High-Level Manpower Planning: An Analysis of Czechoslovak Experience

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THE DEVELOPMENT of productive capacity, of institutions and of relationships within society is very closely connected with the improvement, in both numbers and quality, of the supply of high-level manpower—which is in turn influenced by a whole series of development trends.

The technology of production is evolving along scientific lines and the technical content of products is also altering. Old artisanal and empirically learnt methods of production and traditional products are giving way before new types of production which, to an ever-increasing extent, are scientific in nature. There are fast-expanding sectors and branches of industry that have sprung directly from the development of sciences such as chemistry, electro-technology, electronics, and the like, and even in traditional sectors production processes and the characteristics of products are changing. More and more frequently recourse is had to newly discovered properties of matter not directly perceptible to the senses and the use of natural forces of such magnitude and intensity as to be unmanageable without scientific knowledge.

The organisation of production processes is evolving both within individual undertakings and in society as a whole as a result of the steadily increasing division of labour.

Science is also being intensively applied in the services sector—in education services, in the health services and in public administration with its new tasks in the social and economic fields; all these call for large numbers of qualified workers.

Clearly, therefore, the long-term development trends of modern society place more and more emphasis on highly qualified specialists and give rise to a growing need for changed attitudes of mind paralleling

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the transition from empiricism to exact scientific knowledge. Higher qualifications are of paramount importance for economic growth, but are also dependent on it, for without it real qualification can neither be achieved nor find application.

It would be an over-simplification to infer from this that improvement of qualifications can be the prime mover of economic growth, regardless of material and social conditions. The development of society and the economy requires a whole range of material, institutional and social conditions of such close and complex interdependence that none can of itself form the basic motive force of development.

Education through the schools plays a special role in this process, for it is one of the channels for the transmission of society's accumulated experience and knowledge to the individual. Another such channel is the practice of learning through work. In the development of society the two are complementary and mutually enriching.

The rapid progress of science—which is becoming, as it were, a factor of production—the growing complexity of organisation, the evolution of society and the changing nature of work bring more and more to the fore the importance of theory, of theoretical training and of adaptability to innovation as against the more conservative empiricism.

Even here, however, it would be a mistake to over-simplify, for in every occupation, in every social situation the necessary balance between theory and practice in the training of new high-level manpower is bound to differ.

In addition to this function of preparing trained manpower, the educational system has a further function within society: it brings about a rise in the general educational level. Thus, it leads to an improvement in the quality of man as a citizen and as the ultimate goal of all social activity.

The educational background

The effectiveness of the education system in producing qualified workers depends on a series of factors, for example *(a)* on the needs of the given economy for different types and levels of skill and the opportunities it affords for making use of the education received; *(b)* on the quality of the educational process, i.e. the extent to which by its structure level and global orientation it meets the demands of national economic development, as well as the extent to which it fits the pattern of aptitudes of the population and tends to foster them; *(c)* on how effectively the most able young persons are selected for education and training and are guided towards suitable employment, and how efficient the process of social advancement is.

In Czechoslovakia both the economic and the cultural functions of the school system are strongly in evidence. The country entered on the period of edification of socialism with a relatively large industrial poten-

tial and has continued to develop since. At the present time around 46 per cent. of the economically active population are engaged in industry and construction, which is quite a high proportion. A substantial majority of them are working in large-scale industrial undertakings (in 1964 only 15.3 per cent. of industrial workers were in undertakings with less than 1,000 employees). This is due to the fact that the socialisation of industry in a fair number of sectors resulted in a shift from artisanal to industrial production accompanied by a process of concentration which is still far from being completed, slowed down as it is by the relative smallness of the domestic market.

A similar change-over to mass production is also under way in agriculture. A high proportion of the land is under the management of agricultural co-operatives (average area 592 hectares) and of state farms (average area 4,400 hectares). Marketing and other economic activities have also been concentrated in large undertakings. This naturally opens up possibilities for the application of scientific production methods, but leads to increased demand for highly trained manpower.

The demand is just as high in the services sector. For instance in 1964 there was one doctor for only 504 inhabitants, the total number of pupils and students in full-time education reached approximately 3.1 million (or 22 per cent. of the population), there were professional theatres with 88 stages in full-time operation, and so on. Between 1955 and 1964 the number of workers in the field of science and in research rose from 71,000 to 140,000 (that is, to 2.8 per cent. of the economically active population). This has naturally required a rapid growth in the volume of high-level manpower in all fields, as table I indicates.

TABLE I. GROWTH OF HIGH-LEVEL MANPOWER IN CZECHOSLOVAKIA, 1955 TO 1963

(In thousands)

Level of education	1955	1959	1960	1961	1962	1963
University graduates	103	149	157	163	172	181
Secondary technical school graduates	410	584	631	678	724	763

In 1963 for every 10,000 inhabitants there were 130 university graduates and 550 graduates of secondary technical schools. In 1964 there were 93,000 students enrolled in day courses in the university faculties, while a further 52,000 were following courses while employed. During the same period 306,000 students were enrolled in specialised technical colleges.

