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The relationship between technological and social innovations can be interpreted as the relationship between the productive forces and production relations. Their impact on human resources has always been a key problem for the economic sciences. Ferguson (1772-1826) who taught Adam Smith, predicted the start of the big innovation push created by the first industrial revolution which led to the decline in skills and degradation of human resources. He stated that ignorance is both the "mother of industry and of superstition" (Marx 1962).

The industrial revolution of the 18th and 19th centuries effected the victory of capitalism over feudalism and made petty commodity production economic. It divided the complicated production processes into simple elements. Before this time a long and comprehensive professional training had been necessary. Thus, the skilled labour, dominant until then, was gradually replaced by unskilled labour.

The Industrial Revolution of the eighteenth and nineteenth centuries was created by such basic innovations as the machine-tool, and steam engine, etc. Its main social impact was obviously the reshaping of human resources which allowed a rapid growth of capital and profit, but had disastrous consequences for the living conditions of the working class.

When we think of automation, microelectronics, the resource situation, and the new energy options, etc., it is obvious that today we are preparing a new innovation push, which if it is not connected with social innovations could have some catastrophical results for mankind, similar to those of the first industrial revolution. At the moment we have a contradictory situation in different parts of the world. On the one hand the old industrial division of labour is now undermined by the present technological innovations (microelectronics, automation, etc.), which have the tendency to abolish, simple unskilled labour. On the other hand, the lack of social innovations are blocking the

improvement of quality of human resources and their use for social needs and demands. This is why the issue of "innovation and the better use of human resources" is so critical.

The situation concerning social and technological innovations has arisen from the following issues:

1. The growing imbalance between natural and human resources in different world regions.

2. The inadequacy of technology for the better use of human resources, especially in the developing countries.

3. The social inability to coordinate the innovation cycle of basic and improvement innovations as barriers for the better use of human resources.

4. The necessity to improve the quality of human resources and to create the right conditions for their better use.

I understand the better use of human resources to include:

1. Securing working places for all persons who are able and willing to work.

2. Improving the quality of human resources through education and job training.

3. Creating working and other conditions for the more effective use of the higher quality of human resources and the reduction of unskilled work.

As the social conditions for the use of human resources in developing countries, market economies, and socialist countries are very different, I will mention each of these different groups.

APPROPRIATE TECHNOLOGY AND THE BETTER USE OF HUMAN RESOURCES IN DEVELOPING COUNTRIES

The shortage of natural resources is only one way of expressing the lack of innovations for the conservation of natural resources, and of developing alternative resources. On the other hand is the wastage of human resources which is a result of the lack of social innovations which could make the more effective use of human resources a decisive factor in the realisation of such technical innovations.

This means that shortage of natural resources is only one side of the coin; the wastage of human resources is the other.

The development of human resources in the next fifty years is shown in Figure 1. It must be clear that without social and technological innovations it will not be possible to maintain reasonable living conditions to the end of this century for our

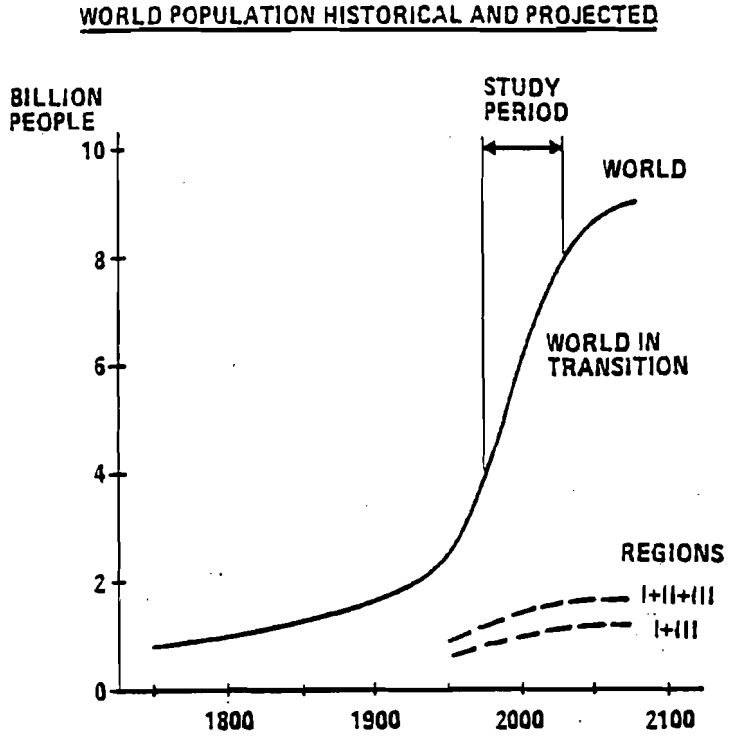


Figure 1. World population historical and projected.

Source: (Häfele, IIASA).

six billion people, and for eight billion people in 2030. The dimension of this challenge is clear, if we realize that today two thirds of the world's population do not enjoy such living conditions. In the next fifty years we will have both the doubling of the world population and extreme imbalances in population growth between the world regions. In 1975 70% of the world population was living in the developing countries and by 2030 this could well be more than 80%. One important issue in these countries is to improve the conditions for the better use of human resources and to identify innovation options which could improve the GDP per capita ratio. Technology transfer without social innovation and a satisfactory level of appropriateness is not able to do this.

We can recognize the size of this problem if we realize that in the developing countries we have more than 300 million able-bodied men and women currently unemployed. Assuming that each working place costs 10,000 dollars in a developing country (in the US $20,000), then 150 billion (10^9) dollars per year will be required to secure enough working places in the developing countries over a 20 year period (Norman 1978). This is a lot of money, but then again it is less than half the annual world expenditure on armaments which was 350 billion dollars in 1975. This situation will become even worse in the following decades because then we will need a billion or more new jobs for the children who are born now (Club of Rome Report 1979).

At present, developing country technologies are not only characterized by their low average levels, but also by great disproportionalities in internal technological development. Sophisticated firms and producers, often multinational corporations, are islands in an ocean of preindustrial production. These sophisticated parts of the national economy are not integrated into the national division of labour, but are isolated groups, more closely linked to foreign than to national control. The production of the modern sectors in developing countries tends to be oriented toward the demands and needs of the companies of the developed country. Standing apart as they do, the sophisticated sectors of developing economies often play a disruptive role in the national economy. They not only fail to accelerate economic development, they also often tend to destroy the traditional technological basis without creating a new technological basis able to meet national needs in the medium- and long-term perspective. These sophisticated parts of the economy play the role of a tool in maximizing profits and exploiting the difficult human resources situation in these countries. The concept of "dual economy" is a reflection of, and to some extent an apology for, this situation, but it is not able to show the way for the establishment of an integrated national technical basis, with a productive relationship between different technological levels.

Table 1 shows us the different technological levels which exist in each country. In all countries lower level systems A to C exist side by side. But in the industrialized countries the production volume of A and B technology is very low and the different technological levels function as parts of an integrated national economy. The concept of intermediate technology is largely oriented towards furthering semi-mechanized technologies (Class B), but this cannot help us meet the objectives of the

Table 1. Levels of technology

Level		
A. Technology	Manual drive, task execution, control and logical functions	a1. Drop spindle a2. Spinning wheel a3. Improved spinning wheel
B. Technology	Substitution of mechanical for human energy (power tools)	b1. Spinning wheels with external drive power
C. Technology	Substitution of the mechanical for human energy and task execution	c1. Selfactor c2. Ring machine c3. Open-end spinning
D. Technology	Complete substitution of mechanical-technical for human operation, including control and logical functions	d1. First generation automated equipment d2. Second generation automated equipment

developing countries to increase their standards of living. It is also not possible to jump from technology level B to D. In most cases the developing countries have not enough investment, skilled workers and infrastructure to use the D technology. This technology is also not appropriate for creating a national technical basis capable of producing enough goods for the population and for securing employment. The developing countries are faced with the problem of allocating their limited resources and investment between the different levels of technology in a way so as to optimize their utilization of domestic natural and human resources for producing the stream of goods and services necessary to meet the demands of their population. Therefore one cannot say what is the appropriate technology from the stand-point of a single company, branch, or territory--one must look at the economy as a whole and resource situation and accumulation potential. This is the reason why the prevailing approach, one in which one only looks to the features of a single technology or to technologies of a specific technological level, is inadequate. The developing countries need an efficient mixture between the different types and levels of a technology. True, there currently seems to be a deficiency of technologies which utilize natural and human resources of the developing countries; what are often referred to as "soft", small scale and low capital technologies, which make extensive use of local labour and raw materials. These kinds of technology are important in the present stage of development and it is necessary to put greater attention to developing such kinds of technology. But this could only be a part of the technical basis of a country.

The problem is to make such kinds of technologies into an integrated part of the national technological basis. Both extreme approaches of "small is beautiful" and "big is wonderful" are not appropriate. This basis must include hard and soft, large and small, high and low technolgies in appropriate proportions in order to be able to improve the economic efficiency of the countries and to help them to use the benefits of the international division of labour. (World Employment Conference 1976)

Table 2 shows the impacts of different technological levels on the satisfaction of national needs in the developing countries. The results of our evaluation are the following:

1. Governmental technology policy should try to find the right mixture between technology, a, b, c, and d.

2. The findings are that technology b1, c1, and c2 must have a dominating role. This results from the benefits and criteria of expenditure.

3. We see also that it is necessary to strengthen the capabilities of developing countries to go from technology a and b to c3 and d1 and to develop technology from level c and d, which are particularly important for the developing countries.

The main concern at present of government technology policy must be the stimulation of flow of labour from a and b technologies

Table 2. Impact of different technology levels on the national economy of developing countries.

Criteria	Levels of Technology a1	a2	a3	b1	c1	c2	c3	d1	d2
Effects on Growth of Production	0	1	2	2	2	3	3	3	3
Better Satisfaction of Basic Income Needs	0	0	1	1	2	3	3	4	4
Employment Effect Capital Growth Savings	3	3	3	3	3	2	1	0	0
Effect on Labor Skills	0	0	0	1	2	2	3	4	4
Impact on National Division of Labor	0	0	0	1	3	3	4	4	4
Use of National Resources	4	4	4	3	3	3	2	1	1
Integration in National Market	4	4	4	4	3	3	2	1	1
Accommodation on National Condition	4	4	4	4	2	2	1	0	0
Linkage to International Developments	0	0	0	0	1	2	3	4	4
Sum of Benefits	15	16	17	19	21	23	22	21	21

Expenditure Criteria	Levels of Technology a1	a2	a3	b1	c1	c2	c3	d1	d2
R&D Intensity	0	0	1	1	2	2	3	4	4
Demand to the Infrastructure	0	0	0	1	2	2	3	4	4
Optimum Production Scale	0	0	0	0	1	2	3	4	4
Import Share	0	0	0	1	2	3	4	4	4
Sum of Expenditure Criteria	0	0	1	3	7	9	13	16	16

Evaluation:
0 without importance
1 little importance
2 medium importance
3 high importance
4 very high importance

Source: Haustein et al (1979).

(small scale production on a manual basis), to the c and d technologies (large scale production on a technologically advanced basis). The a and b technologies must be strongly coupled to the c and d technologies. Conservation of the "dual economy" in the developing countries will not help them solve their problems. Means of attaining integrated developments include the following:

1. For domestic industry (on the c and d technology level) to develop and produce appropriate technology and equipment for a and b sectors of national economy.

2. Social innovations for new organizational forms of small scale production and productive cooperation between small scale production units and large scale factories.

