"
= education/health/social	:			
welfare	:	increase	"	"

It can be supposed that the general trend will be realized with regard to manpower in the agriculture, industry, education and social welfare whereas in the other sectors certain oscillations will occur.

Particularly important is the structural distribution within the different sectors and above all within the industry. These changes arise from the structural policy of the state. So in the GDR industry the following development is expected:

increase in manpower in: electrical engineering and electronics
industry,
engineering,
chemistry

decrease of manpower in: mining, particularly coal mining,
light industry

There are many reasons of the sectoral structure development. Therefore a forecast has to begin with a complex investigation of these reasons. As reasons for the structural development between the branches and sectors come particularly into question:

Technical and economic { Technicians (A6)
schools. { Graduates from

{ these schools (A7)

Universities and Institutes.. Graduates from univer-
of the same level sities (A8)

Therefore the forecast of qualification structure is an
important basis for the planning of educational system.

c) The labour force is the most important productive force.

Its qualification with regard to the national total manpower
is an important criterion of the development level and of
the economic capacities of a country. Supposing that the
qualification development takes place according to the needs
of the scientific, technical and economic development of the
qualification level is an important parameter for estimating
the general level of productive forces.

The general trend is illustrating by the following figure:

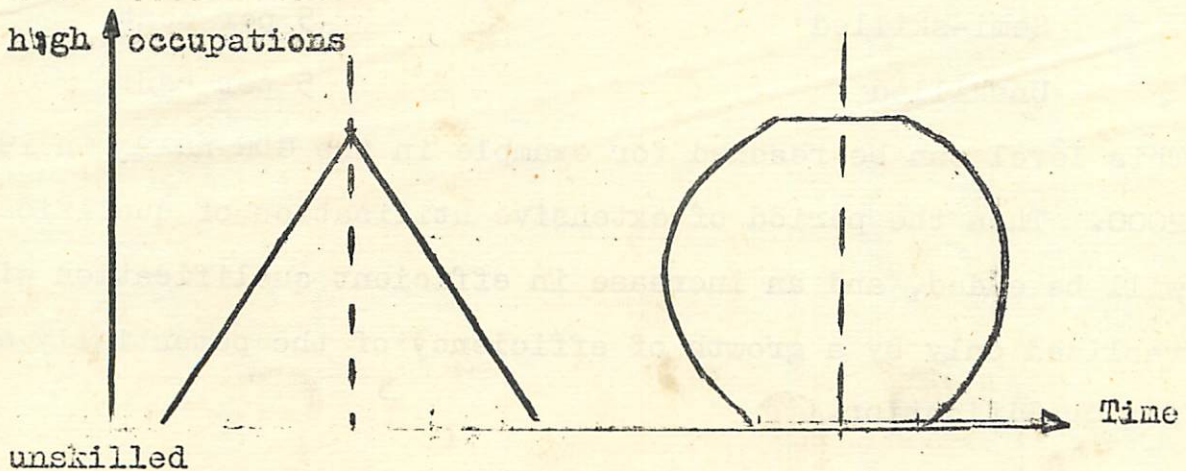


Fig (5)

It is to remark that over long periods:

- a) the educational content of particular stages and specialities changes;
- b) there are shifts in the level of the same stage (for example graduates of universities).

According to studies in socialist countries the given typical circle form will not be reached. We suppose that the limits of qualification structure development of a certain country depend upon the mental abilities of the labour force. There are different conceptions about the estimation of mental abilities. But their maximum may be as follows for the different occupational categories:

Graduates from universities	}	30 per cent
" from technical and		
economic schools		
Skilled workers technicians		60 per cent
Semi-skilled		5 per cent
Unskilled		5 per cent

This level can be reached for example in the GDR namely in 1990-2000. Then the period of extensive utilisation of qualification will be ended, and an increase in efficient qualification will be realized only by a growth of efficiency of the potentially existing qualification.