It would not be right, however, to pass over the other aspect—the general importance which education has for society. In Czechoslovakia

there is a very old tradition of academic education, which has of late developed still further. The Charles University of Prague, founded in 1348, was the first university in Central Europe. The Prague Technical University, founded over 250 years ago, is likewise one of the oldest of its kind in the world. The school system played an important role at the time of the Reformation, as witness the famous Czech pedagogue Comenius, and also during the period of national revival in the nineteenth century. In recent years the school system has been still further and purposefully developed as an important element in economic growth and in the education of socialist man.

For all these reasons from the very outset Czechoslovakia has faced up to the complex and exacting task of planning to meet the demand for highly trained manpower.

The plan for high-level manpower within the framework of national economic planning

The plan for high-level manpower is one of the components of the national economic plan. It is linked with the latter through a whole series of relationships in the material, financial and manpower fields, among which the following merit particular mention:

(1) The growth of the national economy and its rate and pattern determine the demand for trained manpower. In the productive sector this demand depends on the rate of expansion of production in the different branches and on the setting up of new undertakings. In services it depends on the growth requirements of society, but also on the financial resources that the State and the population are willing to provide for the expansion of the school system, the health services, cultural facilities and the like.

(2) In addition to these quantitative aspects of economic growth, the demand for high-level manpower is also influenced by scientific and technical developments within a given economy. It is just as strongly influenced, moreover, by production conditions, by conditions of ownership, by the capacity of institutions to adapt to change, and by conservative or progressive attitudes, which together compose the climate within which productive activities are carried on in the various forms of social organisation.

(3) The above-mentioned influences of development on the demand for high-level manpower are reflected indirectly in trends in the numbers and distribution of workers. The number of workers does not increase proportionally to output or to the volume of services provided because of the differential growth of labour productivity in different sectors. In this respect there is a marked contrast between the situation in the pro-

ductive sector, where there is a long-term trend towards reduction of the quantity of labour per unit of output, and that in services, where the tendency is rather to increase the quantity of labour per person served. Thus, for instance, the long-term trend is towards fewer pupils per teacher, fewer hospital beds per nurse, etc. Nor does mechanisation lead, as a rule, to a reduction in the numbers employed in services, but rather to extension of their coverage.

(4) Obviously, however, problems of labour structure cannot be examined without reference to labour force and population trends. It is therefore necessary to study how natural population movements, changes in the population structure by age and the consequent effects on the education and training of high-level manpower may affect the demand for skills.

(5) The training of high-level manpower, in addition to being linked with the demand for skills, is tied up with the national economic plan in another way as well. The capacity of the education system depends on the prospects of providing the necessary material facilities (schools, manuals, teaching aids, etc.), on the supply of qualified teachers, on the achievement of the required educational " pyramid " (i.e. the whole complex process from elementary school to university, ensuring that for each higher level there is an adequate choice of new entrants) and on the allocation of sufficient financial resources.

These basic factors must be examined when analysing the plan requirements for high-level manpower. In the process, allowance must be made for the fact that high-level manpower planning is essentially long-term planning. In order to plan the supply of university graduates a period of at least ten years is required. For five years of that period the supply can be determined on the basis of the numbers of students already enrolled at universities. For a further three years the supply is roughly determined by the number of students enrolled in secondary schools. Even a ten-year period supplies little information about the long-run trends in education, for example whether the stated requirements were only ephemeral or constitute a permanent trend, for it is difficult to define the " law " relating trends in the demand for and supply of high-level manpower.

Every forecast of demand for such manpower should therefore be accompanied at least by background studies of long-term development trends.

This need for a long-term perspective has a profound effect on the relationship between educational planning and other parts of the state plan. Over a period of more than ten years financial and material planning estimates lose much of their precision. Study of the reliability and variability of different indicators shows that—

(a) the most constantly reliable estimates are those regarding the over-all trends in the labour force, which are largely determined by population trends, particularly when a high level of employment is maintained;

(b) a fair degree of reliance can be placed on forecasts of the distribution of workers between the productive and service sectors, which can be deduced from long-term patterns of development [1];

(c) some regular pattern may also be inferred in the case of over-all trends in the main sectors such as industry, construction, agriculture, transport, education and health services, etc.;

(d) considerable variability is evident in forecasts concerning particular branches and sub-branches of industrial production, the establishment of new undertakings, direct effects of technical progress, technological change, etc., and also in forecasts concerning financial relations, etc.

This means that the actual plan to meet demand for high-level manpower must be prepared with due consideration for possible changes in estimates, that the influence of various alternative developments must be studied and that the " areas of forecasting risk " of different variants of the plan must be examined.

Methodology of high-level manpower planning in Czechoslovakia

In Czechoslovakia the high-level manpower plan is part of the whole system of economic planning. Requirements are therefore analysed under long-term plans (extending over ten to 15 years), five-year plans and current operational plans in which, in addition to the needs for the coming year, the needs for subsequent years are also detailed.

As a basis for this system of plans, on the one hand surveys are made of the present situation and trends as regards the number and distribution of high-level manpower, and on the other hand special studies are made of future requirements, namely—

(a) complex long-term studies covering the whole national economy;

(b) studies by sector and branch;

(c) studies of such special questions as the influence of technical progress on the composition of high-level manpower, optimal staffing of model undertakings, etc.