3. Development of education system and eliminating illiteracy. Generally the educational system needs to be made more production oriented. Such educational innovation is crucial because the old educational systems, whose main aim was conservation of the traditional social structures are to a large extent consumption oriented and incapable of preparing the new generation to cope with the problems resulting from the process of industrialization and from global development. The UNESCO projections by region for 1980 show an illiteracy rate of 73% in Africa, 63% in South Asia, and 23% in Latin America. Illiteracy is closely connected with poverty. The 20 poorest countries have an illiteracy rate of 80%. The number of illiterate people has grown in recent decades. There were 700 million illiterate people in 1965, 800 million in 1975 and it is projected that there will be 820 million in 1980 (UNESCO 1976, Bataille 1975). However the elimination of illiteracy is only one side of the coin. The other is that we need not only literate people but also people who are able to cope with social and technical innovations. Educational systems which only transfer the knowledge of one generation to another, or more precisely, from the upper classes to the working classes, are not able to prepare the new generation to cope with social and technological innovations and these are crucial not only for survival but also for the radical improvement of their social, economical and cultural situation. For this we need a new type of learning which not only develops the ability to read, write and count, but also develops the ability to cope with social and technological systems, and to change their content and structure according to the needs of man. Such kinds of innovative learning could be a very important factor in the solution of the crucial problems of our world.

4. To support the small scale, labour intensive, export oriented sectors and to stimulate selective export lines based on large scale production.

5. To establish technological consulting points and service feasibilities (especially for agriculture and handicrafts).

6. To step up the R & D expenditure for technological development of small scale industry.

7. To promote stimulation measures for the technical development of final product industry through brokerages, credit, guaranteed markets, etc.

These measures aim to integrate small scale production into the national socio-economic and technological basis. Only through integrated development can national natural and human resources be effectively employed to attain the economic growth needed to meet the needs of the population.

The main problem for developing country planners is therefore to seek a combination of different technological levels which will lead to well proportioned development of the technical basis. This combination could have the following features:

1. Use of surplus manpower for the production of labour intensive production means.

2. Concentration on the import of advanced technology (level c and d) on key operations of the core processes. There the processes should be based on labour intensive technologies.

3. Use of the limited stock of advanced equipment for demonstration and education.

4. Transposition of old production means to small scale firms.

5. Promotion of high standards of quality strategy in means of production.

6. Establishment of a closed technological cycle from raw materials to final products on the basis of national division of labour.

7. Avoidance of nonintegrated investments and technological conservatism.

The precondition for such a development policy is the reconstruction of the current "world economic" order and to stop the brain drain from the developing countries to the developed countries (Bhagvati 1976).

BASIC AND IMPROVEMENT INNOVATIONS: DIRECTIONS FOR THE HUMAN RESOURCES ALLOCATION

Understanding the mechanisms of basic and improvement innovations is crucial for the better use of human resources, especially in the developed countries. These mechanisms create an innovation cycle which has an important impact on the use of human resources. The main function of basic innovations is to give a

push to the existing system of technology and to change it into a new system with higher efficiency. This way basic innovations open new fields and directions for economic activities, which in turn create a new efficiency potential for the development of production. The main function of improvement innovations is to absorb this efficiency potential through balancing and improving the given system. This is done through incremental changes in the product performance and cost reduction through the improvement of the production process. I will try to demonstrate the usefulness of this approach with the following mental model (Figure 2). First we must develop an index of relationships between innovation and production efficiency.

$e_i(t)$ is the efficiency coefficient of production units i, which are adopted innovations at time t;

$e(t)$ is the coefficient of average efficiency for the production system as a whole at time t;

$x = \frac{e_i(t)}{\bar{e}(t)}$ is the coefficient of the efficiency of the innovation process, which is adopted from production units i, in comparison with the average efficiency of the system as a whole.

The ratio between the two efficiency coefficient changes over time. Its variation creates five very different situations for innovation management.

Figure 2 shows the five different stages of the innovation process:

I. This is the starting point for the basic innovation. The invention becomes applicable and it is possible to start

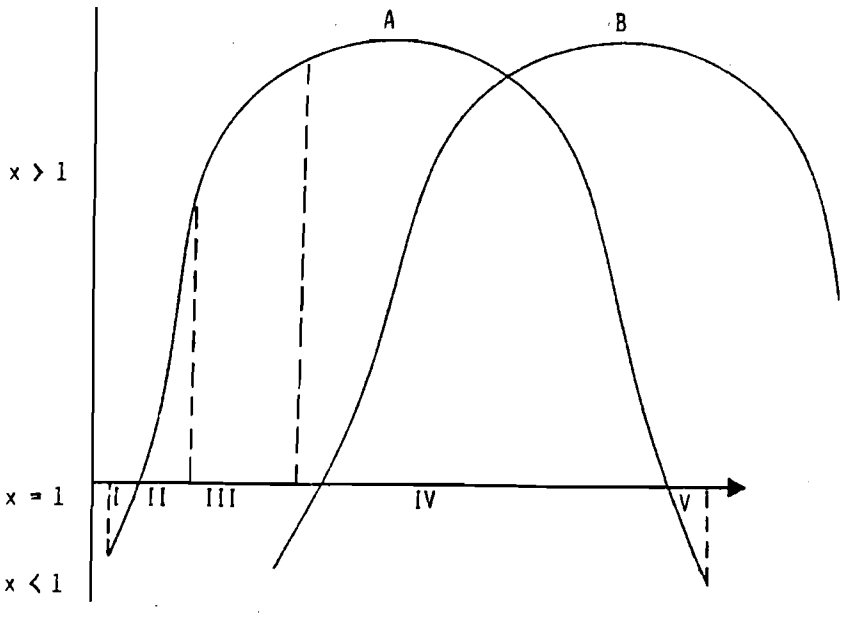


Figure 2. Relation between efficiency of an innovation process and efficiency of the production system as a whole, over time.

production. This is a fluid situation in which we have many technological options for the realization of the basic innovation and it is not clear which of the different technical options will be successful. A typical example of this was the starting up period for the motor car, where there were a large number of possible technical options available. In this period the market share of new innovations is low, the costs are very high and the product is far from being competitive. We also have a large retention of investment for the creation of working places because most companies have a "wait and see" strategy being unwilling to play the pioneer role. Here the role of government innovation policy is crucial, they must encourage the pioneers and provide information about the future innovation fields.

II. In this situation basic innovations become more and more efficient. The organization which applies the basic innovation first gains a high marginal efficiency in comparison with the average efficiency. Many other entrepreneurs will try to imitate and improve on the basic innovation, but the decisive factors for the rise in marginal efficiency are the new qualities, functions, and features of the new product. Those who adopt the basic innovation first are able to protect their knowledge of the basic innovation. The decisive factors in this period are the highly qualified experts who have the knowledge to use the basic innovation, and on the other hand, because of the protection of the know-how concerning the innovation, the shortage of qualified people with the special knowledge and experience to apply it. The market share of the innovation is not very high and the investment and employment effect is relatively low.

III. Here not only the new properties and features of the basic innovation play an important role in the increase of efficiency, but also the improvement innovations which are devoted to improving both the quality of the product and the efficiency of the production process. Improvement innovations tempt more and more firms to participate in the use of the basic innovation. The result is the extension of the market share and acceleration of the investment and employment effect. In this period process innovations become more and more important. They reduce the cost tremendously and raise the labour productivity. Through the possibility of extending the market share, the positive working place effect will rise to a higher level.

IV. Here the improvement innovations play a dominant role. Cost reduction and increase of labour productivity are the main factors in raising marginal efficiency. But the growth rate of marginal efficiency began diminishing because the market share of the basic innovation approaches saturation point. In this period the replacement of the work force becomes dominant and the elimination of working places is the most important result of this phase.

V. In this period marginal efficiency becomes lower than average efficiency. The improvement and incremental innovations are not comparable with the diminishing average efficiency because of the higher resource cost and infrastructural expenditure. The result is that many activities will be devoted to securing the market position through product differentiation, supervision of design changes and product performance. These kinds of innovation are really pseudo-innovations, because they are not improving efficiency and have only a very small effect on the number of working places. Over a long period they create dangers to the number of available jobs.

The main thing that we learn here is that in using human resources we need to coordinate the innovation cycle. This means starting a new basic innovation at the time when another basic innovation is approaching saturation point, and thus eliminating working places. However, this kind of coordination demands planning and coordination of the innovation process, as the result of real social innovations.

The IIASA Energy Study confirms this assumption. The findings show that such traditional resources as oil, coal, and gas, which currently make up more than 90% of our primary energy supply will not be able to satisfying more than 65% of our energy demand in 2030. The remaining 35% will have to come from new resources such as nuclear power, solar energy, coal liquefication, biogas, etc. These are all basic innovations which need a lot of investments and which create new working places. The IIASA Energy Study shows us the increasing share of investment for energy (Figure 3), and the deterioration of the primary energy GDP coefficient (Figure 4). If we wait too long for such basic innovations then we run into the danger of not having enough time to realize them. We are also in danger of wasting human resources.

THE IMPROVEMENT IN QUALITY OF HUMAN RESOURCES AND THEIR USE

Most of the developed countries have had a significant improvement in the quality of human resources in the last two decades. On one side the higher quality of human resources is an important precondition for technological and social innovation, and on the other it is not possible to appraoch a higher quality in human resources without social and technological innovations. The creation of social conditions in which the quality of human resource can grow and become a decision social and economic force is a crucial point for the further social progress of mankind. In a socialist country like the GDR, full employment and improvement in the quality of human resources are two important features of the social policy.

The number of working people in the GDR has risen consistently in spite of the fact that the total population has decreased (Figure 5). This was mainly caused by two factors:

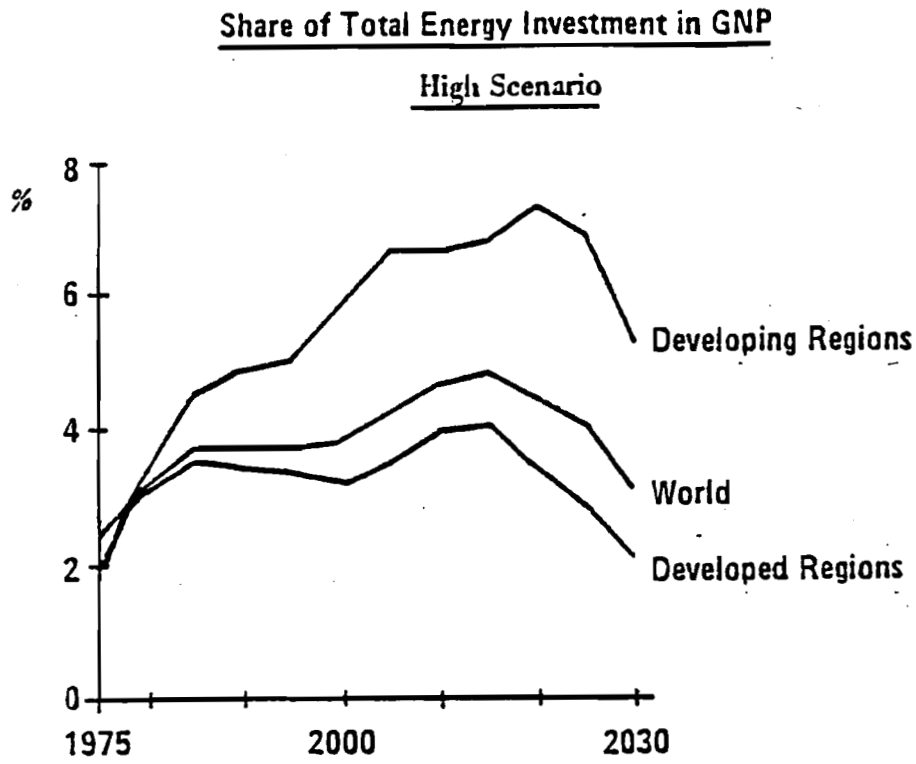
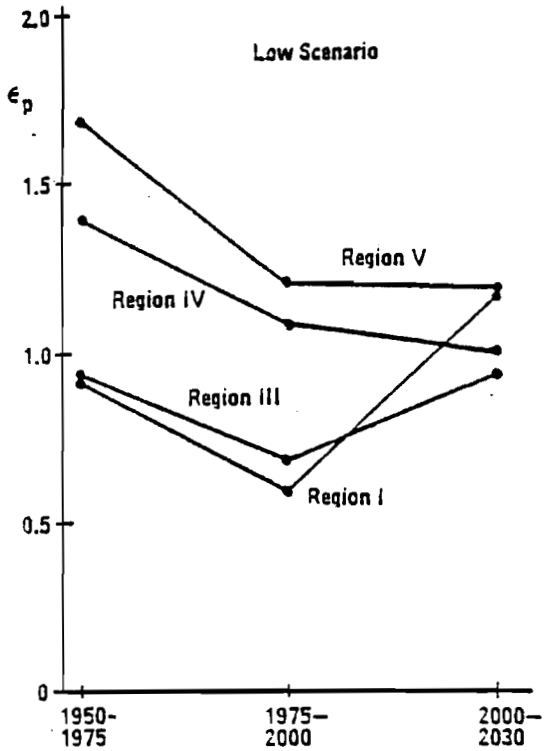


Figure 3. Share of total energy investment in GNP.