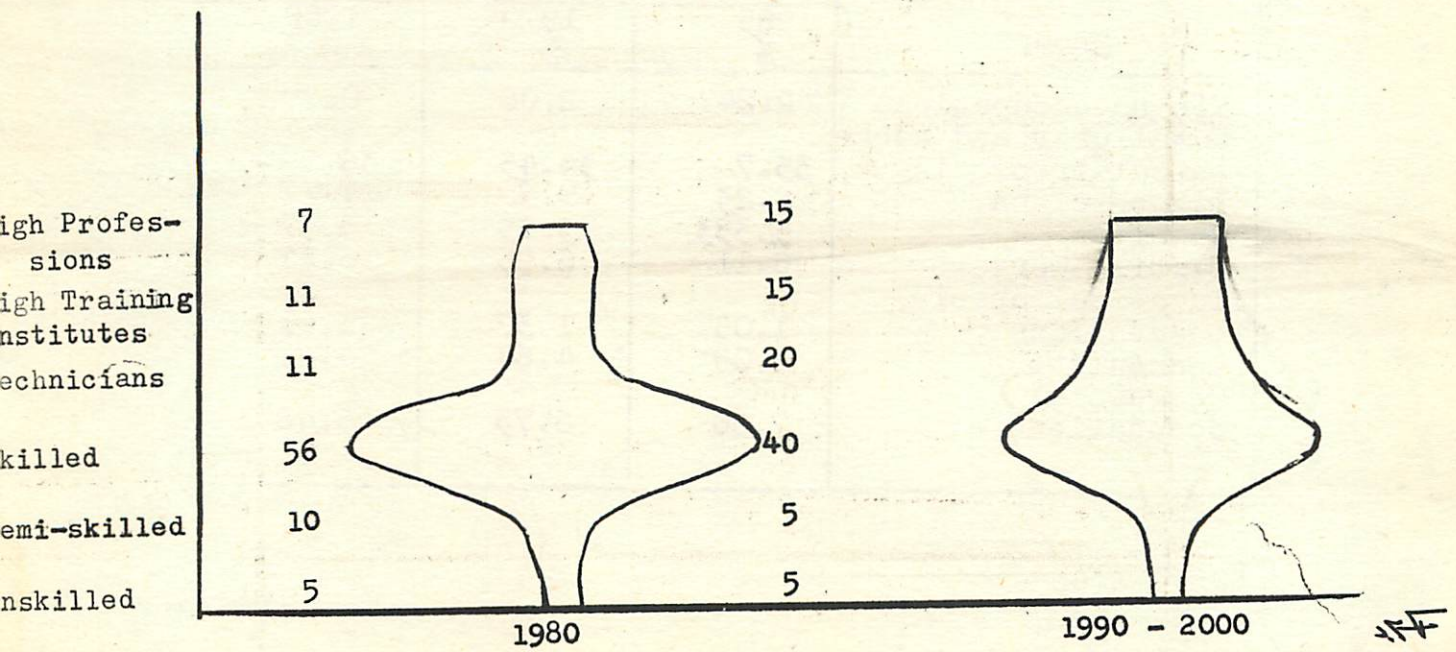
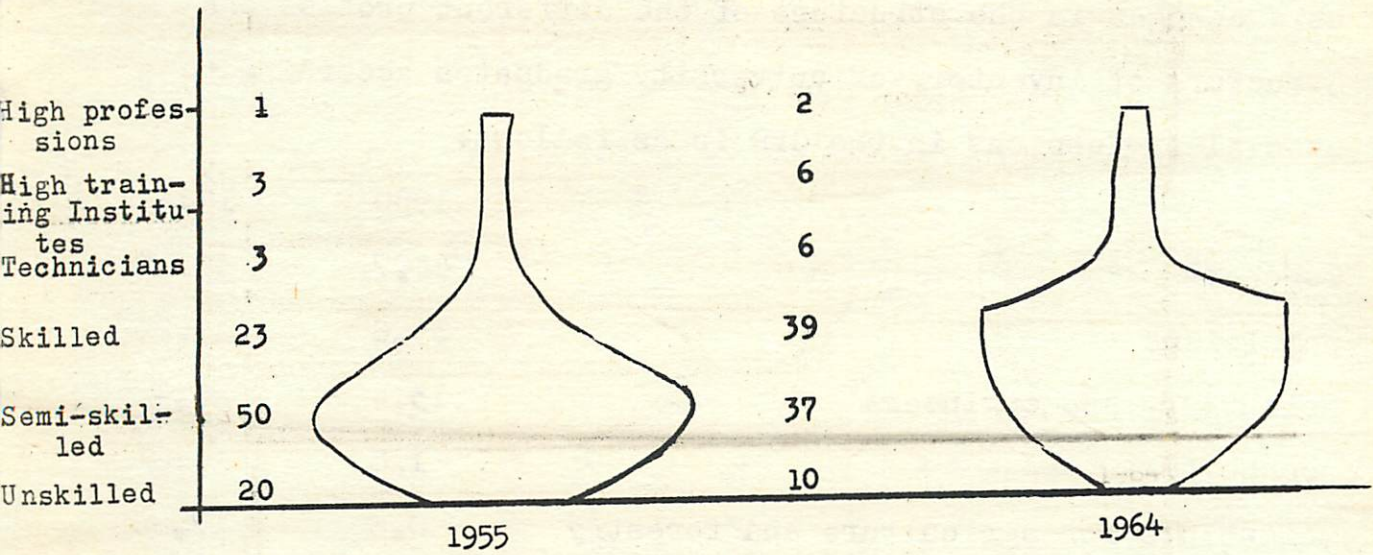


Fig. (6)