[1] In this connection see W. GALENSON: " Economic development and the sectoral expansion of employment ", in *International Labour Review*, Vol. LXXXVII, No. 6, June 1963, pp. 505-519. The author concludes that the growth of the number of workers in services (E_t) varies as the growth of number of workers in industry (E_m) or the growth of industrial production (P_m) according to the following formula: in developing countries $E_t = 1.083 + 0.581E_m$; in advanced industrial countries $E_t = 0.795 + 0.689E_m$, $P_m = 1.004 + 0.244E_t$.

This system in its entirety cannot be fully described here. It may therefore be useful to concentrate on some basic types of study in order to illustrate the methods applied.

Complex studies of demand up to 1980

In 1962, in connection with the preparation of long-term forecasts, a study was made of trends in the demand for high-level manpower until 1980.

This study took as its point of departure the forecasts included in the other sections of the national economic plan, i.e. the analysis of the growth of production, manpower balances, etc.[1]

The first of the analyses proper of the demand for high-level manpower involved forecasting the growth of the economically active population by broad sectors. The results are shown in table II.

TABLE II. ECONOMICALLY ACTIVE POPULATION BY BROAD SECTORS OF THE ECONOMY, 1960 AND 1980

Sector	Number (in thousands)		Index (1980/1960)
	1960	1980	
All sectors (including agriculture)	**5 961**	**7 040**	**118.1**
of which:			
Industry	2 040	2 707	132.7
Construction	425	479	112.7
Agriculture	1 704	1 018	59.7
Education and culture	248	450	181.9
Health services	183	362	197.8

These forecasts are the result of extensive work on a long-term plan in which it was necessary to complete the following steps:

(1) To elaborate a concept of production trends in different sectors and check it as regards *(a)* concordance of material proportions through the system of material balances under which the demand for various commodities and the resources needed to produce them are determined, *(b)* the required magnitude and distribution of investment needed to create new productive capacity, *(c)* manpower resources, and *(d)* financial implications.

[1] The methodological problems in these fields cannot be examined in this article. We refer, however, for example to the article by János TIMÁR: " Long-term planning of employment in the Hungarian People's Republic ", in *International Labour Review*, Vol. LXXXIX, No. 2, Feb. 1964, pp. 103-124.

(2) To forecast the growth of labour productivity resulting from improved techniques, the organisation of production and the production process, improvement of the skills and initiative of workers, etc. For this purpose, macro-economic methods are used, i.e. analyses of the relation of labour productivity growth with such indices as level of equipment of workers with fixed capital, electrical power, etc., and detailed analyses of the various factors of growth of labour productivity. As reserves of manpower are exhausted it is necessary to reckon with the fact that the growth of labour productivity will play an ever-increasing part in the growth of production.

(3) To calculate, on the basis of the rate of growth of production and labour productivity, the anticipated increase in numbers of workers (growth of production divided by growth of labour productivity).

(4) To work out a concept of expansion of the service sector, taking account of population growth and of the goal of raising the health and cultural level of the population, as well as the share of national income that can be allotted to services.

(5) To analyse the required growth of numbers of workers in services.

(6) To check the consistency of the over-all programme in the light of the whole system of plan balances of the national economy, from the point of view *(a)* of the formation and distribution of the material product [1] and of the national income, *(b)* of the balances of the most important materials, *(c)* of labour force balances, and *(d)* of the most important financial balances.

The result of these studies must be checked, moreover, against long-term trends in the structure of the labour force. Some of the regular patterns of this evolution stem from shifts in the structure of the population's requirements from essential to less-essential goods and services as well as from the pattern of growth of labour productivity and the division of labour, and are therefore inexorable trends. Others stem from the social conditions of production and services. At the same time, particularly in regard to services, there is some tendency towards excessive growth, e.g. in certain commercial activities, in administration, etc. (In the socialist countries this has given rise to widespread discussion of the pattern of growth of the productive and non-productive sectors; in the non-productive sector, there are different trends in the various branches, so that certain services must be systematically stimulated while others —for example public administration—must be held back.)

The trends envisaged in Czechoslovakia up to 1980 are characteristic of long-term development trends observed in advanced countries as a whole.

[1] For a definition of this term see United Nations: *Yearbook of National Accounts Statistics, 1965* (New York, 1966), general note, p. 86.

In general, development in different countries can be expressed by the figures in table III, which shows the percentage distribution of the economically active population by sectors at different stages of the industrialisation process.

TABLE III. TYPICAL PERCENTAGE DISTRIBUTION OF ECONOMICALLY ACTIVE POPULATION BY SECTOR AT VARIOUS STAGES OF INDUSTRIALISATION

Sector	Initial phase of industrialisation	Industrialisation process	Scientific and technological revolution
Agriculture	70-60	45-25	20-3
Mining and quarrying	2-3	3-5	4-2
Manufacturing	10-12	25-35	30-25
Construction	2-3	5-7	8-10
Transport	2-3	4-6	8-6
Commerce	7-8	9-10	11-16
Services	8-12	10-14	20-35

Source: Based on a study by T. FREJKA of the Economic Institute of the Czechoslovak Academy of Sciences.