Source: Häfele, 1979



Region I North America
Region III W.Europe, Japan, Australia, New Zealand, S.Africa Israel
Region IV Latin America
Region V Africa (except Northern and Southern) South and Southeast Asia

Figure 4. Primary energy - GDP coefficient.

Source: Häfele, 1979

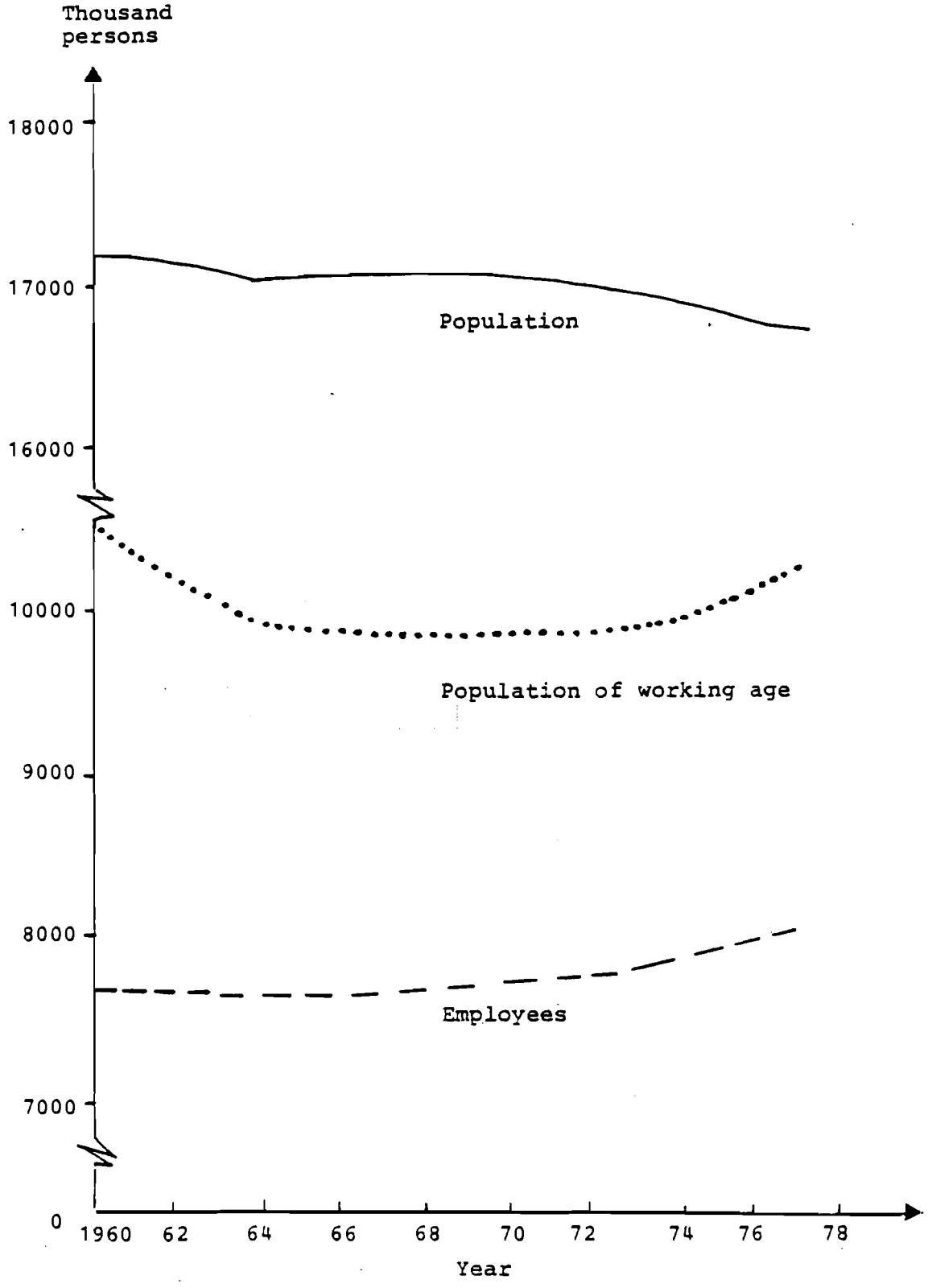


Figure 5. Development of population, population of working age, and employees in the German Democratic Republic.

1. The development of possibilities enabling women to work, both in full and part-time employment. The level in the employment of women has steadily increased and is now approaching 87%, its natural constraints.

2. The increase in life expectancy meant that our country was faced with the necessity of creating working places for older people who might wish to continue working after approaching retiring age. In the GDR 18.1% of pensioners use this possibility, 25% of them are male and 15% female. Through this the number of employed people increased by more than half a million.

With the increasing degree of employment it was possible to extend the free time of all employees, especially through such social measures as:

a. Reducing the working time for all employees, especially for shift workers and mothers with more than two children.

b. Implementation of the five day working week.

c. Extension of vacation time.

d. Extension of maternity leave.

e. Extending mother-care for women with more than one child.

The free time which was obtained by these measures is equivalent to the working value of one million people as under the working hours in 1960. This is equivalent to 35 working days per employee, per year, in comparison with 1960.

The reduction of working hours to this extent was possible only through the fact that the increase in employees was connected with the increase in labour productivity. More than 90% of the production growth in the period from 1962 to 1978 was caused by the increase in labor productivity, which was in turn connected with better use of capital and material resources. The basis for this was the increase in the scientific-technological level of production. One important factor in the scientific-technological basis of our production was the rise in the quality of labour resources.

In a socialist society the improvement of the quality of human resources plays a double function. On the one hand, advanced education for all proves to be an essential target for a socialist society, the true wealth of which is the full development of the social, productive, intellectual and aesthetical faculties and capabilities of all members of society, and on the other hand an essential factor for the enhancement of social labour productivity and the effectiveness of national economy. Step by step the concrete shaping of these two components of the role of education brings about a merger of intellectual and physical labour, the emergence of a new type of labour.

In the economy of the GDR the quote of graduates of technical schools and universities increased from 6.7% of employees in 1962 to 17.2% in 1977. During the same period the quota of skilled workers and foremen rose from 33.6% to 48.2% and the quota of semi-skilled and unskilled workers declined from 59.6% to 24.6% (Figure 6). More than 90 percent of pupils who passed through the 8th form continued their schooling in the 9th and 10th forms and claimed their constitutional right to receive vocational training.

It can be foreseen that up to the end of this century the quota of graduates of technical schools and universities will increase to about 20-25%, the quota of skilled workers to about 65%. The quota of semi-skilled and unskilled workers will decrease to about 10-15% (Korn and Maier 1977).

Therefore today's educational outlays are by no means of slight importance when it comes to the distribution of national income, as was actually the case even in the developed industrial countries at the beginning of this century. At that time, they amounted to only 1 to 2 percent of national income, but today in countries like the GDR, 7 percent of national income is devoted to education.

The increasing importance of qualified labor in the production process can be seen in the rising volume of educational funds (human capital) in the GDR economy. The educational funds (human capital) are the expenses of socialist society for education and qualifications, materialized in the qualification level of the employees. The educational funds in the GDR increased from 66.5 billion marks in 1962 to an amount of 250.8 billion marks in 1975. That is about one quarter of the funds of fixed assets (material capital) of today's GDR economy (Figures 7,8,9).

In the period between 1962 and 1975 the growth rate of educational funds (human capital) was essentially higher than that of the funds of fixed assets (material capital). During this time the educational funds increased to an amount of 227%, compared with an increase of 165% of the funds of fixed assets. The research funds in the material sphere--the research expenses materialized in the scientific-level of production--increased to an amount of 333.5%. Educational funds, production funds, and research funds are the technological funds of a society, which gain more and more importance for the scientific-technical revolution. In 1972 the technological funds of the GDR consisted of 73% production funds, 21% educational funds, and 6% research funds (Figure 10)(Haustein 1976).

The high efficiency of social expenditure for education and qualifications can also be seen in the close connection between the increased qualification level and a growing contribution of the innovator's movement ot the efficiency of the national economy. The benefit of the innovator's movement (more than 50% of prime cost reduction in the national-owned economy of the GDR result from it) per unit of educational funds was 2.5 times higher in 1971-1975 than during the period of 1960-65.