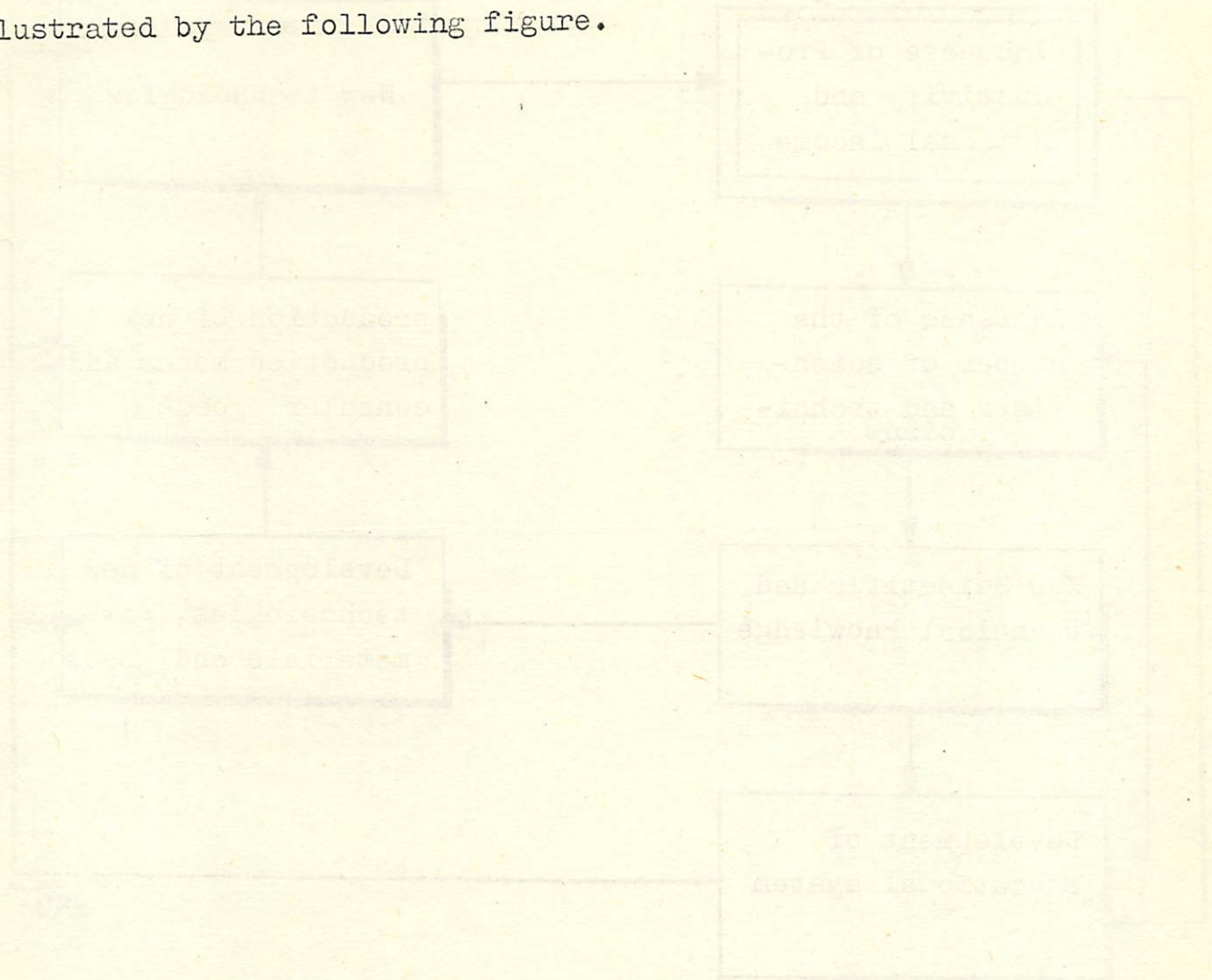
The increase in qualification is connected with partly considerable changes in the structure of the different professions. Structure of inventory of university graduates according to special professions in the GDR is as follows:

	1950	1964
Teachers	44.7	37.2%
physicians	35.6	13.2%
scientists and engineers	13.4	20.4%
economists	1.8	14.8%
scientists for agriculture and forestry	0.6	7.6%

Similarly the occupational structure of skilled worker changes as follows:

Occupational (trade) groups	share of total inventory of skilled worker		
	1965 %	1970 %	1980 %
Mining occupations	2.24	2.08	0.77
Metallurgy and mechanical processing	35.7	34.45	36.19
Electricians	8.23	9.1	9.72
Chemists	3.333	3.85	3.97
Textile workers	6.11	6.95	6.22
Technical special occupations	1.05	1.37	1.61
Mechanists	4.05	4.64	4.81
Commercial occupations	7.56	6.75	5.46

The increase of the qualification level depends on the development of other factors such as: scientific and technical progress, development of the educational system, increase of productivity and national income. The interrelations between these factors are illustrated by the following figure.