The evolution of labour force distribution by sector in itself provides very valuable information for high-level manpower planning for the following reasons:

(1) The different sectors have quite a distinct labour force structure as regards the ratio of non-manual [1] to manual workers. In the productive sector the proportion of non-manual workers varies from 10 to 30 per cent. according to the nature of the branch. In some branches of the non-productive sector, particularly education and health, it reaches 70 to 75 per cent. Moreover, non-manual workers in these sectors form a substantial proportion of all high-level manpower.

(2) In the non-productive sector the educational requirements are often very definitely established, e.g. for doctors, teachers, lawyers, civil servants, etc. The numbers of these specialists can thus be planned with comparative precision as a function of the growth of the corresponding institutions.

In contrast, the rise in the proportion of high-level manpower in the productive sector is complicated by reason of the penetration of science into production, and requires special study.

In this evaluation it is again necessary to proceed differently in the productive and non-productive sectors. In science, research, the health

[1] The category " non-manual workers " includes technico-economic workers in the productive sector (see below) and other non-manual workers in the non-productive sector, such as teachers, doctors, lawyers, actors, nurses and so forth.

services, the law, finance and insurance, the civil service, etc., the proportion of non-manual workers is on the whole constant, in some cases it is even necessary to reckon with an increase in the number of auxiliary workers per non-manual worker.

In the productive sector, on the other hand, there is a long-term rise in the proportion of non-manual workers, and this has to be analysed in the light of long-term development trends and on the basis of concrete analyses, the study of reorganisation programmes in selected undertakings, etc. An effective method is also to analyse trends in the demand for such workers in individual typical activities (e.g. management personnel dealing with production, maintenance, inspection, records, planning, supplies, sales, wages and personnel, design, technology, etc.). In this connection account must be taken of the fact that labour productivity in production work is estimated to have increased about fifteen-fold in the last century, whereas it has only doubled in administrative work. This ratio is likely to change markedly in the future with the introduction of more sophisticated data-processing techniques. Even though a certain increase in the proportion of non-manual workers is a necessary consequence of technical progress and better organisation of production, it is sometimes inflated through an excessive growth of paper work, which must be resisted.

The next step is therefore to estimate future trends as regards numbers of non-manual workers by sector. The results of these estimates for Czechoslovakia are given in table IV.

TABLE IV. ESTIMATED TRENDS IN NUMBERS OF NON-MANUAL WORKERS BY SECTOR, 1960 AND 1980

Sector	Number (in thousands)		Index of non-manual workers (1980/1960)	Index of total workers (1980/1960) [1]
	1960	1980		
All sectors (including agriculture)	**1 336**	**2 346**	**174.9**	**118.1**
of which:				
Industry	380	616	162.2	132.7
Construction	81	100	162.2	112.7
Agriculture	125	287	229.5	59.7
Education and culture	182	340	187.6	181.9
Health services	126	256	198.2	197.8

[1] From table II.

The table shows that the number of non-manual workers grows more than four times faster than the total number of workers, both because of the increase in the relative share of services and because of the increased influence of science and technology in production, which is

reflected in a marked growth of the proportion of non-manual workers, particularly in agriculture.

This increase of non-manual workers is to be observed in all advanced countries. Indeed, it has not even been halted by the advent of mechanisation and automation of some types of non-manual work, and it must therefore be taken into account as a definite long-term trend.

The above data are, of course, based on detailed trend analyses of each sector. For example the anticipated trend in manufacturing is shown in table V.

TABLE V. PERCENTAGE AND INDEX OF GROWTH OF TECHNICO-ECONOMIC WORKERS IN MANUFACTURING, BY BRANCH, 1960 AND 1980

Branch of manufacturing	Technico-economic workers [1] as a percentage of all workers in the branch		Index of growth (1980/1960)
	1960	1980	
All branches	**18.6**	**22.9**	**163.7**
Fuel	11.6	12.4	132.9
Power	25.9	26.5	152.1
Metallurgy and extraction of ores	17.3	23.6	186.0
Chemicals	17.5	20.9	220.7
Heavy engineering	26.3	32.2	205.6
Other engineering	23.1	28.2	165.2
Building materials	17.2	21.5	130.2
Consumer goods	12.0	14.5	145.6
Food processing	22.9	24.6	103.3

[1] The category of " technico-economic " workers includes the whole engineering and technical staff, and administrative officials.

From table V it will be seen that the fastest proportionate increase of non-manual workers is foreseen in the chemical and mining industries (as a result of technical evolution and automation of production processes) and in heavy engineering (as a result of the growing requirements of work preparation).

Trends in the microstructure of the labour force

A further important step in the planning process is to calculate changes in the distribution of non-manual workers by level of skill.

As explained above, it is comparatively easy to plan the development of the labour force in the non-productive sector, where the basic relationships are clearly established by laws and regulations and by largely reliable long-term trends.