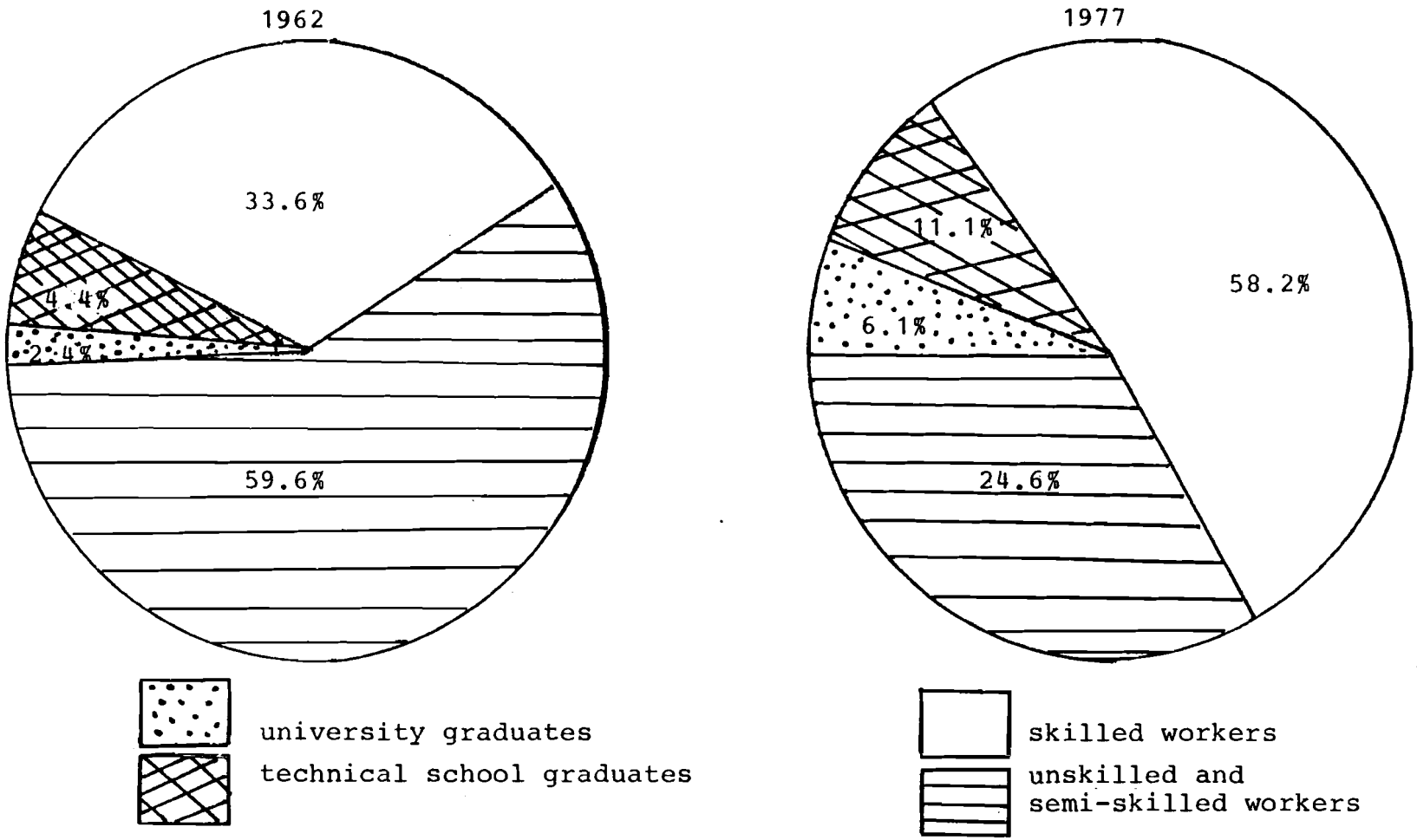


Figure 6. Qualification structure in the socialist economy of the GDR (%).

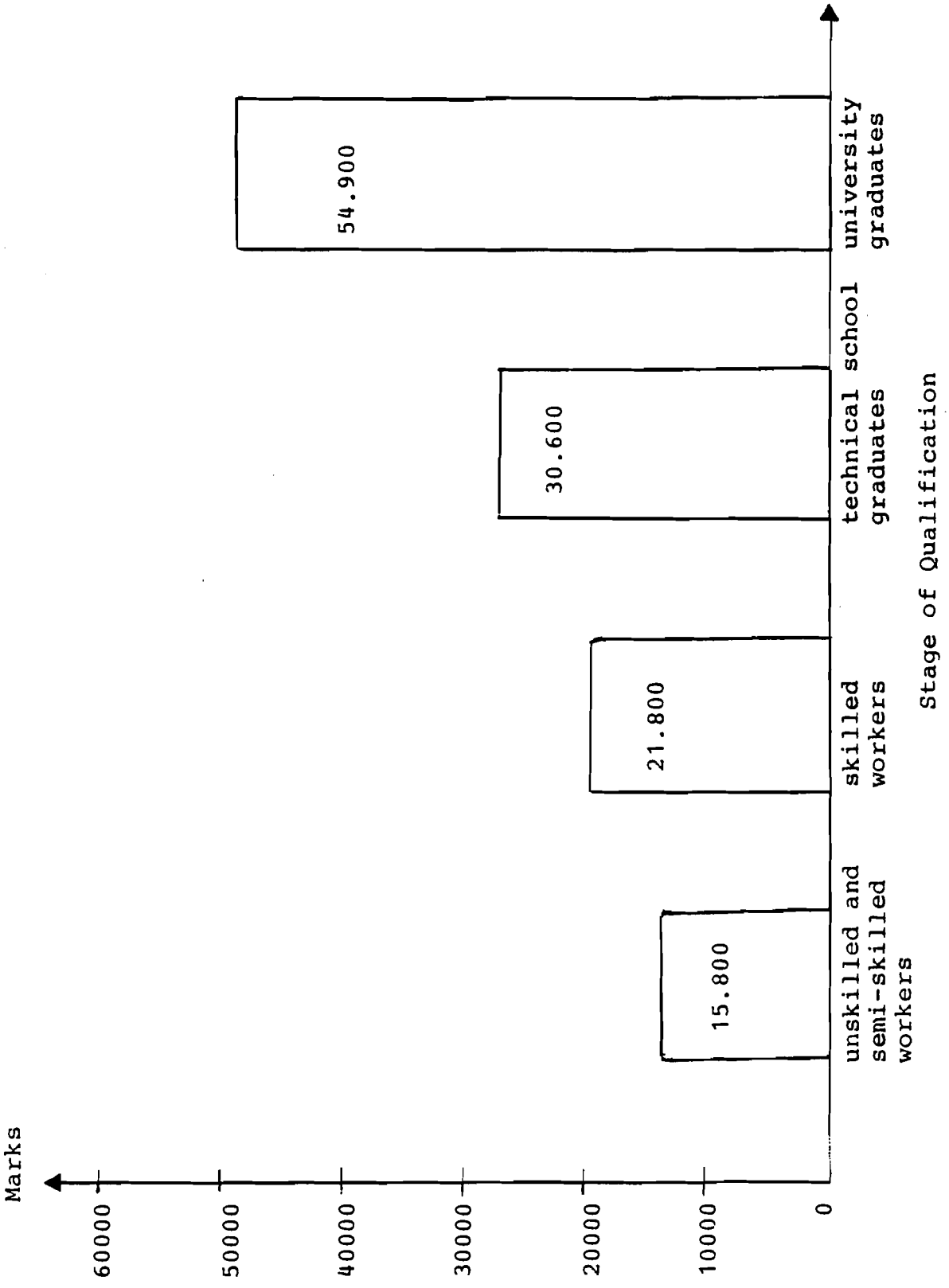


Figure 7. Education funds per person in Marks (1977).

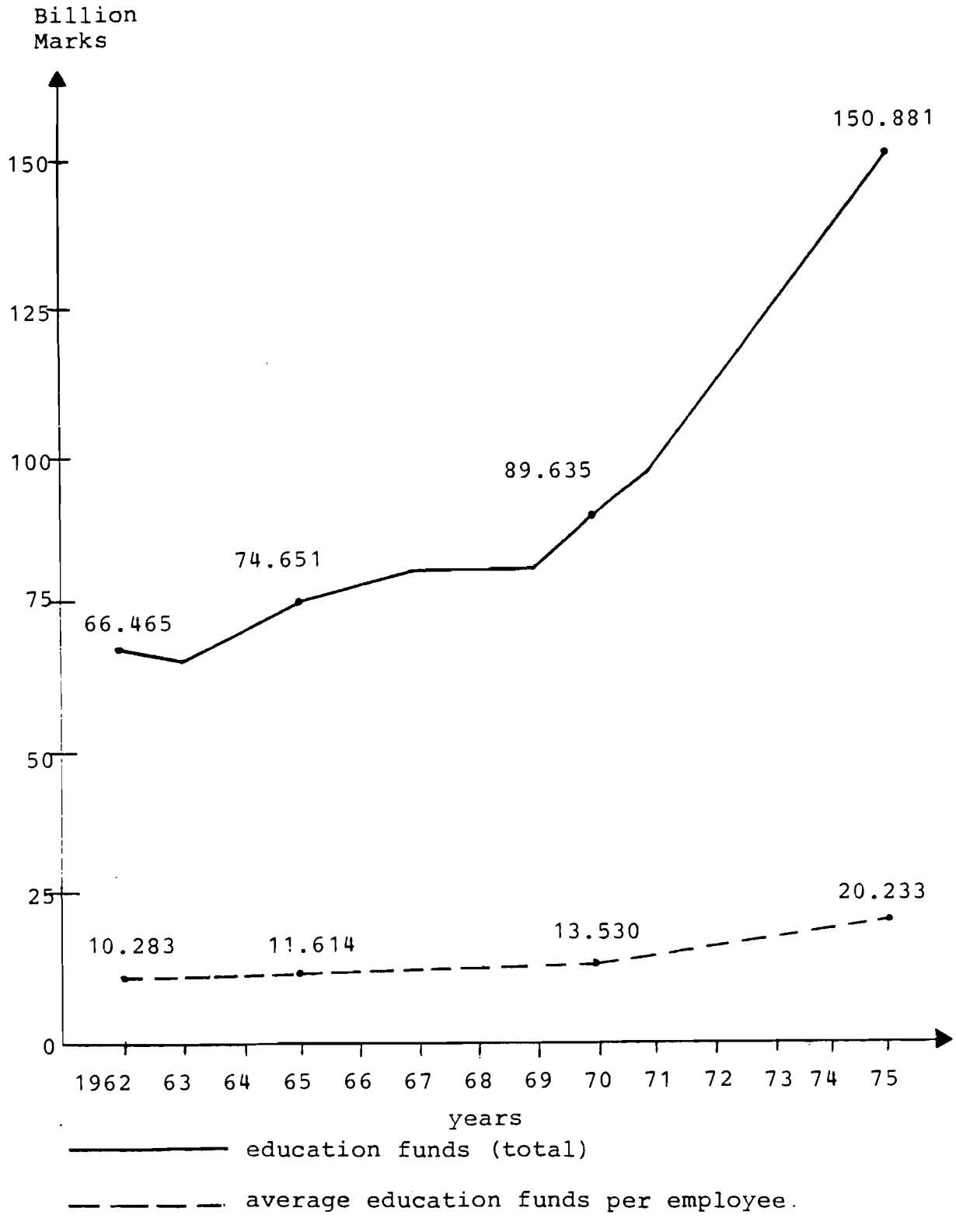


Figure 8. Education funds (human capital) in the socialist economy of the GDR (billion Marks).