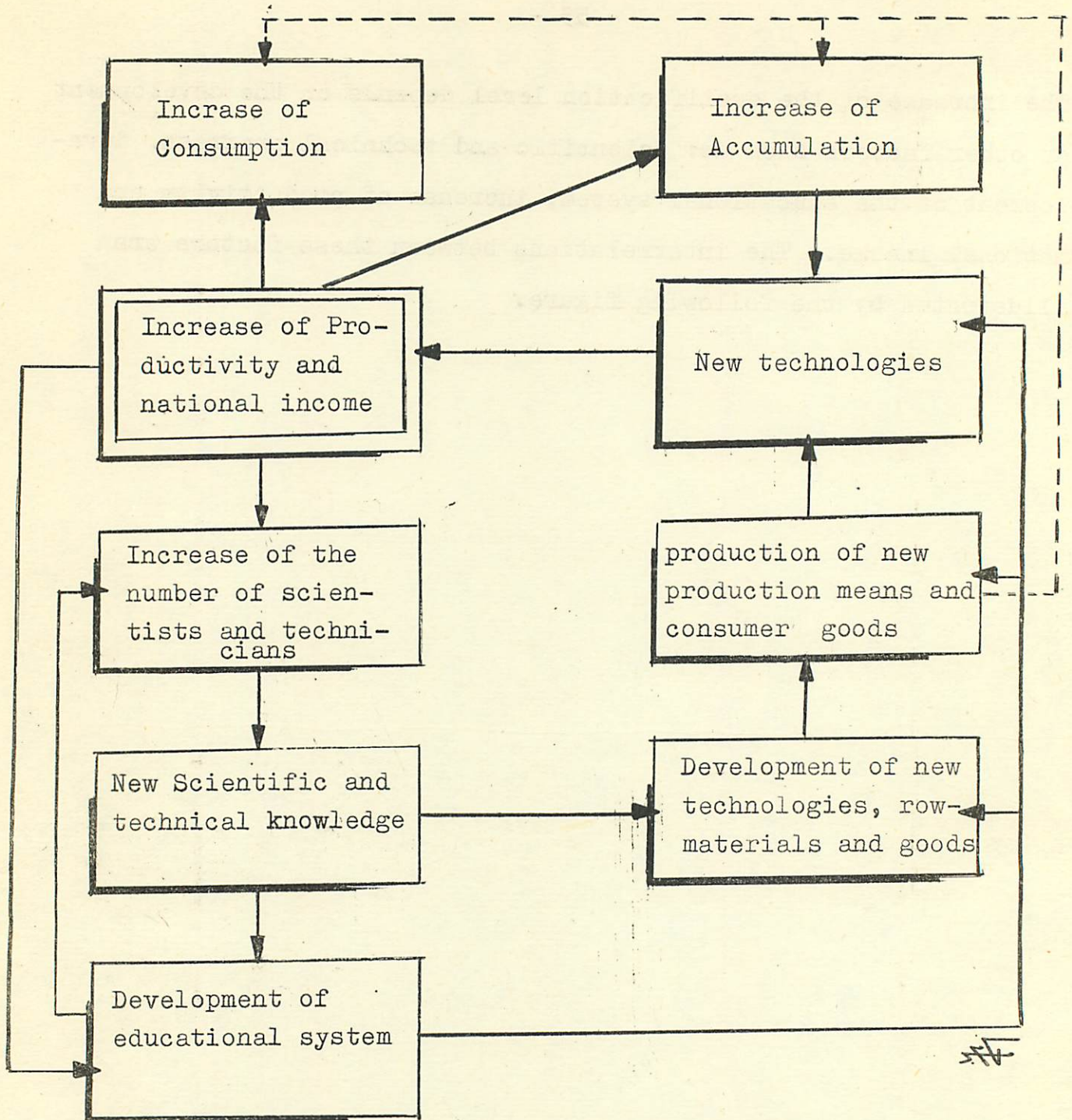


Fig. (7)

2.2. Planning system of National Total Manpower

2.2.1. Planning system

Planning of manpower development takes place in connection with the planning of educational system as a complex and iterative process. The planning system can be illustrated as on the following page.

The given figure illustrates that in the planning process there are complex relations. For planning we must have:

- a) a planning system;
- b) planning methods.

The manpower planning process is a joint work of the central, regional and enterprise organs.