For example for teaching the following analyses have to be made:

(1) Number of young persons in school, which can be deduced from the number of children of school age and the duration of compulsory schooling, and number of young persons who have to be prepared for skilled work (account being taken of trends in the duration and forms of study, " drop-outs ", etc.). Further, it is indispensable to take into consideration also what is the optimal development of the educational " pyramid ", so as to ensure that universities and technical colleges have a sufficient choice of suitable entrants from the lower levels and that school leavers are not steered into " blind-alley " courses of education.

(2) Number of classes, based on the number of pupils per class as determined by long-term pedagogical trends towards reduction in the size of classes, the structure of the school system and the extension of the network of schools as a result of changes in the residential distribution of the population.

(3) Number of teachers per class in relation to the development of teaching programmes and teacher loads (in universities and other schools not organised in compact classes it is useful to study directly the evolving pattern of teacher/student ratios).

(4) In more detailed studies designed to show the demand for teachers by level and type of training, it is necessary to analyse further the evolution of the qualifications required by teachers in different types of school and also the structure of the teaching programmes, etc.

In health services the keystone of the whole system is the doctor, and thus attention must be concentrated on planning so as to have the required number of doctors. To do so, one can start either with analysis of long-term trends or with comparison with other countries.

For example in Czechoslovakia the number of inhabitants per doctor fell from 1,158 in 1948 to 504 in 1964, which ranks well by international standards. For the future it is, however, necessary to reckon with further expansion of health services and to study the optimal coverage in connection with the population's rising standard of living.

The studies and analyses that have to be undertaken in the productive sector are more difficult, for the trends in the structure of high-level manpower in this sector are more complex.

The 1962 study referred to above, reckoned with the basic changes in the distribution by skill of high-level manpower in industry shown in table VI.

As table VI shows, the swiftest increase was forecast among university graduates, who are expected to make up more than one-quarter of industry's technico-economic staff in 1980.

TABLE VI. ESTIMATED CHANGES IN THE DISTRIBUTION BY LEVEL OF EDUCATION OF HIGH-LEVEL MANPOWER IN INDUSTRY, 1960 TO 1980

Level of education [1]	1960		1980		Index (1980/1960)
	Number (in thousands)	Percentage of total	Number (in thousands)	Percentage of total	
All technico-economic workers	**376.4**	**100.0**	**616.0**	**100.0**	**163.7**
of whom:					
University graduates . . .	25.0	6.6	162.3	26.3	649.2
Secondary technical school graduates	81.4	21.6	341.6	55.4	419.7
Lower technical school graduates	100.9	26.8	100.3	16.3	99.4

[1] In Czechoslovakia technical training takes place at three levels. The lowest level is provided by two- or three-year lower technical schools, which prepare lower administrative staff and also production foremen (pupils being accepted, however, only after completing their apprenticeship in their branch), etc.; at the medium level there are four-to-five-year secondary technical schools, which prepare specialists of medium qualifications; and, finally, the universities give four to six years of high-level training. In addition they provide postgraduate scientific training.

At the same time differences of structure are obviously to be expected in different branches. This is illustrated by the figures in table VII; the differences they show are determined by the nature of production, the results of penetration of science into production and the varying organisation of undertakings.

These analyses were based on the study of work groups in various branches; they were then compared, co-ordinated and evaluated by international comparison. In spite of this it is impossible to say that the resulting distribution exactly indicates the demand indispensable for technical development. In this matter the fact that training high-level manpower is very costly must be weighed against the undesirability of hampering technical development by insufficient provision for training.

Very special attention was therefore given to a more exact elaboration of the influence of technical development on the structure of qualifications. These questions were carefully explored in particular by the State Commission on Technology and, under its guidance, working groups have undertaken analyses of the influence of technical development on high-level skills. The changing pattern of staffing has been analysed by various methods including: (1) Study of model undertakings, i.e. analyses of the staffing of recently planned undertakings where work is to be so organised as to use technological advances to the full. From the findings some norms for staffing requirements were deduced (normative methods). (2) Extrapolation of past development in correlation with growth of production and labour productivity. (3) International comparison.

TABLE VII. HIGH-LEVEL MANPOWER, BY LEVEL OF EDUCATION, AS A PERCENTAGE OF ALL TECHNICO-ECONOMIC WORKERS IN DIFFERENT BRANCHES OF MANUFACTURING, 1980

Branch of manufacturing	University graduates	Secondary technical school graduates	Lower technical school graduates
All manufacturing	**26.3**	**55.4**	**16.3**
of which:			
Fuel and power	30	50	10
Metallurgy and extraction of ores	25	55	15
Chemicals	40	50	10
Heavy engineering	30	55	15
Other engineering	28	55	17
Building materials	25	60	15
Consumer goods	15	60	25
Food processing	16	55	18

The first part of this task was completed in 1966 with the results shown in table VIII.

TABLE VIII. PERSONNEL WITH HIGHER TECHNICAL QUALIFICATIONS AS A PERCENTAGE OF ALL NON-MANUAL WORKERS IN SELECTED INDUSTRIES, 1964-65 AND 1980

Industry	Actual (1964-65)		Forecast (1980)	
	University	Secondary technical schools	University	Secondary technical schools
Mining	13.1	36.4	18.6	48.5
Metallurgy	10.4	38.5	17.2	55.7
Chemicals	14.9	31.8	29.7	44.6
Building materials	7.2	32.1	18.0	52.0
Consumer goods	6.5	44.4	11.3	55.8
Food processing	12.4	45.5	21.7	51.9
Construction	10.6	33.7	20.0	56.0

The results of analysis of so-called model undertakings are illustrated by the figures in table IX for the food-processing industry.