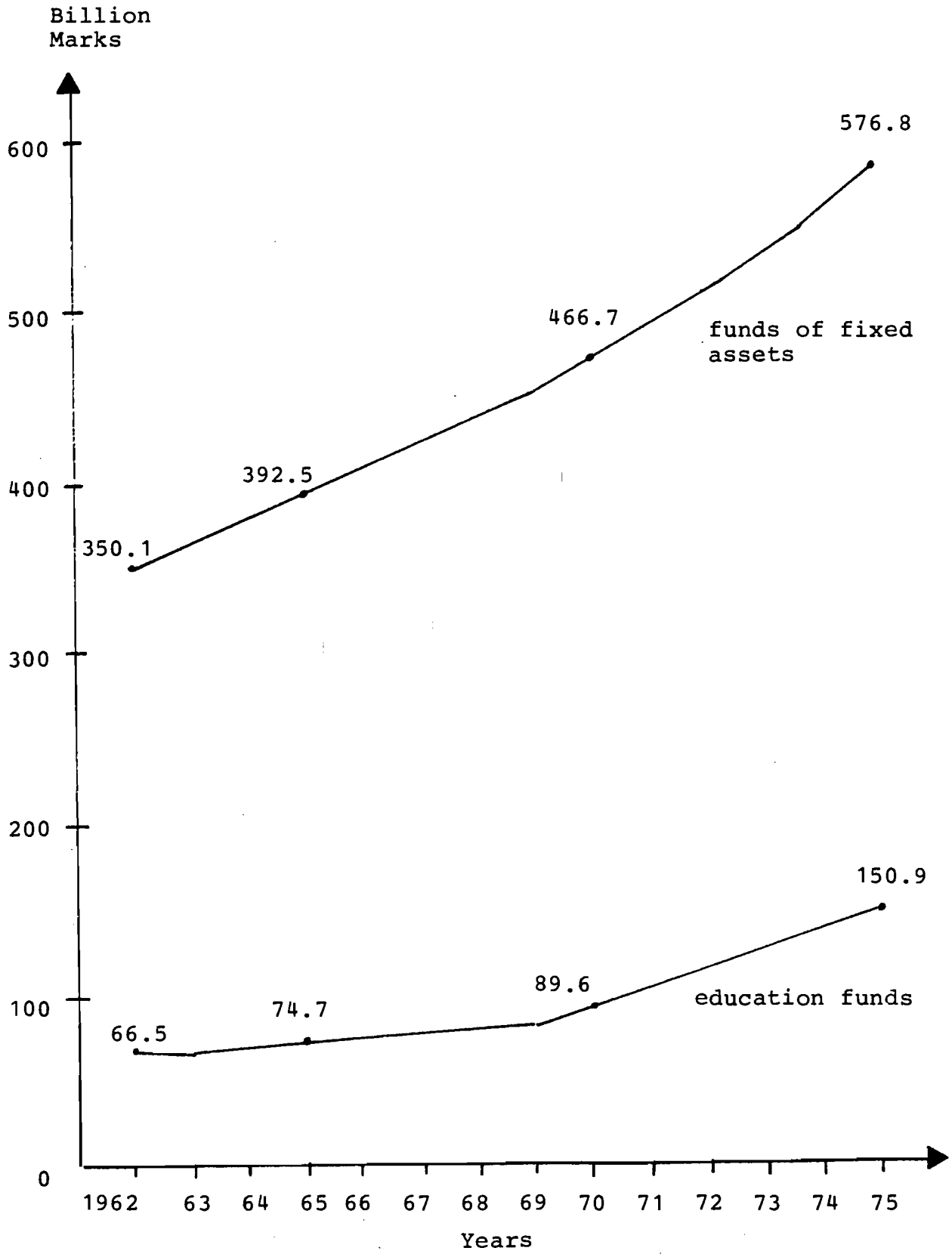


Figure 9. Development of education funds (human capital) and funds of fixed assets (material capital) in the socialist economy fo the GDR (Billion Marks).

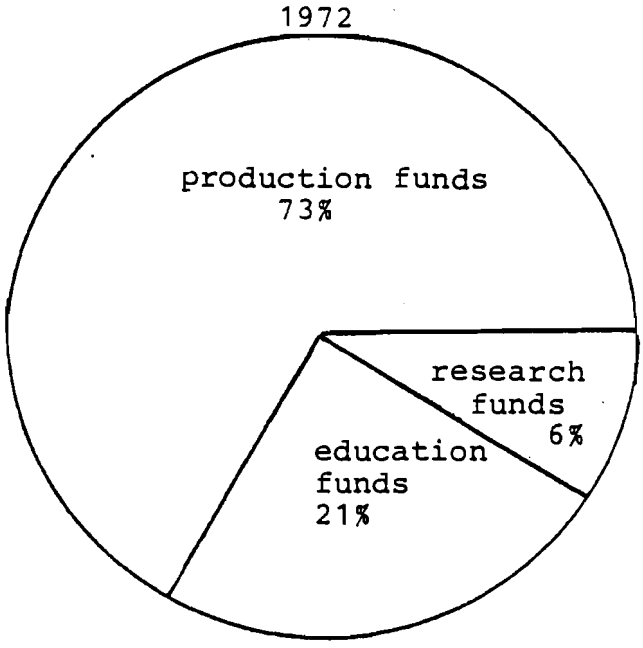


Figure 10. Composition of the technological funds of the GDR economy (%).

Figure 11 shows us the connection between the adoption of innovation and the level of qualification. In 1976 alone 1.6 million employees participated in the innovator's movement with a benefit of 3.6 billion marks. The main concern of this innovator's movement is certainly the improvement- and rationalization-innovations.

The increasing importance of qualified labour in the production process is an essential productive and social power. This power must be utilized in a better way than at present for both the development of production and for the further formation of the quality of life. Thereby the demands of production and way of life become more and more interlaced.

This means realizing a structure policy that utilizes the high level of working people's qualifications in order to decrease the raw material and energy intensity of production by a higher rate of intelligence intensity. An important problem thereby is the employment of working people according to their qualifications and the use of these qualifications to implement and control technical innovations. Only by an effective use of qualified labour can the productive potency created by educating and qualifying people be transformed into real and productive development forces. Therefore the employment of qualified people in the national income producing spheres--that means in the material production--has great importance.

By this industry could nearly double its share in the total of university graduates in the period 1962-1975. In 1962 every tenth university graduate of the GDR economy worked in industry, today it is every fifth. Building industry, transport, and the post and telegraphs could even more than double their share in the total of university graduates. A similar development can be seen in the field of employment of technical school graduates (Figures 12 and 13).

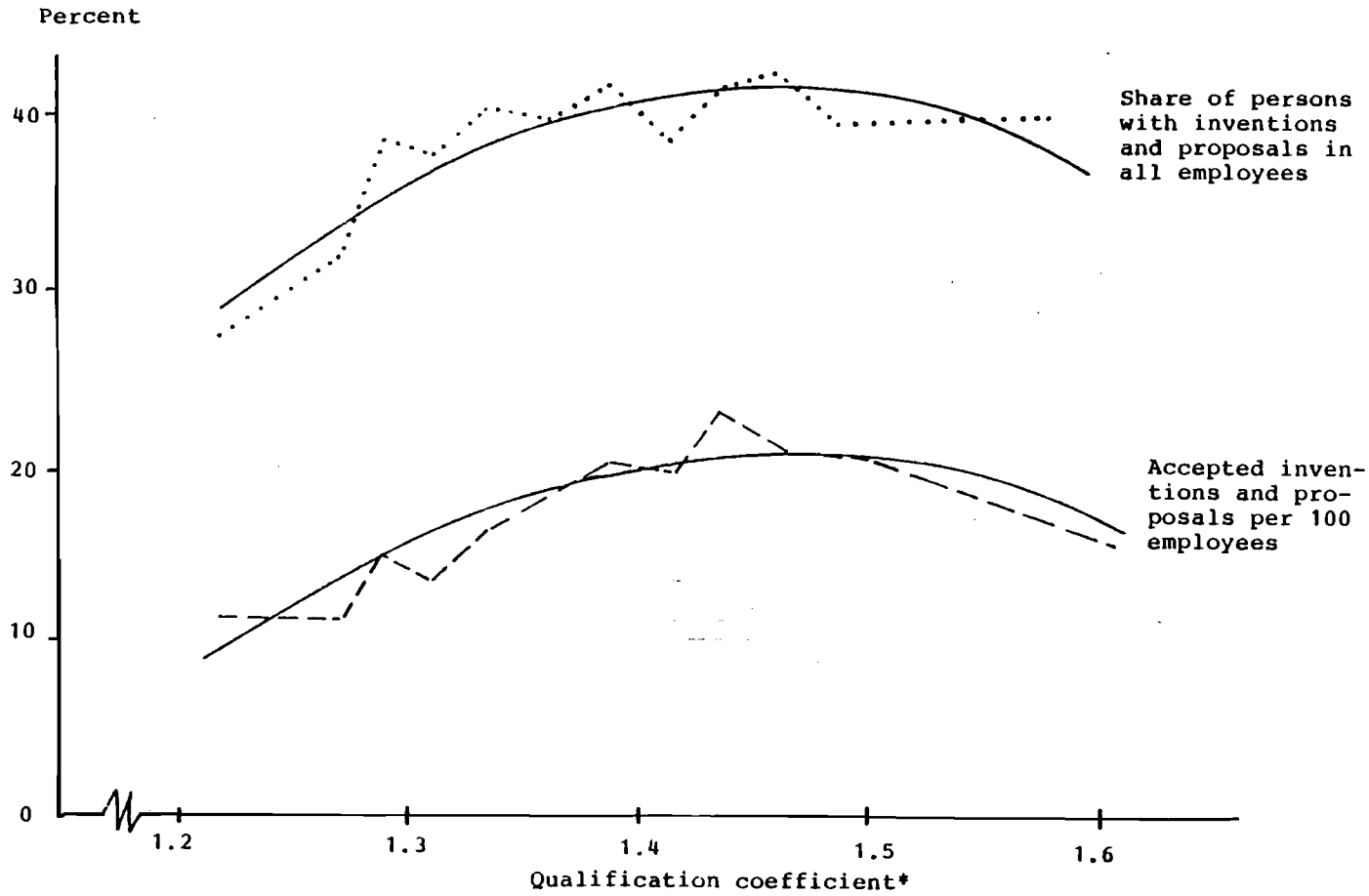


Figure 11. Average qualifications coefficient: the use of adopted innovations per 100 employees and the share of innovations over all employees.*

*The qualifications coefficient is estimated by the reduction of highly skilled work over unskilled work. As weights for the different groups of qualified work we used the reproduction costs of labor forces with different levels of qualification. For the methodology of estimating the qualification coefficient see Maier, Ludwig, and Wahse (1972).

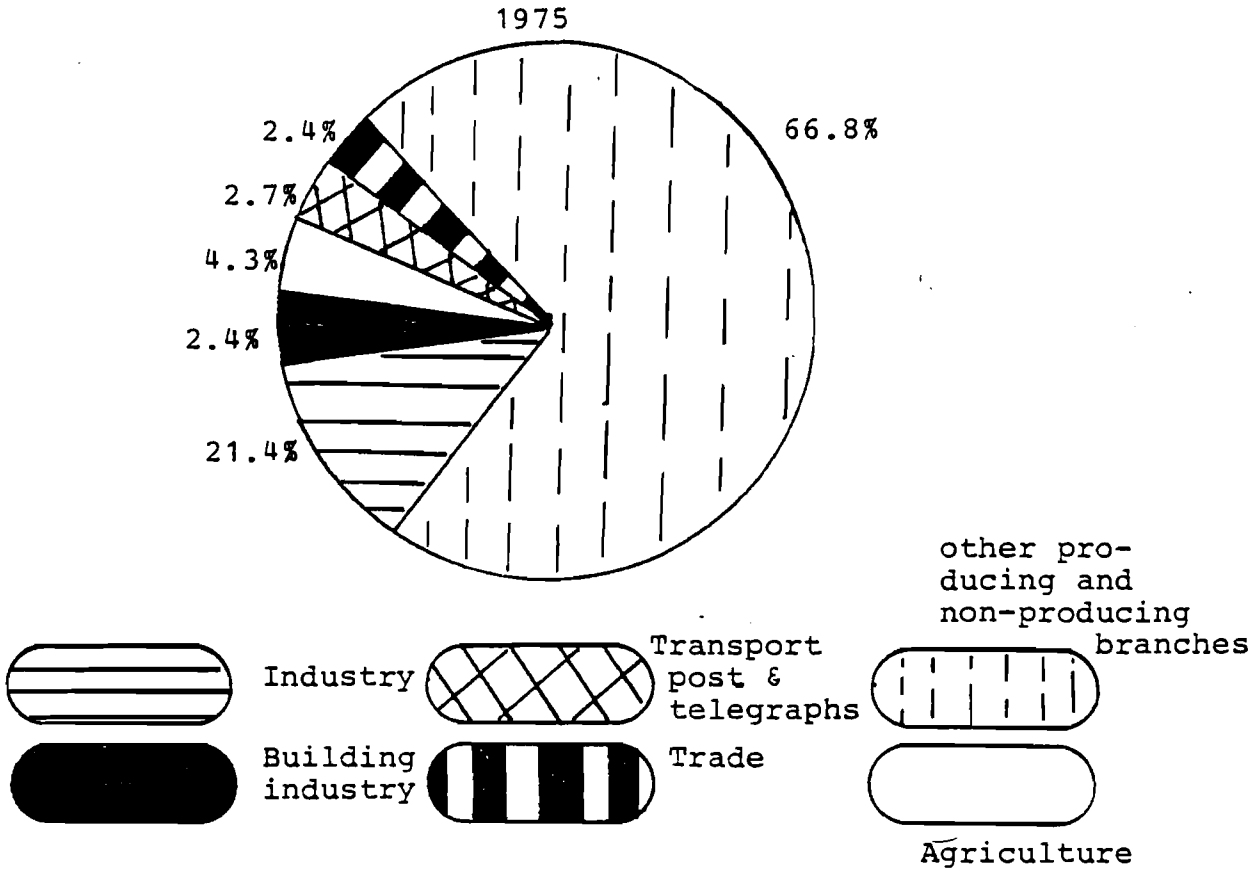


Figure 12. Distribution of university graduates to branches of socialist economy of the GDR (%).