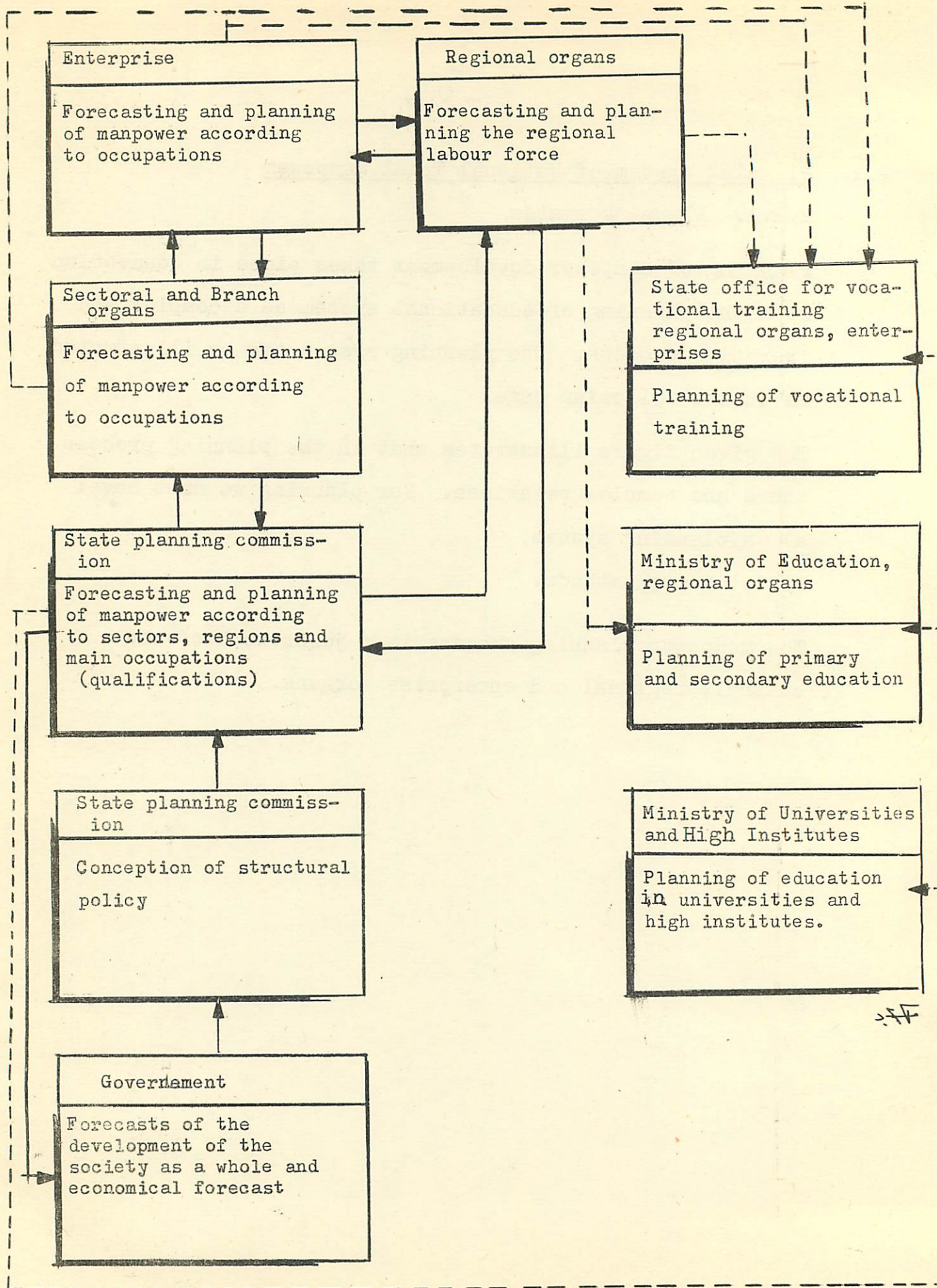


Fig.(8)

Manpower Planning Process ———→
Graduates Planning Process - - - - -→

The figure shows that during the planning process arise two problems, the solution of which is important for the success of planning:

- a) The relation between sectoral and regional structure of manpower. The demand develops according to sectors while its satisfaction is according to regions
- b) the relation between demand according to qualification levels and its satisfaction according to educational levels and the capacity of the educational systems. These 2 problems will be discussed in the following items.

2.2.2. Relation between sectoral and Regional Structure of Manpower

The national reproduction process is realized by a system of division of labour being characterized among others economical by branches and sectors. The system of division of labour is primarily determined technologically, lechnically and economically. The national reproduction process is realized by necessary relations between sectors (branches), and the particular elements of production processes become efficient by productive consumption. Subsequently an appropriate demand arises on manpower .

But the labour force, as the most important productive force is reproducing itself in the region. Therefore the origin of demand and its satisfaction (reproduction) do not coincide. Whereas with regard to objective production elements both categories are connected with the sector. The subjective element (the labour force) on the one side is connected with the sector on the other with the region. This is reflected on the one hand by the sectoral structure and on the other by the regional structure of labour force. With regard to the objective elements we have the supply-demand-matrix as relation between sectors (such as input-output-tables), in view of the labour force this matrix represents a sector ("demand")- and a region ("supply")-matrix.

The problem can be described as follows:

Z_k = number of Manpower in the sector k

Z_i = number of " in the region i

Z_{ki} = number of " of the sector k in the region i

Z = Total number of manpower (=NTM)

There is:

$$Z_k = \sum_{i=1}^n Z_{ki} \quad (n \text{ in the GDR}=15)$$

$$Z_i = \sum_{k=1}^m Z_{ki}$$

$$Z = \sum_{k=1}^m Z_k = \sum_{i=1}^n Z_i$$

If ΔZ is the increase in labour force then

$$\Delta Z = \sum_{k=1}^m \Delta Z_k = \sum_{i=1}^n \Delta Z_i$$

and due to the reproduction of the national total manpower in the region:

$$\Delta Z_k = \sum_{i=1}^n \Delta Z_{ki}$$

The increase in manpower of a region corresponds with the sum of increases in the particular regions with

$$\Delta Z_k \geq 0$$

From these relations we can give the following balance scheme:

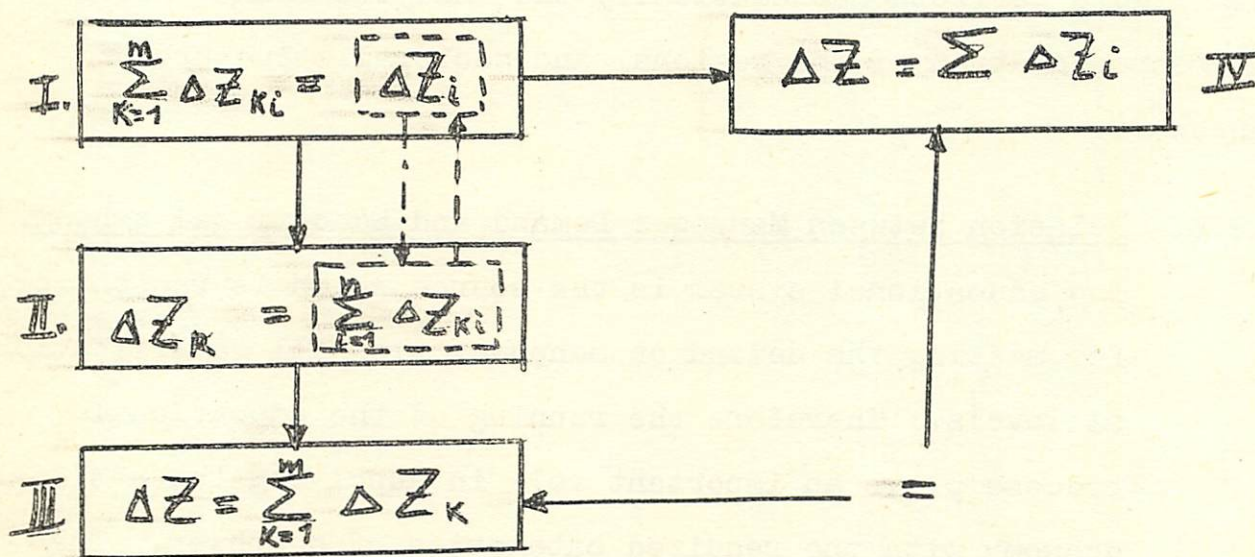


Fig. (9)

The regional allocation of economy has to conform with the regional resources

Migration is to be stimulated according to economic structure in concentration points.

It is clear from the above figure that:

- I. The total increase of all sectors in the region (i) corresponds with the manpower increase in this region.
- II. The increase of the sector (k) is dependent on the increase shares of manpower in the regions $(i) = 1, \dots, n$.
- III. ΔZ is the sum of increase shares of the sectors.
- IV. ΔZ " " " " " regions.

This figure reflects mathematically the analytical and forecasting representation of the regional and sectoral structure of manpower.

2.2.3. Relation between Manpower Demand and Educational system.

The educational system is the source which is responsible for meeting the demand on manpower with all qualification levels. Therefore the running of the educational process plays an important role in supplying the national economy with the required categories of manpower. The educational and training process is a long-term one and therefore:

- a) The forecasts of manpower development are connected with those of scientific and economic progress. As the educational system needs a certain time span there is a time lag between these forecasts.
- b) A plan of manpower development over 5 years can be secured only in a limited way by changes in the educational system. Even a forecast of 12-15 years is limited in its efficiency with regard to the educational system.

From the time lag between decisions for the educational system and the efficiency of these decisions in practice arise the following problems:

1. problem: The control of educational flow of a birth cohort has to be realized by backwards calculations from the higher educational levels to the lower ones.

See the diagram on the following page

Educational flow diagram of a Birth Cohort.