Compared with earlier estimates, the results of these studies provide more sober forecasts of the demand for university graduates in 1980, which are to a great extent drawn from a re-evaluation of development in the field of production, investment, etc., as well as from actual experience regarding the speed of technological improvements and the utilisation of specialised staff in production.

TABLE IX. SHARE OF TECHNICO-ECONOMIC WORKERS AND THEIR DISTRIBUTION BY LEVEL OF EDUCATION IN ALL UNDERTAKINGS AND IN MODEL UNDERTAKINGS IN FOOD PROCESSING, 1963 AND 1980

Category	All undertakings		Model undertakings
	1963	1980	1980
(All workers = 100)			
Manual workers	73.9	73.2	75.2
Technico-economic workers	17.3	21.5	19.5
(Technico-economic workers = 100)			
University graduates	5.3	21.3	30.2
Secondary technical school graduates	23.7	51.1	51.4
Lower technical school graduates	27.1	26.1	17.5

Source: Based on data supplied by S. RUFERT in the compendium *Pracovní síly v ČSSR* (Labour force in Czechoslovakia) published by the Prague School of Economics in 1966.

Admittedly the methods hitherto applied reflect only to a limited extent the specific nature of technical progress, which at times advances by leaps and bounds. These bounds forward are reflected to a varying degree in the structure of high-level manpower. More considerable changes occur on the introduction of advanced automation, when not only do particular job functions disappear (most typically when work with simple tools is abandoned) but also the workers lose that immediate control over the production process, its preparation and direct supervision which they still exert even in mechanised processes. On the other hand, such advanced automation creates the need for specialised technical preparation of work, complex supervision and for more fitters, maintenance men, electromechanics, etc.

In assessing the influence of these changes on the staffing pattern in different workshops (so-called "microanalysis") it is necessary to work from various levels. For one thing, a study has to be made of changes in the functions of man as a producer and in the structure of production itself, as well as in the resultant organisation required in different types of process. For this purpose the State Commission on Technology, in co-operation with the Economic Institute of the Czechoslovak Academy of Sciences, has worked out a descriptive classification of human production functions (executive, managerial, preparatory and supervisory), and a classification of technical progress into 11 levels, ranging from manual work with simple tools and then with power-driven tools, through various degrees of mechanisation (universal and semi-automatic machines) up to the levels of complex mechanisation and automation.

Table X was compiled on the basis of an analysis by this method.

TABLE X. TYPICAL PERCENTAGE DISTRIBUTION OF THE LABOUR FORCE BY SKILL LEVEL AT THE VARIOUS STAGES OF TECHNICAL DEVELOPMENT

Skill level	Stages of technical development [1]								
	3	4	5	6	7	8	9	10	11
Without qualification	15	7	—	—	—	—	—	—	—
Trained on the job	20	65	57	38	11	3	—	—	—
Qualified (apprenticeship served) .	60	20	33	45	60	55	40	21	—
With complete secondary education	4	6.5	8	12.5	21	30	40	50	60
University graduates	1	1.5	2	4	7	10	17	25	34
With higher degrees	—	—	—	0.5	1	2	3	4	6

Source: Jan AUERHAN: *Technika, kvalifikace vzdelaní* (Technology, skill, education) (Prague, Nakladatelství politicke literatury, 1965).

[1] The various stages of technical development are characterised by the following equipment: (3) universal machine tools; (4) semi-automatic tools; (5) mechanised production-line; (6) automatic machines and automatic transfer assembly-line; (7) automatic equipment with automatic feed-back control; (8)-(11) further prospective types of more advanced automation linked with automatic optimalisation of activity, automatic reactions to market requirements, etc.

On the basis of the ratios arrived at in this manner an attempt was also made, in the light of the expected rate of technical progress, to estimate the required composition of the labour force by skill level, and the results are interesting if compared with those obtained by other methods. It must, however, be kept in mind that as automation progresses in a given branch the number of workers employed in it is reduced at the outset (e.g. the output of the branch may represent 20 per cent. of the total but require only 4 per cent. of total labour force) and thus the incidence of automation on the pattern of the labour force as a whole is attenuated.

Other methods may also be used to evaluate the required composition of the labour force. In Czechoslovakia the wage and salary regulations prescribe what education and experience are required for access to a given post or wage category. For the purpose a model nomenclature, as well as nomenclatures specifically adapted to different branches, have been established. In these regulations the requirements regarding education and experience are usually defined within a certain range. For instance, in respect of a given post, requirements may be stated to be either university-level education and five years of experience, or secondary technical school and 15 years of experience. An analysis of the structure of work posts according to these higher or lower educational requirements represents an important source of information concerning the present state as well as future trends of the demand for highly trained manpower. A detailed study of the whole pattern of education for specialists thus shown to be required was undertaken in 1961 and produced the results shown in table XI.