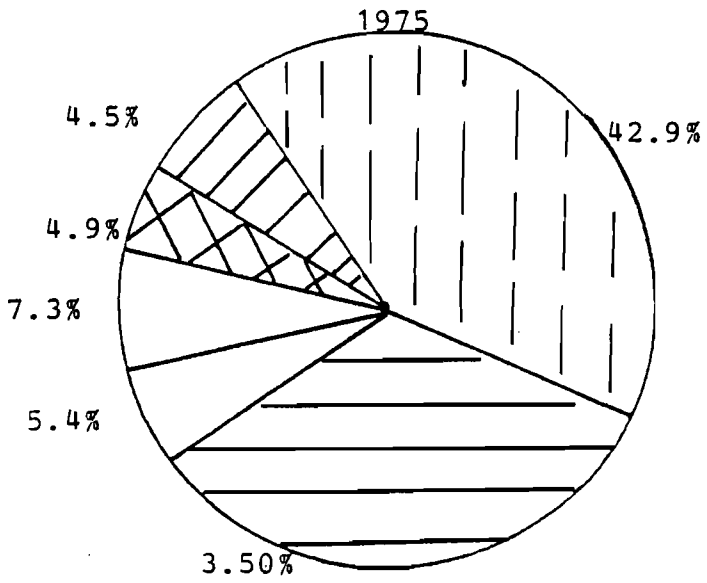


Figure 13. Distribution of technical school graduates to branches of socialist economy of the GDR (%).

The impact of technical innovations on the use of human resources is not without contradictions. We want to demonstrate this with the case of automation and mechanization.

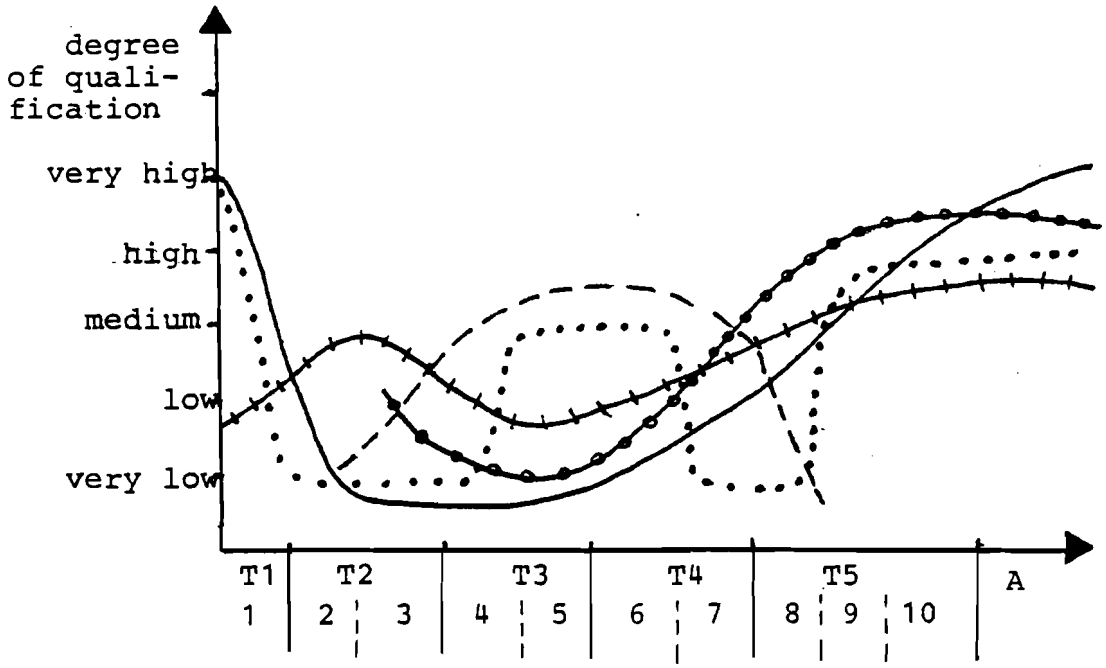
The assumptions about the influence of automation and mechanization of the structure of the labour force are very different. Figure 14 shows the different assumption in the literature. The findings of our analysis in the industry of the GDR shows us another situation. (This analysis includes more than 2.5 million workers of the GDR.) We found an S-curve in the technological demand for qualifications which is shown in Figure 15.

In Figures 16 and 17 we find the highest share of semi-skilled and unskilled workers at manual (T1), fully mechanized (T3) and partly automated working places (T4). The highest share of skilled workers can be found at partly mechanized (T2) and fully automated working places (T5).

It can be seen that even if the requirements to manpower differ widely depending on the level of technical development the basic tendency is the rising importance of qualified labour in connection with the increasing degree of mechanization and automation.

The conclusion of this finding is not that we have to make the level of qualifications of the workers appropriate to the changing technological demands on the different technological levels. Such technocratic solutions are inappropriate for the nature of the socialist society. The problem is to use the higher quality human resources also in situations in which the technological demand for qualifications is relatively low. They must be employed for the creation of conditions to eliminate unskilled working places.

The changes in the technical demand for qualified labour forces indicate the fact that the socialist society faces the never ending task of overcoming the contradiction between the existing structure of work places and the emergence of new work places. The solution of this contradiction in the interest of society and the individual worker is possible on the basis of a high level disposability and mobility of workers on all levels of qualification. Disposability of this kind can only be produced on the basis of a sound general education and the development of specialized capabilities, in order to arrive at a continuous appropriation of new knowledge, to assimilate it, to expand it, and to apply it in an effective manner. There are no limits to the development of these capabilities on the basis of comprehensive general education, but to gain purely factual knowledge does in fact meet with objective limits. Views and corresponding practical endeavours which aim to reduce the school to a pure supply of factual knowledge and to overburden students with empirical facts, to give them encyclopaedic knowledge are generally paid for by decreasing faculties for independent logical thinking. If the supply of knowledge is not connected with the development of the capability to independent thinking, with the production of sound educational motives, then exactly these faculties remain



1. Simple manual tools, hand and foot driven machinery and equipment.
2. Energy driven machinery tools.
3. Manual steered and regulated machinery.
4. Manual steered and regulated machinery or equipment, mechanisms for subsidiary processes.
5. Long distance controlled machines or equipment, manual and long distance steering or regulation, mechanisms for subsidiary processes.
6. Through regulating mechanisms driven and controlled machinery and equipment, mechanized subsidiary processes.
7. Machinery with flexible program steering, mechanized subsidiary processes.
8. Machinery with flexible program steering, subsidiaries are steered manually by workers.
9. Subsidiary process machines with flexible program steering.
10. Machinery and subsidiary processes of great complexity with flexible program steering and the possibility of self optimization of the steering program.

A. Stages of technological development, features of production tools.

——— Blauner (USA) – – – Bright (USA) • • • Kern/Schumann (BRD)

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Figure 14. Different opinions from the literature about the influence of mechanization/automation on the qualification structure.

Source: Langen et al. 1978.

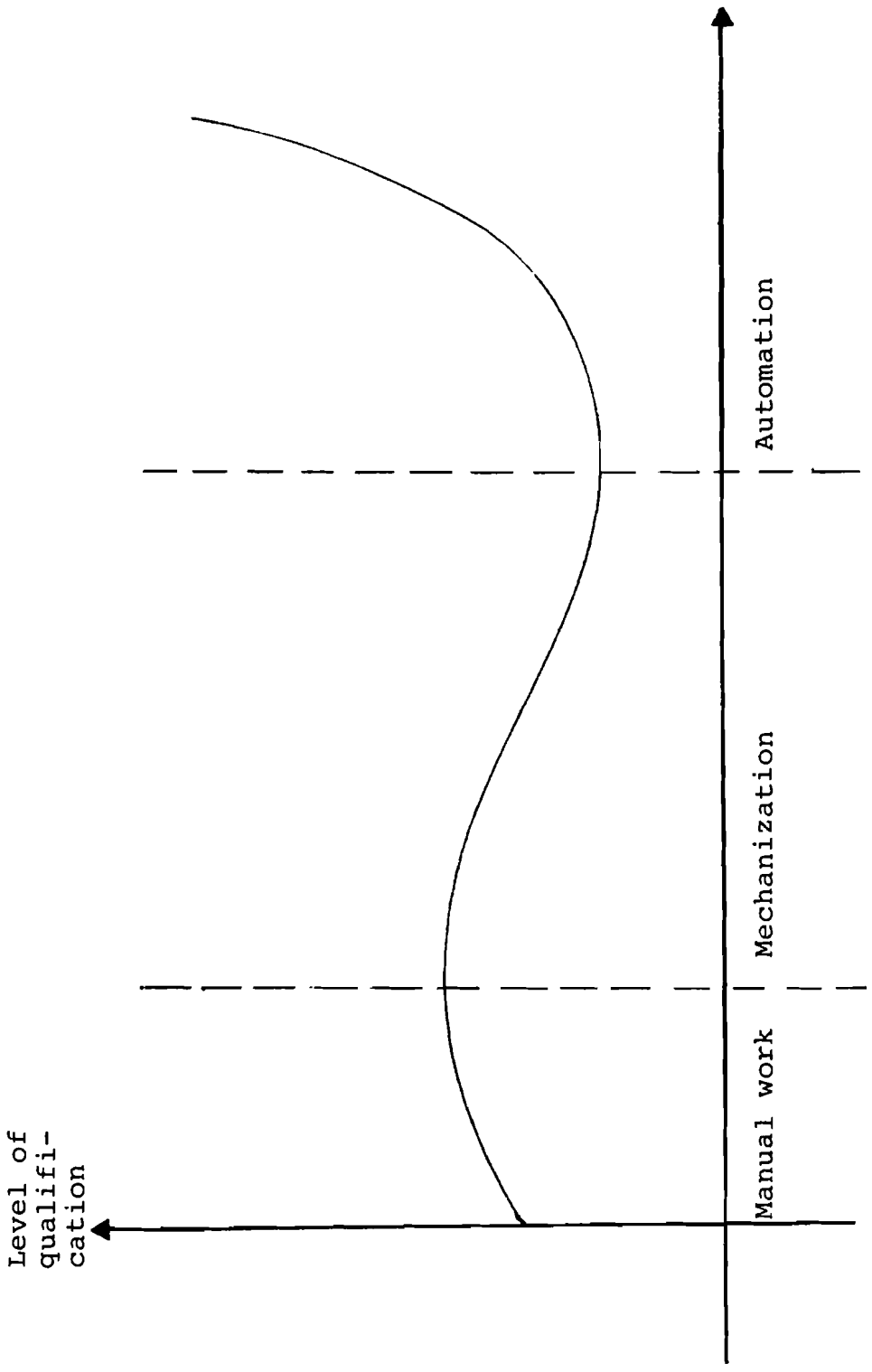

Figure 15. Development of the technological demand for qualifications in the different stages of technological development.