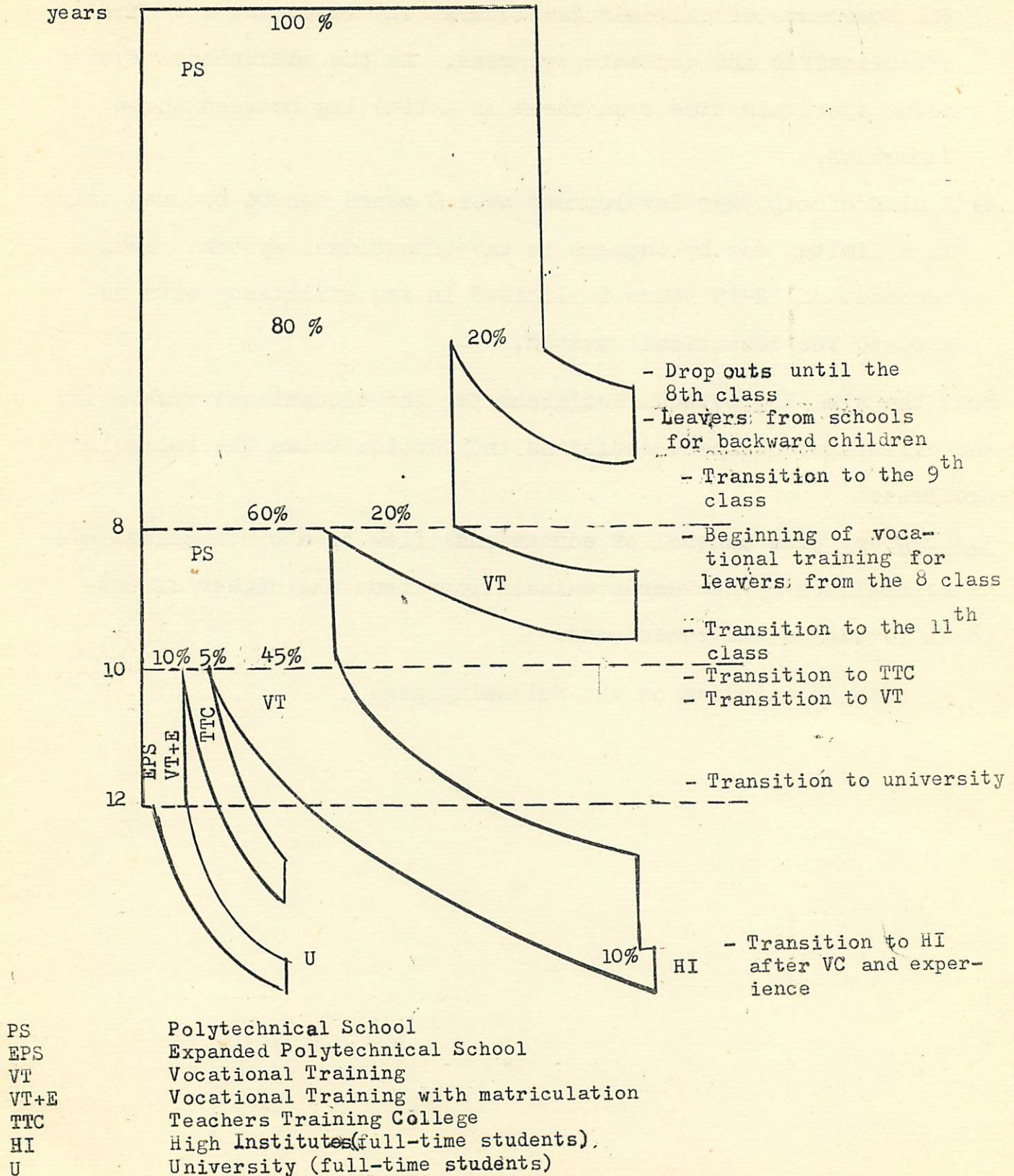


Fig. (10)

There is an objective framework limited extremely by the mental abilities. These limits however cannot be reached due to sociological factors.

Remark: The diagram contents the share of drop-outs only at the lowest level. For calculation of the graduates these shares have to be considered also on other levels.

2. problem: The members of the same birth cohort enter the labour force in stages at different times. It follows that we have to construct such a diagram for each stage.

3. problem: The time lag can differ from 1 to 20 years and is dependent on the effect of the decision on the educational system but also from the respective educational level. It follows that it is necessary to distinguish between the minimum and the maximum time lag:

maximum time lag: total period of education + time for preparation of necessary changes.

minimum time lag: education period of the last level + time for preparation of necessary changes.

The following table illustrates this problem:

qualification level	Time lag (years)	
	minimum	maximum
Skilled worker	2 + P	12 + P
Technical and economical Graduates from high Institutes	3 + P	15 + P
Graduates from university	4-5 + P	16-17 + P
p = preparation time		

- The coverage of the demand on qualified manpower is realized not only by graduates but also by training and qualification of working people. There are several possibilities:

- training within a qualification level without changing the speciality;
- training within a qualification level with change in speciality;
- training and/or education for a higher qualification level.

This leads to changes in the qualification and occupational structure of the national total manpower by itself. There are several possible transitions, for example:

Semi-skilled \longrightarrow Skilled
 Skilled \longrightarrow Technician \longrightarrow Engineer

The volume of these transitions is to be considered by manpower planning. The educational system is dependent on economic limits (number of schools, class-rooms, teachers, teaching means etc.). It follows that the outputs of particular educational levels are limited by:

- the demographic situation;
- the mental abilities and sociological factors;
- the capacity of educational system;
- Manpower demand of the national economy.

2.3. Experiments of Planning Models¹⁾

2.3.1. Construction of a statical Model for calculating Manpower Inventory according to structural Elements

Manpower planning on the national level includes complex calculations and balances at different levels.

There are different submodels according to which the planning takes place (such as on the enterprise level).

It comes into question whether a model can be built up which is applicable on the national level and permitting the calculation of variables relevant for the national economy. Principally this

1) This item is only for those who are specially concerned with mathematical models.

task should be solvable considering the following:

- a) such a model cannot replace the system of manpower planning but only completes and precises it.
- b) The central planning can take into consideration only variables relevant for national economy (development of employment, of employment rate, of graduates from universities, of the proportions according to educational level and occupations, of the migration etc.).
- c) The planning is a democratic process including the different levels from enterprise to the centre.

Today there is no complete and sufficiently exact planning model on the national level in contrast with the high developed educational models).

The following framework gives the principles of such a model:

I. National total manpower Z :

$$Z = f(\text{Population in the working age, degree of employment})$$

II. Regional manpower Z_i ($i = 1, \dots, n$):

$$Z_i = f_i (\text{Population in the working age, degree of employment})$$

III. Manpower of the sector Z_k ($k = 1 \dots m$):

Determinants (examples)

$$\begin{aligned} Z_{\text{industry}} &= f(\text{volume of production, productivity})^{1)} \\ &= x(\text{volume of production, factors of productivity,} \\ &\quad \text{degree of utilisation of production factors}) \end{aligned}$$

1) $f()$ means a functional relations
 $x()$ " " correlative "

$$Z_{\text{health-system}} = f(\text{Population, employees per unit of population})$$

$$= x(\text{population, Living-standard})$$

Structural relations (examples)

$$Z_{\text{Educational System}}: Z = k_1 \dots k_2$$

$$Z_{\text{health-system}} : \text{Population} = l_1 \dots l_2$$

IV. Manpower according to main occupational groups $Z_r (r=1\dots s)$

Determinants (example)

$$\begin{aligned} Z_{\text{research/development}} &= f(\text{Volume of Research work, productivity}) \\ &= x(\text{Assortment and degree of complication of production, Living-time of a good etc.}) \end{aligned}$$

Structural relations (example)

$$Z_{\text{research/development}} : Z_{\text{technological department}} = h_1 \dots h_2$$