TABLE XI. OPTIMAL PROPORTIONS OF HIGH-LEVEL MANPOWER IN VARIOUS BRANCHES OF MANUFACTURING IN ACCORDANCE WITH HIGHER AND LOWER REQUIREMENTS REGARDING EDUCATIONAL ATTAINMENT, 1961

Branch of manufacturing		Engineers and technicians (= 100)		Administrative personnel (= 100)	
		University	Secondary technical schools	University	Secondary technical schools
Fuel	a.	28.0	54.5	10.1	25.0
	b.	10.1	32.2	3.1	16.2
Power	a.	24.0	61.0	18.5	25.5
	b.	11.2	42.0	7.6	15.5
Metallurgy and extractions of ores	a.	24.0	47.0	6.1	32.4
	b.	13.6	36.0	3.8	20.7
Chemicals	a.	41.0	49.0	5.2	26.2
	b.	22.5	55.0	4.2	21.0
Heavy engineering	a.	16.5	62.0	2.2	30.6
	b.	4.2	39.4	1.0	14.0
Other engineering	a.	14.5	60.0	2.9	27.6
	b.	4.9	40.0	1.2	16.2
Building materials	a.	30.0	43.0	5.8	36.5
	b.	12.4	39.0	2.5	23.9
Consumer goods	a.	21.2	50.0	5.3	48.0
	b.	2.8	32.0	0.9	18.4
Food processing	a.	30.0	52.0	11.9	52.0
	b.	13.0	39.0	3.1	23.7

a = higher educational requirements.
b = lower educational requirements.

In 1961 the actual number of university graduates in technical occupations was 26 per cent. above the minimum needed according to the lower educational requirements, but covered only one-half of the number corresponding to the higher requirements. The demand for secondary technical school graduates was not met in respect of either the lower or the higher requirements.

At the same time, questions concerning education of high-level manpower are under constant discussion. On the one hand, the view is expressed that the education of such manpower should be expanded to the maximum, on the grounds that investment in men is the most effective investment. On the other hand, the more cautious opinion is heard from time to time that it is not possible to skip a given stage of development, and that each such stage requires its own particular type of division of labour. Naturally, moreover, high quality cannot be sacrificed to quantity. Further development is thus largely dependent on the extent to which standards can be raised at all levels of the school pyramid, as well as on the capacity of the national economy to absorb new specialists.

Due account must also be taken of the need to give every young graduate purposeful on-the-job training in his profession and to lead him gradually, through further training in the work process, to those work posts where he can make best use of his acquired knowledge. The process of raising the qualifications of workers thus represents an important factor in shaping the profile of society.

The methods described above are used to calculate the total number of workers in each sector, as well as the desired educational structure. From these calculations it is relatively easy to derive the number of workers required with university or secondary technical education. It is of course necessary to make this analysis not only in terms of the level of education but also in terms of the type of education at each level. Finally, data on the planned number of workers with each standard and type of education serve as a basis for planning the number of new students to be educated.

Transforming the demand forecasts into an educational plan

Transformation of the estimates of demand for high-level manpower into a development plan for schools involves—

(a) Calculating the expected increase in the demand for high-level manpower over a given period, e.g. during the years 1960-80.

(b) Adding this increase to the natural wastage of workers (through retirement, death, etc.). According to these studies the average time spent in employment by university graduates is approximately 32 years, which would correspond to an average yearly loss of 3.1 per cent. The actual natural wastage is, however, influenced by the regulations governing retirement and by mortality and morbidity trends. The largest discrepancy is due to the distorted age structure of high-level manpower; the higher the rate of increase, the lower the average age.

(c) Allowing for additional losses due to adoption of other professions, pursuit of higher studies, etc. Abandonment of employment by women is a particular problem, especially in sectors with a high rate of female employment (schools, health services). It is of course always necessary to reckon with a natural scattering of specialists according to their interests and further individual development.

In this way the over-all demand for new high-level manpower in a given period can be calculated.

When determining the demand for school education and the required number of students in the entrance grades it is further necessary to add the numbers liable to drop out in the course of study and to take into account the length of the course of study.

Auxiliary ways of checking results

In view of the complexity of the calculations involved in estimating high-level manpower demand it is necessary to check the results by other methods in order to avoid mistakes. Experience with this type of calculation shows that the more detailed methods do not always lead to better results than more global methods. In many cases detailed analyses tend to cumulate partial errors so that it is indispensable to check the results of micro-economic study by applying macro-economic proportions. Some of the methods that can be applied are briefly discussed below.

Analysis of development trends and correlations

These questions have been dealt with by numerous authors. The most frequent hypothesis is that there is a close correlation between the growth of the national income and the increase in the volume of high-level manpower. These relations must be studied in the light of the particular conditions of each economy. It should be borne in mind that two phenomena that show regular growth in time often appear to be closely correlated, even if they are not actually interdependent; such results must therefore be examined with due caution.

Some authors point, for instance, to the probability that the number of engineers will increase at the same rate as national income or labour productivity, etc. Although such reflections must also be considered with proper reserve, it is useful to apply them with a view to obtaining some sort of comparison of the proposed concepts.