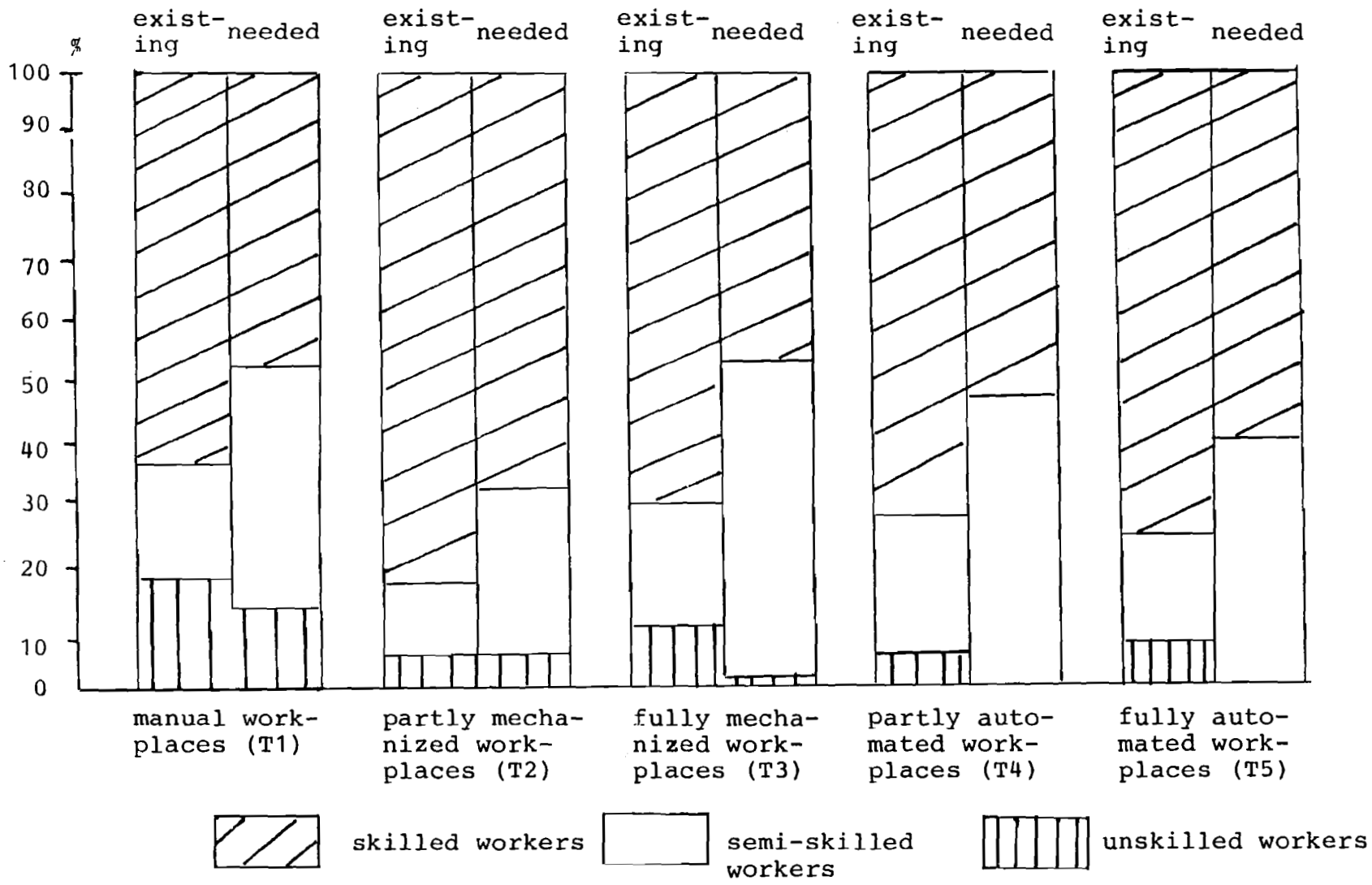

Figure 16. Existing and needed qualification structure of production workers in various stages of technological development in industry (%).

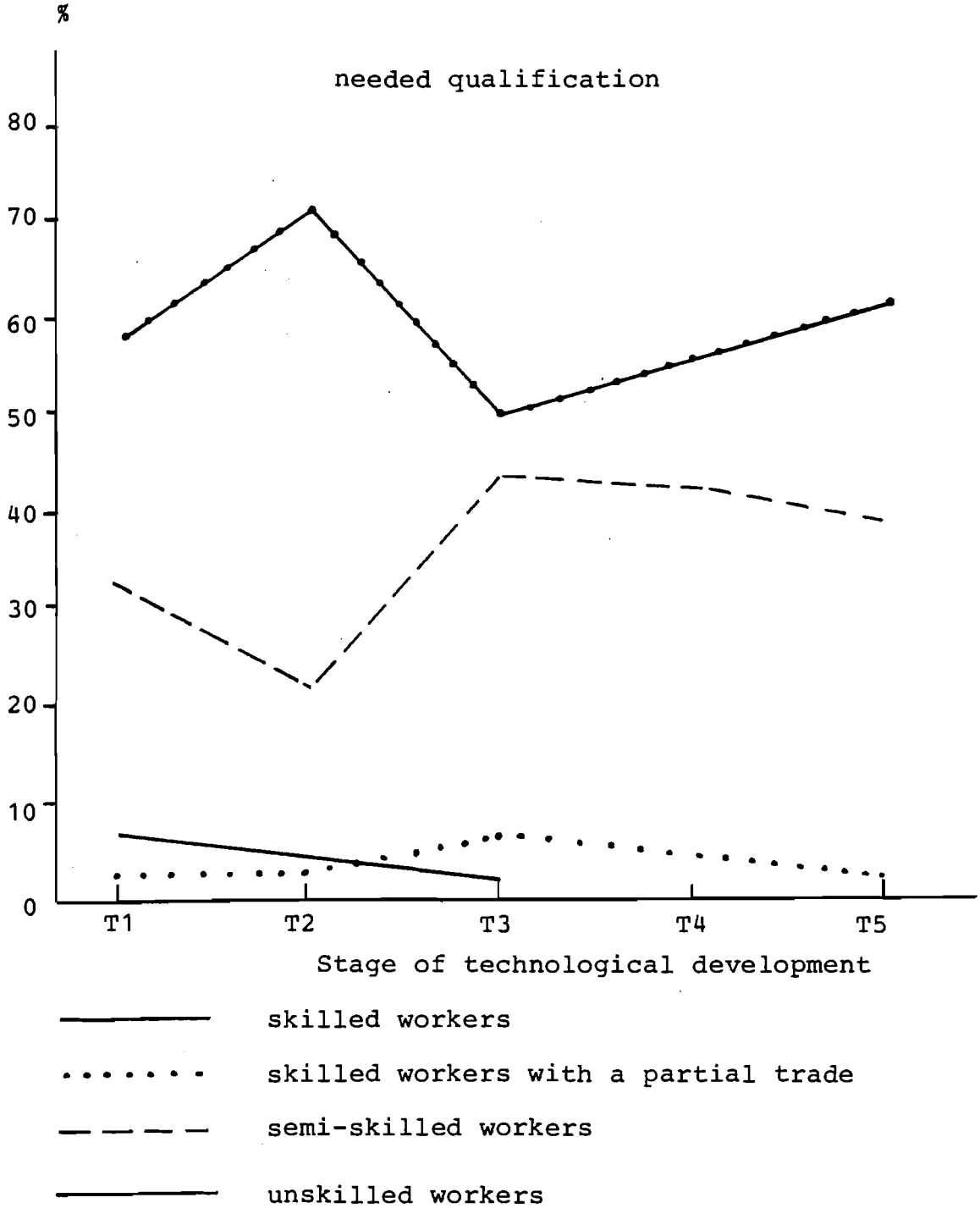

Figure 17. Qualification structure of production workers depending on stages of technological development (%).

Source: Langen (1978).

underdeveloped, which are decisive for dealing with social and technological innovation. Innovative learning demands the development of the capability of independent and creative thinking and an optimistic attitude in participating in the solution of technical, social and cultural problems.

There is a close connection between the increase of qualification requirements and the decrease in hard physical work. The relatively high share of production workers who do not work with machines and equipment, show the great importance of mechanization in the present stage of development. Mechanization does not only essentially contribute to abolishing hard physical and unskilled labour but creates decisive preconditions for automation. The relatively high share of unskilled workers on automated equipment results from the fact that at present automation does not completely cover the whole production cycle. At present mainly directed machining tasks are automated so that feeding and emptying of automatic machines as well as the connection to other sections of the production cycle has to be done manually.

In increasing the importance of qualified labour, attention has to be paid not only to mechanization and automation of the main production processes but increasingly to auxiliary and subsidiary processes. Here especially mechanization and automation make it possible not only to release manpower on a large scale but also to increase the importance of qualified labour essentially. This is particularly true for the mechanization and automation of processes of transport and turnover.

For the better use of thequality of human resources it is necessary that management and planning have to be concerned with the following problems:

1. At the stage of projecting and constructing new equipment, targets have to be set as to what degree unskilled and hard physical work can be reduced and what kinds of qualifications are needed. In this field there are real sources for an increase in efficiency. The exact determination of contents and extent of necessary qualifications can contribute essentially to raise productivity.

2. Planning and realization of investments requires a well-timed determination of the necessary abilities and knowledge for operating new equipment. The enterprises must be given programs for additional training, as far as possibile in a programmed form. Underestimation of this aspect of investment preparation leads to economic losses such as breakdowns, etc. with an amount of some hundreds of million marks a year.

3. The high quota of women in unskilled labour is still a fact. Therefore everything has to be done to prevent the negative effects of differentiation in qualification requirements concerned with scientific-technical progress. By means of organization of scientific work everything has to be done in order to reduce such operations which

only require simple and unskilled work, as well as reducing the monotony of work, and one-sided physical and psychological burden. It is necessary to analyze and generalize experiences in organizing job rotation and in improving the metnal climate within working teams. In cases where equipment still requires one-sided and unskilled operations, large scale possibilities have to be found and realized for creating substantial operations by applying new combinations of labour, of planned job rotation and of job enlargement.

4. The better utilization of the increased education and qualification level does not mean blocking such lines of technological innovations which are connected with a reduction of qualification requirements. Doing so would mean conserving mentally complicated technologies which are difficult to master. So for instance, qualification requirements for operating the first computer generation was incomparably higher than the present qualifications necessary for operating equipment with microprocessors. Simplification of operation and reduction of the training period are without doubt an essential aspect of scientific-technical progress and substantially contribute to its rapid extension and to an increase in economic efficiency. The reduction of mental requirements can of course, have positive consequences for the development of personality. With that a considerably higher number of working people are able to gain the necessary qualifications for operating automatic equipment in the shortest possible time, and so to have knowledge in various fields. In order to emphasize the problem: the way we have to go is not to conserve mentally difficult operations, but far more, by means of organizing work--which takes the increased qualification level into account--we have to give working people the possibility of using their physical, social and mental abilities in various ways in the process of increasing the efficiency of labour. Management and planning of production have to guarantee such a scientific work organization that brings into action modern technology as well as an increased qualification level of working people for the growth of social labour productivity and efficiency.