V. Manpower according to the qualification groups $Z_q (q = \text{high professionals; unskilled})$

Determinants (example)

$$Z_{\text{High professionals}} = X(\text{Volume of production, productivity})$$

Structural relations (example)

$$Z_{\text{High professionals}} : Z_{\text{Technicians}} = j_1 \dots j_2$$

VI. Manpower according to a special occupational group Z_{qs}

(q = High professionals, graduates of high instituts, technicians, skilled workers; S = 1...u which indicates the different specialities) Determinants (example)

$$Z_{\text{engineers}} = x(\text{Volume of production, productivity})$$

Structural relations (example)

$$Z_{\text{scientists}} : Z_{\text{engineers}} = 0_1 \dots 0_2$$

VII. Summary:

$$1. \quad Z = \sum_{i=1}^n Z_i = \sum_{k=1}^m Z_k$$

$$2. \quad Z_{\text{material production}} = \sum_{r=1}^w Z_r$$

$$3. \quad Z = \sum_{q=1}^x Z_q$$

$$4. \quad Z = \sum_{k=1}^{u1} Z_{Q_1S} + \sum_{k=1}^{u2} Q_{2S} + \dots + Z_{Q_e}$$

Q_1 = number of high professionals

Q_2 = " " graduates from high institutes

\vdots

Q_e = " " unskilled workers.

The following considerations are the basic of this model:

The principle of the model is that both the total system and its important structural elements were given by their determining variables, or the structural elements are derived from the corresponding structural relations. The sum of the partial manpower calculations so evaluated will be confronted by the total variable Z calculated according to the equations of part VII. In the case of unequality it is necessary to carry out iterative calculations till we reach the state of equality.

The model shows by means of particular examples the dependence of the particular structural elements of the national total manpower on the respective determining variables. It is possible to build up an equation serving the calculation of the volume of the structural elements. But it is not useful and in several cases impossible to represent each structural element by an equation relating its determining variables. Inversely each model has to combine the determining variables and structural relations permitting the calculations with minimum expenditures. As a rule the structural relations are variable with time but this variation exists in a given interval ($k_1 \dots k_2$ etc.) This interval has limiting points where the existing values are approaching asymptotically the limit. For example the number of employees in the research development activities can increase only until

a given maximum related to the total number of employees since by exceeding this limit new products would not been fully realized by the production system.

2.3.2. Illustrative examples

In the following we shall give simple examples of the calculations of some structural elements or structural relations which are considered as submodels. In many cases it is sufficient to carry out such simple calculations without the necessity of constructing the whole model.

The first example illustrates a possibility for calculating the number of the required high professionals in a certain plan year by means of a regressional equation. Here the basis year was 1955 and the plan year was 1965. The following equation relates:

- 1) T : number of high professionals;
- 2) P : production volume;
- 3) p : productivity.

$$T = f(P, p)$$

Time series from 1928 till 1955 were used. Accordingly the equation has the following general form:

$$T = a_0 + a_1P + a_2P^2$$

By introducing the values of these time series we got:

$$T = 18 + 0.875p + 0.185 P$$

The given planning values relative of p and P in 1965 were 202 and 218 respectively (1955 = 100) and we obtained:

$$T_{1965} = 18 + 0.875 \times 202 + 0.185 \times 218 = 234.3$$

This means that the number of high professionals (T) had to be 234.3 % compared with 100% in 1955. The actual percentage was 230 in 1965.

The second example is concerned with structural relations.

Analysis of manpower structure in the metallic industry 1966 gave the following tables

Qualification - structure of production - workers in the metallic industry

Degree of mechanisation Qualification groups		T_1	T_2	T_3	T_4	T_5	$\sum_{j=1}^5 T_j$
Skilled	Q_1	22.1	11.5	13.5	5.1	3.3	55.5
Semi-skilled	Q_2	13.0	5.2	13.6	2.6	0.2	34.6
unskilled	Q_3	6.7	1.1	2.1	-	-	9.9
$\sum_{i=1}^3 Q_i$		41.8	17.8	29.2	7.7	3.5	100.0

Table - 9 -

- T_1 : work with simple tools.
 T_2 : work with mechanised tools.
 T_3 : work on mechanised machines.
 T_4 : work on half automatisised machines.
 T_5 : work on full " " .

Degree of machnisation		T_1	T_2	T_3	T_4	T_5	$\sum_{j=1}^5 T_j$
Activities							
casting, etc.	V_1	3,39	-	1,57	0,76	0,20	5,92
pressing, rolling, etc.	V_2	0,20	1,54	3,13	0,69	0,23	5,79
Cutting, etc.	V_3	-	0,60	16,73	4,39	2,32	24,04
Heating processes	V_4	0,17	-	0,65	0,21	0,10	1,13
Finishing processes	V_5	2,03	1,27	0,57	0,28	0,13	4,28
welding, etc.	V_6	-	1,88	2,40	0,72	-	5,00
Montage	V_7	15,70	7,14	0,36	-	-	32,20
Storing	V_8	2,20	0,40	-	-	-	2,60
Transportation	V_9	3,54	0,34	1,52	0,30	-	5,70
Repairs	V_{10}	6,53	3,30	0,47	-	-	10,30
Quality Tests	V_{11}	5,34	0,40	0,80	0,35	0,22	7,11
other activities	V_{12}	2,70	0,93	1,00	-	0,30	4,93
$\sum_{i=1}^{12} V_i$		41,80	17,80	29,20	7,70	3,50	100,00

Table(10)

For short-term planning it can be supposed that the given structures will be nearly constant. Thus when we estimate the development of the structural elements (v and T) we can calculate the corresponding qualification structure.