In some cases recourse is also had to correlations between the development of school education and the growth of national income. However, it must be borne in mind that, besides the limited explanatory value of the growth trends, this apparent correlation reflects two quite distinct relations: the national income grows faster because of the past faster growth of qualifications, but at the same time society is in a position to invest more in school education because the national income has risen.

International comparison

An important auxiliary method in planning high-level manpower demand is international comparison, which is applicable to both micro-economic and macro-economic aspects; the following analyses appear particularly useful:

(a) comparison of the total numbers of high-level manpower and students in countries with similar levels of development;

(b) comparison of trends in numbers of high-level manpower and students and their correlation with the development of the national economy;

(c) comparison of the levels of saturation by high-level manpower of the various sectors in different countries, particularly with respect to certain typical occupations;

(d) comparison of other special parameters such as, for instance, the numerical ratio of doctors to population, teachers to students, agricultural engineers to area under cultivation, engineers to volume of industrial production, or volume of fixed capital, or electricity consumption, etc.

In all these international comparisons due care must be taken not to compare phenomena that are not actually comparable, as regards both the level and structure of the economy and the system of school education. For instance the university systems of various countries are quite different in character. The American schools differ from European, etc. In universities education is differently classified; in many countries there are two to three years of university courses, or the university education is divided into two or more stages, etc. For purposes of international comparison it is also very important to analyse the functions and levels of the secondary technical schools. In many countries with advanced-level technical schools the graduates of the latter take over a part of the functions of university-level personnel with the result that saturation by specialists is higher than might be deduced from study of the number of engineers and other university-trained personnel alone.

Population and labour force trends

An important auxiliary method is verification of the results of analysis on the basis of population and labour force trends. All analyses covering a limited period of time, long as this may be, incur the danger of systematic error due precisely to the time limitation of the study. Thus, analysis may indicate that it would be useful to double the stock of high-level manpower in ten years' time. If this should actually be done it would overburden the schools, and this during a quite short period of time (for during the first five years the number of graduates issuing is determined by the existing school population). Moreover, at the end of the period the demand might be so largely satisfied that the output of the schools would have to be limited again. This would, of course, be undesirable, and that is why it is necessary to study the patterns and trends of the labour force and base the long-term development of the school system on them.

This can be achieved only through long-term perspective studies. At the global macro-economic level a simple rule may be formulated, namely that the proportion of university and technical-school graduates in the corresponding age groups should roughly correspond to 80-90 per cent. of the proportion of non-manual workers expected in 15 to 20 years' time according to the long-term development trends.

In Czechoslovakia, for example, the ratio of non-manual workers to all workers grew from 17.6 per cent. in 1950 (estimate based on the census of population), to 22.4 per cent. in 1960; and it is estimated that by 1980 it will have grown to 32.4 per cent.

According to the rule referred to above, the number of university and secondary-school graduates should reach, in the 1960s, some 26 to 29 per cent. of the number of young people of the appropriate age groups as this corresponds to the average structure of the population 20 years hence, when today's graduates will be at the mid-point of their working life.

A similar study can also be undertaken for different sectors and types of technical qualifications, e.g. according to the expected share of engineers, doctors, teachers, etc., in order to estimate the proportion required from the appropriate age groups at the present time and thus to calculate some kind of " long-term stabilised percentage distribution of graduates " of different types of schools, which may of course differ from the actual numbers of graduates in those sectors where it is appropriate to speed up the training of particular specialists.

In these calculations it is clearly necessary to make special allowance for the status of women in society and for their rate of participation in education and in the labour force; if necessary, the calculations may be undertaken separately for men and for women in order to avoid serious distortions.

The influence of the goal of better education on the foregoing reflections

The above considerations proceed basically from the idea that the requirements of the economy are the sole criterion in the expansion of school education. This of course would be one-sided. In modern societies the average level of education is rising, this rise being only partly related to the increasing requirements of the economy as it is in part relatively independent. This means that where a primary school sufficed 30 to 50 years ago, in a similar location a secondary school may be needed today, etc. This evolution is related to the second function of school education, namely personal development, and is linked with the changing requirements in work resulting from the development of science and technology.

This very process creates new objective conditions in respect also of the economy. Even if in actual fact there were no change in the skill requirements of jobs in a given sector, the recruitment of highly qualified manpower would still have to be anticipated even if only, for instance, because of a steadily increasing proportion of exceptionally capable people graduating from the universities.

This process, together with technical progress, leads ultimately to the blurring of differences between manual and non-manual labour. In

Czechoslovakia this trend is already apparent, for instance, in the substantial increase in the level and scope of the theoretical training of apprentices (their two to three years of apprenticeship includes three days of school attendance per week). The development of this process has been widely discussed. Some hold that 12 years of compulsory general school education should be introduced for all young people, while others recommend, on the contrary, a greater differentiation of studies. It is not at all clear, either, to what extent the graduates of technical schools, or even university graduates, will seep through into highly specialised technical occupations such as maintenance, setting of particularly sensitive, complicated mechanisms, etc.

It is beyond doubt, however, that the whole complex process of education of highly qualified manpower will substantially alter the general nature of society. Planning to meet the demand for such manpower therefore requires profound economic, technical and sociological analysis.