It is necessary to consider the different situations which skilled workers have to manage in the various stages of mechanization and automation. In mechanized production the qualification of a skilled worker is needed permanently for producing a special product. In this case qualifications are a precondition for the machining operation. Though in automated production skilled worker qualification is an absolute precondition for production, it is not directly needed for carrying out the typical operations in automated production, such as steering, regulating and controlling. So skilled worker qualifications in automated production are not permanently used. In order to prevent a permanent undercharge of skilled workers scientific work organization has to

find new kinds of division of labour and with this to enrich and enlarge the work (Langen 1977).

So scientific work organization has to guarantee:

-- formation of new kinds of combinations of labour for creating substantial and ambitious operations,

-- increase of responsibility of working people in management and planning of the production process,

-- planned job rotation,

-- possibilities of identification with the final product,

-- balance between physical and mental requirements,

-- job enlargement,

-- possibilities for communication and cooperation,

-- possibilities for realizing ideas and initiatives,

-- pleasant working environment.

An important component of securing a higher quality in human resources is the creation of conditions for lifelong learning for working people. In the past, the educational system was able to confine itself largely to the role of transfering the existing knowledge of the active generation to the following generation. It concentrated its efforts on that stage in the life of a person which precedes the adult stage. One learned and taught "for a lifetime", and therefore in the early stages of life. This approach is outdated. Today, a modern educational system is unthinkable without conditions for the education of already trained personnel. Thus, for instance in the GDR, about 20% of the outlay for education is devoted to further training, and almost every fourth person employed in industry takes part in an organized training course (50% of them are women). Without doubt a permanent in-service training will in future play an important role in the system of needs of a socialist society and in the further development of the socialist way of life. Recently adult education has essentially contributed to the increase of the number of skilled workers and of university and technical school graduates. 30 to 40% of today's skilled workers in the GDR got their qualifications by adult education. Every third university graduate and every second technical school graduate got his diploma by way of external studies. Taking the now reached high qualification level into account, adult education will in future take up its actual function, reproduction of the existing qualification level (Figure 18).

Under the conditions of speeding up scientific technical progress, we are confronted with the obsolescence of knowledge. The scale of necessary requirements for in-service training can be illustrated by the following consideration: assuming a 3%

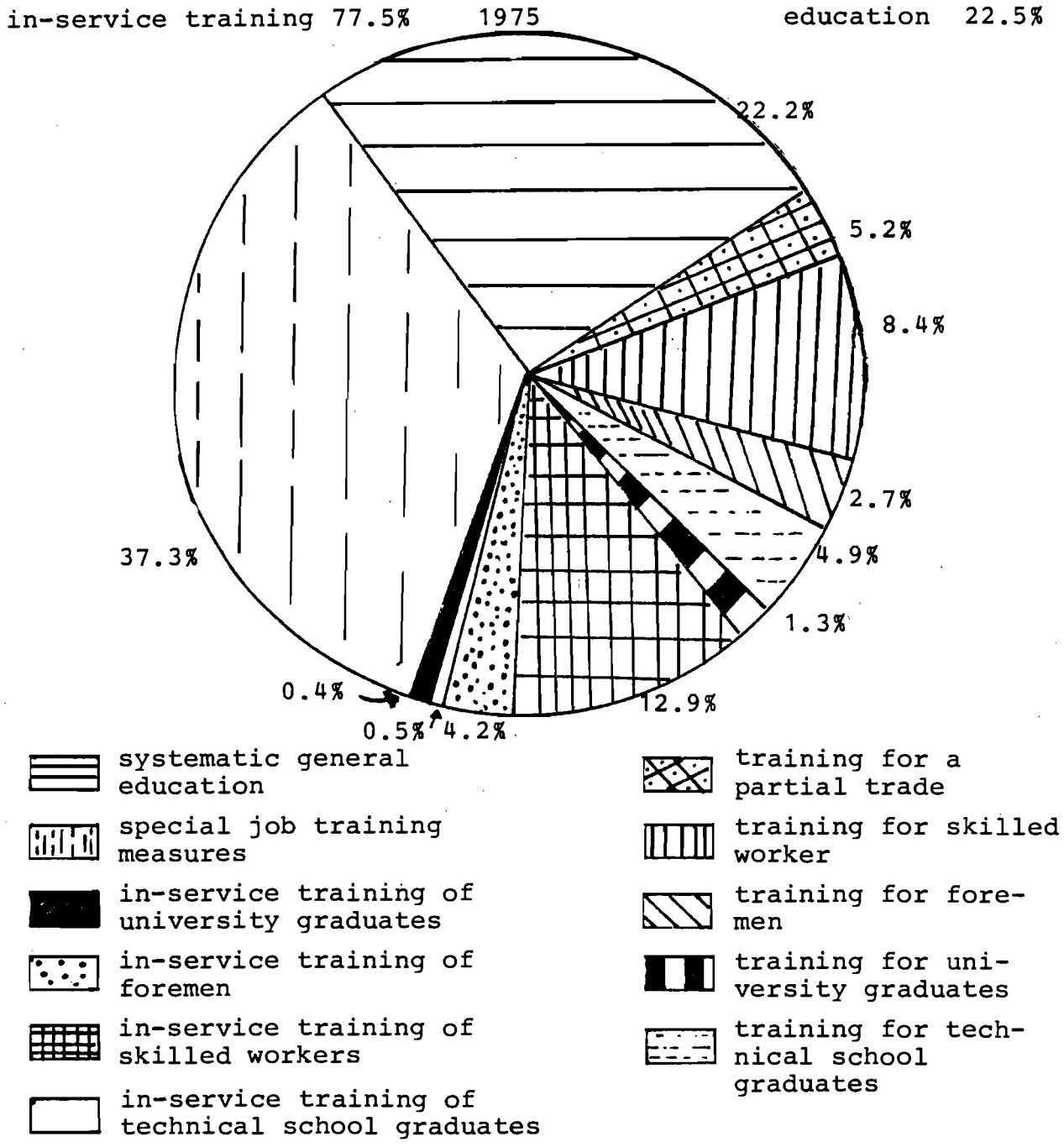

Figure 18. Various measures of qualification in adult education in the socialist economy of the GDR (only industry, building industry, transport, posts and telegraphs (%).

progress rate of knowledge, you come to the following expenditure of time needed for in-service training during the whole period of working life: skilled workers 2.8 years, technical school graduates 6.7 years, university graduates 7.8 years. This means that 10% of the working life period of skilled workers, 24% of that of technical school graduates, 28% of that of university graduates (Figure 19). Of course there exists no "law of increasing expenditure" for in-service training. But these figures show how important it is to take measures in time in order to meet the process of obsolescence of knowledge and to care for an interlacing of education and work processes so that in-service training will get an adequate place in the socialist way of life. All this emphasizes the importance of general education which sets the preconditions for a permanent interlacing of existing knowledge with new knowledge, for a permanent transformation of existing knowledge to the socially necessary level by in-service training. This emphasis also gives more consideration to innovative learning, to improve the ability of man for self-education.

The requirements resulting from the rate of progress of knowledge show that we need an effective combination between three components of in-service training:

-- in-service training in an organized form,

-- in-service training according to own interests and initiatives,

-- in-service training by an active participation in various forms of the intellectual-cultural life of society.

Of course these three forms are mutually connected. They influence each other to a very high degree. The organized form of in-service training can only fulfill its actual task if it is based on the other two components and vice versa if they support it effectively. At present the organized form of in-service training in the GDR is realized to about 80% during working hours. That does not only bring along high economic expenditure in direct and indirect forms, but it is furthermore connected with another. danger: if in-service training is too tightly bound to the direct operations and tasks of the working place, it cannot fulfill its stimulating functions for participation in intellectual-cultural life. Therefore organized in-service training has not only to give working people knowledge directly applicable to working tasks, but also to contribute to the development of political and philosophical thinking as well as to the enrichment of intellectual and cultural life. At the same time new possibilities for the two other forms of in-service training have to be found by a higher efficiency of the spare time of working people.

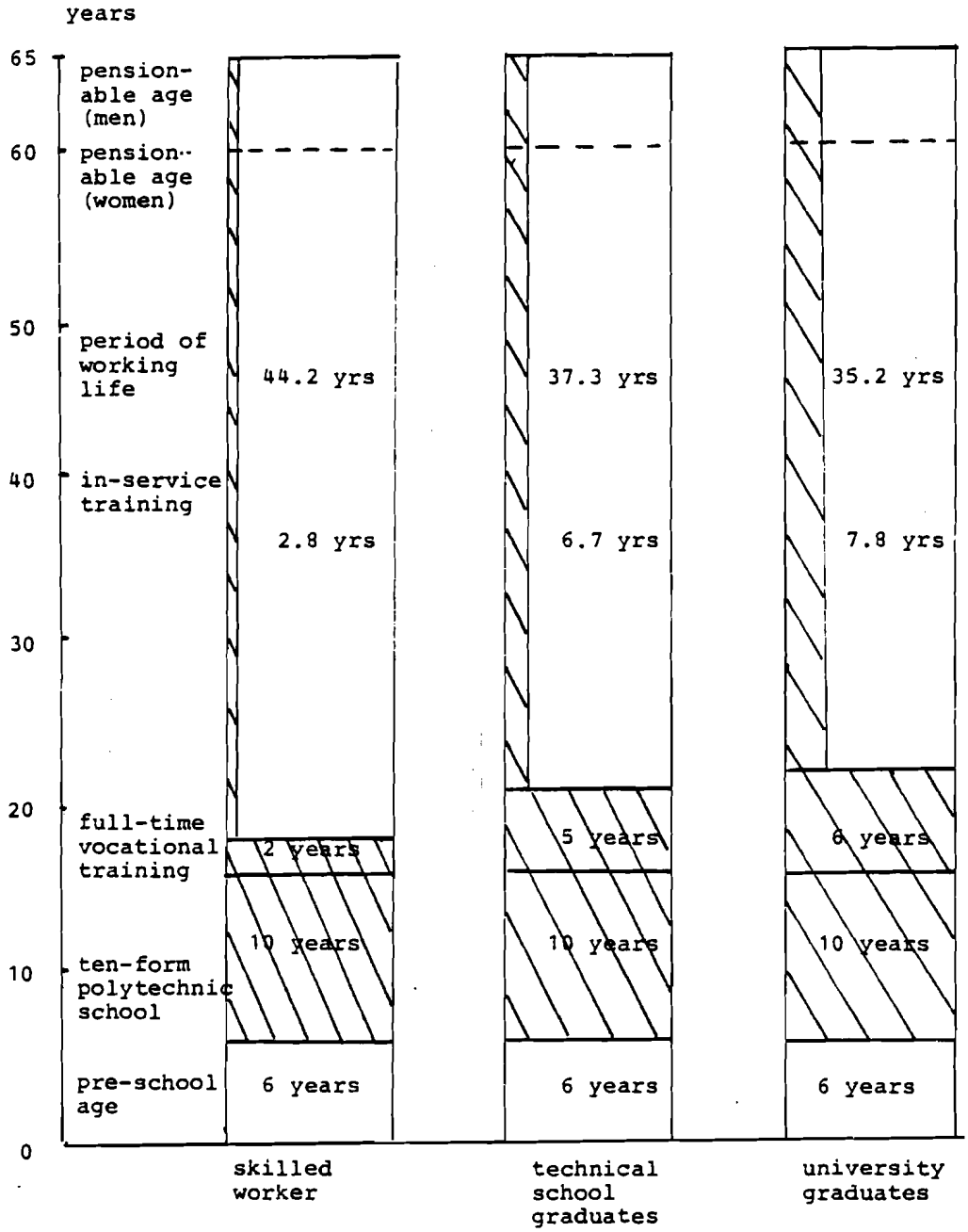

Figure 19. Full time education, in-service training and period of working life of qualified employees.

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